National Universities Commission

Core Curriculum and Minimum Academic Standards for the Nigerian University System (CCMAS)

Sciences

2022

Ten Unique Features

1. The courses in the discipline are tailored towards the deployment of science and technology in addressing societal problems.
2. All programmes in the discipline are re-organised in tune with global trends in scientific research and knowledge transfer for development.
3. The science discipline has identified with global frontiers of knowledge by including new relevant courses in the programmes.
4. Programme specific entrepreneurial courses are incorporated to ensure graduates acquire necessary skills to identify business opportunities.
5. Requisite skills are incorporated in each programme to make the graduates versatile and competitive for employment nationally and globally.
6. The courses in the programmes are designed to provide the basic foundations and diverse fields of specialisation for further studies and research.
7. The programmes are designed to instill in the students, the scientific culture of questioning and seeking for proof.
8. Learning objectives are clearly stated for each course to guide both the teachers and students towards satisfying the philosophy of the programmes.
9. The programmes are designed with emphasis on logical thinking, creativity, and innovation with a view to develop local technology.
10. The programmes in the discipline are designed to promote the culture of multidisciplinary research and sustainable development.

Executive Secretary: Abubakar Adamu Rasheed

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For more information, please contact:
Executive Secretary, National Universities Commission
26 Aguiyi Ironsi Street, P.M.B. 237 Garki GPO, Maitama, Abuja, Nigeria
Telephone:+2348027455412,+234054407741.Email: info@nuc.edu.ng.
Website: www.nuc.edu.ng

Lead Consultant: Peter A. Okebukola
Coordinating NUC Director: Dr. Noel Biodun Saliu

Formally unveiled by

His Excellency, Professor Yemi Osinbajo, *SAN, GCON*
Vice President, Federal Republic of Nigeria

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Professor	MAFIANA	Chiedu	National Open University of Nigeria	**Co-Chairman**
Professor	OSILIKE	Micah	University of Nigeria Nsukka	Representative Nigerian Academy of Science
Professor	ONIYE	Sonnie	Ahmadu Bello University Zaria	Biology
Professor	OKIGBO	Raphael	Nnamdi Azikiwe University Awka	Botany
Professor	EKPO	Uwemedimo Friday	Federal University of Agriculture Abeokuta	Zoology
Professor	ILORI	Matthew Olusoji	University of Lagos	Biotechnology
Professor	ADEJUMO	Timothy Olubisi	Adekunle Ajasin University, Akungba-Akoko	Brewing Science
Professor	ODOKUMA	Lucky	University of Port Harcourt	Microbiology
Professor	ALIYU	Adetutu	Nigeria Defence Academy	Chemistry
Professor	LAWAL	Abdulazeez	Fountain University Osogbo	Industrial Chemistry
Professor	YAKASSAI	Ibrahim Adamu	Bayero University Kano	Medicinal Chemistry
Professor	OSUJI	Leo Chigbu	University of Port Harcourt	Petroleum Chemistry
Professor	OLAYINKA	Adewoye	Ladoke Akintola University of Technology Ogbomoso	Environmental Management & Toxicology
Professor	OJO	Sola	Federal University Oye-Ekiti	Geology
Professor	ISAAC	Aigbedion	Ambrose Alli University, Ekpoma	Geophysics
Professor	IBRAHEEM	Mohammed	University of Ilorin	Mathematics
Professor	BAKARI	Harun	University of Maiduguri	Statistics
Professor	ALAO	Felix	Federal University of Technology Akure	Industrial Mathematics
Professor	UGWUMBA	Adiaha Alda	University of Ibadan	Marine Science

Title	Surname	First Name	Institution	Programme
Professor	AMA- ABASI	Daniel	University of Calabar	Maritime Science
Professor	MATAZU	Mansur Bako	Federal University Dutsina-Ma	Meteorology
Professor	DARMA	Tijjani Hassan	Bayero University Kano	Physics
Professor	EKPUNOBI	Azubike Joshua	Nnamdi Azikiwe University Awka	Industrial Physics
Professor	AWOJOYOGBE	Bamidele O.	Federal University of Technology Minna	Medical Physics
Professor	MBOTO	Clement Obi	University of calabar	Science Laboratory Technology
Professor	ARZAI	Auwalu Halliru	Bayero University Kano	Forensic Science
Professor	TIJJANI	Auwal Musa	Abubakar Tafawa Balewa University Bauchi	Physics with Electronics

List of NUC Representatives

Title	Surname	First Name	Programme
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Mr.	EBEGUNA	Ikechukwu Paul	Biochemistry
Miss.	ETIM	Okoho	Botany
Miss.	SANI	Zainab Onayi	Zoology & Chemistry
Dr.	IRENE	Angela	Biotechnology
Mrs.	DADA	Olayemi	Brewing Science & Technology and Industrial Chemistry
Mrs.	ODAUDU	Oluwabukunmi	Microbiology
Mr.	MOHAMMED	Abubakar Tanko	Medicinal Chemistry
Mr.	KOLAWALE	Banji	Petroleum Chemistry and Forensic Science
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Mrs.	SULE	Olufunke	Marine Science
Dr.	AUDU	Bridget	Maritime Science
Mr.	BAKO	Audu	Physics
Mr.	OKAFOR	Ikechukwu David	Industrial Physics
Mr.	DAUDA	Nehemiah	Medical Physics
Miss.	EKWUEME	Amuche	Science Laboratory Technology
Mr.	ADELEKE	Adeyemi	Physics with Electronics

Foreword

In furtherance of the "change" mantra of the present administration, I published a roadmap to guide my Ministry on ways of addressing the multiple problems that faced the education sector of the country shortly after my assumption of office in 2016. Known as "***Education for Change: Ministerial Strategic Plan – 2016-2019"*** (updated to 2018-2022), the content of the document reaffirms government's commitment to strengthening institutional structures and establishing innovative approaches that would quickly revamp the education sector.

The nations' universities hold a pride of place in the execution of such a strategy, being at the peak of the educational system and charged in an overall manner, with the responsibility of catalysing the sustainable and inclusive growth and prosperity that the "change" mantra envisions. Thus, a "rapid revitalization of the Nigerian university system", which is proceeding apace, became imperative. Improvement in research, teaching and learning facilities, deepening ICT penetration and the provision of enhanced power supply in our university campuses are some of the areas receiving stringent attention. In the same vein, the need was felt to radically review the curricula which universities had used for more than a decade so as to put in place one that would more directly address local issues, meet international standards and is fit for purpose for the training of 21st century graduates.

The National Universities Commission has concluded the review of the former *Benchmark Minimum Academic Standards (BMAS)* of 14 disciplines into those of Core *Curriculum and Minimum Academic Standards (CCMAS)* of 17 disciplines. I am therefore pleased to present these documents to the universities, the general public and the international community as I am sure that their application would tremendously uplift scholarship in our universities. I thank all and sundry who worked assiduously to bring this seminal enterprise to fruition.

Malam Adamu Adamu
Honourable Minister of Education

Preface

Section 10 (1) of the Education (National Minimum Standards and Establishment of Institutions) Act, Cap E3, Laws of the Federation of Nigeria 2004, empowers the National Universities Commission to lay down minimum standards for all universities and other degree awarding institutions of higher learning in the Federation and the accreditation of their degrees and other academic awards. The earliest efforts at giving effect to this legal framework in the Nigerian University System (NUS) started in 1989 following the collaboration between the Commission and Nigerian Universities, which led to the development of the Minimum Academic Standards (MAS) for all programmes in Nigerian universities. The MAS documents were subsequently approved by the Federal Government for use as a major instrument for quality assurance in the Nigerian University System (NUS). The documents were employed in the accreditation of programmes in the NUS for over a decade.

In 2001, the Commission initiated a process to revise the documents because the said MAS documents were essentially content-based and merely prescriptive. In 2004, the Commission developed outcome-based benchmark statements for all the programmes through a workshop that allowed for exhaustive deliberations by relevant stakeholders. Following comments and feedback from the universities to the effect that the Benchmark-style Statements were too sketchy to meaningfully guide the development of curriculum and inadequate for the purpose of accreditation, the Commission, in 2007 put in place a mechanism for the merger of the Benchmark-style Statements and the revised Minimum Academic Standards, which birthed the Benchmark Minimum Academic Standards (BMAS). The resultant BMAS, an amalgam of the outcome-based Benchmark statements and the content-based MAS clearly articulated the Learning Outcomes and competencies expected of graduates of each academic programme in Nigerian Universities without being overly prescriptive while at the same time providing the requisite flexibility and innovativeness consistent with institutional autonomy. In all, the BMAS documents were developed for the thirteen existing disciplines namely, **Administration and Management, Agriculture, Arts, Basic Medical Sciences, Education, Engineering and Technology, Environmental Sciences, Law, Medicine and Dentistry, Pharmaceutical Science, Sciences, Social Sciences and Veterinary Medicine.**

The Commission, in 2016, in its sustained commitment to make the NUS adaptable to global trends in higher education, constituted a group of relevant academic experts to develop a BMAS in **Computing**, thus increasing the number of disciplines in Nigerian Universities to fourteen.

In keeping with its mandate of making university education in Nigeria more responsive to the needs of the society, the National Universities Commission commenced the journey to restructure the BMAS in 2018, introducing in its place, the **Core Curriculum and Minimum Academic Standards (CCMAS),** to reflect the 21st Century realities, in the existing and new disciplines and programmes in the Nigerian University System.

The new CCMAS is a product of sustained stakeholder interactions over two years. The composition of each panel took into consideration, the triple helix model, as a unique feature. This involved a blend of academic experts, academies, government (represented by NUC), professional bodies and of course, the private sector represented by the Nigerian Economic Summit Group (NESG). In order to enrich the draft documents, copies of each discipline were

forwarded to all critical stakeholders including the relevant academic units in Nigerian Universities, the private sector, professional bodies and the academies for their comments and input. These inputs along with the curriculum of programmes obtained from some foreign and renowned universities served as major working materials for the various panels constituted for that purpose.

Bearing in mind the need to adhere to covid-19 protocol as prescribed by the National Centre for Disease Control (NCDC), the Commission was compelled by prevailing circumstances to finalize the curriculum virtually. General Assemblies were also held via Zoom, comprising, the NUC Strategic Advisory Committee (STRADVCOM), Chairpersons/Co-Chairpersons of the various disciplines and Panel Members of the respective programmes. Each Discipline and Programme had NUC representatives who assisted panellists with all the tools and working materials. Several online meetings were held at programmes level, where the real business of developing the CCMAS took place. The products of the various programme-based virtual meetings were submitted to the corresponding discipline group and then to the National Universities Commission. These documents were further scrutinized and fine-tuned by a smaller group of versatile subject matter specialists and relevant private sector practitioners.

In line with the dynamism in higher education provisioning, the Commission took cognizance of complaints by the universities on the high number of General Studies (GST) courses in the BMAS, and was subsequently streamlined. Entrepreneurship courses such as Venture Creation and Entrepreneurship, and innovation found generous space. In addition, the new curriculum unbundled the Bachelor of Agriculture, Bachelor of Science in Mass Communication and the Bachelor of Architecture Programmes, while establishing some emerging specializations in these fields as obtained globally. This is in furtherance of the goal of producing fit for purpose graduates. The Allied Health Sciences was also carved out as a new Discipline from the existing Basic Medical Sciences discipline.

Preceding the completion of the curriculum review content and language editing, a 3-day validation workshop (face-to-face mode) involving critical stakeholders, including STRADVCOM, Vice-Chancellors and Directors of Academic Planning of Nigerian Universities, as well as the Nigerian Economic Summit Group (NESG) was organized by the Commission to validate the CCMAS documents, and to engender ownership for ease of implementation.

Consequent upon the afore-mentioned processes, seventeen CCMAS documents were produced for the following academic disciplines in the NUS:

1. Administration and Management
2. Agriculture
3. Allied Health Sciences
4. Architecture
5. Arts
6. Basic Medical Sciences
7. Computing
8. Communication and Media Studies
9. Education
10. Engineering and Technology
11. Environmental Sciences
12. Law

13. Medicine and Dentistry
14. Pharmaceutical Science
15. Sciences
16. Social Sciences
17. Veterinary Medicine

The CCMAS documents are uniquely structured to provide for 70% of core courses for each programme, while allowing universities to utilise the remaining 30% for other innovative courses in their peculiar areas of focus. In addition to the overall Learning Outcomes for each discipline, there are also Learning Outcomes for each programme and course. In general, programmes are typically structured such that a student does not carry less than 30 credit units or more than 48 credit units per session.

Consequently, the Commission is optimistic that the 2021 CCMAS documents will serve as a guide to Nigerian Universities in the design of curriculum for their programmes with regards to the minimum acceptable standards of input and process, as well as, measurable benchmark of knowledge, 21st century skills and competences expected to be acquired by an average graduate of each of the academic programmes, for self, national and global relevance.

Professor Abubakar Adamu Rasheed, *mni, MFR, FNAL*
Executive Secretary

Contents

Introduction

Two Acts provide the legal framework for the quality assurance and regulatory mandates of the National Universities Commission. The first is the **National Universities Commission Act No. N81 Laws of Federation Nigeria (L.F.N.) 2004**.

This Act sets up the National Universities Commission as a body corporate charged with the responsibility of advising the Federal and State Governments of all aspects of university education and the general development of universities in Nigeria. The second, **Education (National Minimum Standard and Establishment of Institutions) Act No. E3 L.F.N. 2004**, *empowers the National Universities Commission to lay down minimum standards for all universities and other institutions of higher learning in the Federation and the accreditation of their degrees and other academic awards in formal consultation with the universities for that purpose, after obtaining prior approval therefor through the Minister, from the President.*

Following the enactment of NUC Act No. E3 L.F.N. 2004, the National Universities Commission developed the first set of Minimum Academic Standards (MAS) in 1989 for all the academic programmes existing in the Nigerian University System (NUS) at that time under the 13 major disciplines of Administration, Agriculture, Arts, Education, Engineering and Technology, Environmental Sciences, Law, Medicine and Dentistry, Management Sciences, Pharmaceutical Science , Science, Social Sciences and Veterinary Medicine. The Minimum Academic Standard served as the reference documents for the first accreditation of programmes conducted in NUS in 1990.

In its bid to review the Minimum Academic Standard documents, which was predicated on the fact that they were prescriptive, the Commission decided to develop the outcome-based Benchmark Statements for all programmes in the Nigerian University System in line with contemporary global practice in 1999. In the first comprehensive review of the Minimum Academic Standards by NUC, which was in 2004, the Commission decided to merge the Benchmark Statements and the revised Minimum Academic Standards into a new document called Benchmark Minimum Academic Standards (BMAS). These documents were approved for use in Nigerian universities in 2007. A second attempt at reviewing the BMAS was in 2011. It must however be noted that stand alone BMAS for new programmes were at different times developed by the Commission on request from some Nigerian universities.

The Current Review of the BMAS

The journey of the current curriculum review efforts commenced in 2018, when the National Universities Commission circulated the 2018 draft BMAS to all Nigerian universities and other stakeholders for their comments. In addition to the harvested comments, the curriculum of different programmes of some world-class universities were downloaded. The draft 2018 BMAS, compiled comments of Nigerian universities and other stakeholders and the downloaded curriculum of some foreign universities served as the working documents for the curriculum review panels. A multi-stakeholder approach was deployed in constituting the panels for the curriculum review exercise. The constituted panels included:

i. Academic staff of Nigerian universities;

ii. Representatives of the Academies;
iii. Representatives of Professional bodies/associations
iv. Representatives of the private sector

In addition to the reviewers working individually and in consultation with their subject area peers, over 512 cumulative online meetings of the general assembly (Vice-Chancellors, Discipline Chairmen/Chairpersons, programme-specific reviewers and Heads/representatives of international quality assurance agencies and institutions); Discipline groups; and programme groups were held between March and November, 2021. Physical meetings were also held to finalize the curriculum review exercise.

The reviewers carried out their assignments with a view to producing a curriculum for their respective programmes that will reflect both national and international expectations. Specifically, the reviewers focused on ensuring that the emerging curriculum will be adequate to train Nigerian university students in the 21st Century. By implication and in addition to current trends in the various programmatic areas, the curriculum will be ICT oriented, promote Artificial Intelligence, enhance skills acquisition (including soft skills), inculcate and sharpen entrepreneurship mindset of students and capable of steering the deployment of evolving technologies to deliver its content.

The Core Curriculum and Minimum Academic Standards (CCMAS)
The major highlights of the new curriculum are:

1. Change of nomenclature from **Benchmarks Minimum Academic Standards (BMAS)** to **Core Curriculum and Minimum Academic Standards (CCMAS);**
2. The curriculum provides for 70% minimum core courses requirements for graduation. Nigerian universities are expected to provide the remaining 30%;
3. In consonance with global best practice, the curriculum is to stimulate blended learning in its delivery;
4. Mass Communication has been unbundled to create a distinct discipline of Communications comprising degree programmes in Advertising, Broadcasting, Development Communication Studies, Film and Multimedia, Information and Media Studies, Journalism and Media Studies, Mass Communication, Public Relations and Strategic Communication;
5. Agriculture has been unbundled into programmes in its contributing components of B.Sc Agricultural Economics, B.Sc. Animal Science, B.Sc. Crop Science and B.Sc. Soil Science;
6. The unbundling of Architecture and introduction of Architecture as a new discipline with programmes like Architecture, Architectural Technology, Furniture Design, Interior Architecture Design, Landscape Architecture and Naval architecture;
7. The split of the Basic Medical Sciences discipline into two – Basic Medical Sciences and Allied Health Sciences;
8. Reduction of the General Studies (GST) course from 36 credit units to 12 credit units of 6 courses as follows:
    i. Communication in English;
    ii. Nigerian People and Culture;
    iii. Philosophy, Logic and Human Existence;
    iv. Entrepreneurship and Innovation;
    v. Venture creation; and
    vi. Peace and Conflict resolution.

9. Entrepreneurship has been repackaged with the introduction of programme-specific entrepreneurship;
10. The number of academic disciplines has been increased from 14 to 17 as follows:

    i. Administration and Management
    ii. Agriculture
    iii. Allied Health Sciences
    iv. Architecture
    v. Arts
    vi. Basic Medical Sciences
    vii. Communications and Media Studies
    viii. Computing
    ix. Education
    x. Engineering and Technology
    xi. Environmental Sciences
    xii. Law
    xiii. Medicine and Dentistry
    xiv. Pharmaceutical Science
    xv. Sciences
    xvi. Social Sciences
    xvii. Veterinary Medicine

Having reviewed the curriculum of Nigerian universities, the next steps will include training and retraining of academic staff of Nigerian universities to effectively deliver the content of the curriculum.

Glossary of Course Codes

Course Codes are the 3-letter codes for the identification of courses offered in the various programmes in the Arts discipline as well as courses offered in other disciplines covered in the CCMAS for the Nigerian University System. They are in three categories dictated by the sources of courses involved:

Category A: Course codes for the General Studies Courses offered by all students.

Category B: Course codes for Faculty Courses offered in the Science Discipline.

Category C: Course codes for courses offered by the various programmes in the Science Discipline.

The List of Programmes and Their Course Codes

Category A: General Studies

Programme	Course Code
General Studies Courses offered at the University Level by all students.	GST
Entrepreneurial Courses offered at the University Level by all Students	ENT

Category B: Common Courses in the Science Discipline

Course	Course Code
MTH 101 Elementary Mathematics I	MTH 101
MTH 102 Elementary Mathematics II	MTH 102
COS 101 Introduction to Computing Science	COS 101

Category C: The List of Programmes and Their Course Codes

Programmes	Course Codes
Applied Geophysics	GPH
Biochemistry	BCH
Biology	BIO
Biotechnology	BTG
Botany	BOT
Brewing Science and Technology	BST
Chemistry	CHM
Environmental Management and Toxicology	EMT
Forensic Science	FRS
Geology	GEY
Industrial Chemistry	ICH
Industrial Mathematics	IMT
Industrial Physics	IPH
Marine Science	MSE
Maritime Science	MTS
Mathematics	MTH
Medical Physics	MPH
Medicinal Chemistry	MCM
Meteorology	MET
Microbiology	MCB
Petroleum Chemistry	PCM
Physics with Electronics	PYE
Physics	PHY
Science Laboratory Technology	SLT
Statistics	STA
Zoology	ZOO

Preamble

The Core Curriculum and Minimum Academic Standards (CCMAS) are designed for the education and training of undergraduate students wishing to obtain first degrees in the different areas of Science in Nigerian University System. Presented in this section are the basic operational elements that serve to define the minimum academic standards required to achieve the cardinal goal of producing graduates in Science with sufficient academic background to face the challenges of a developing economy in an increasingly globalized economy.

It is pertinent to note that this CCMAS document is expected to guide institutions in the design of curricula for their Science programmes by stipulating the minimum requirements. Being such, institutions are encouraged to take due cognizance of the CCMAS while bringing necessary innovation to the content and delivery of their programmes towards achieving the overall goal of Science education and training in the country.

Programmes and Degrees

Presented in Table 1 is a list of programmes and degrees covered in this CCMAS document. The list covers existing programmes being currently run in various faculties/schools/colleges of science in Nigeria as well as some new programmes in line with current global trends in required skill acquisition in the sciences. The contents of many courses of existing programmes have also been modified in consonance with modern trends in the requisite knowledge and skills of science graduates.

Table 1: List of Programmes and Degrees

S/N	Programme	Degree in View
1	Applied Geophysics	B.Sc.
2	Biochemistry	B.Sc.
3	Biology	B.Sc.
4	Biotechnology	B.Sc.
5	Botany	B.Sc.
6	Brewing Science and Technology	B.Sc.
7	Chemistry	B.Sc.
8	Environmental Management and Toxicology	B.Sc.
9	Forensic Science	B.Sc.
10	Geology	B.Sc.
11	Industrial Chemistry	B.Sc.
12	Industrial Mathematics	B.Sc.
13	Industrial Physics	B.Sc.
14	Marine Science	B.Sc.
15	Maritime Science	B.Sc.
16	Mathematics	B.Sc.
17	Medical Physics	B.Sc.
18	Medicinal Chemistry	B.Sc.
19	Meteorology	B.Sc.
20	Microbiology	B.Sc.
21	Petroleum Chemistry	B.Sc.

22	Physics with Electronics	B.Sc.
23	Physics	B.Sc.
24	Science Laboratory Technology	B.Sc.
25	Statistics	B.Sc.
26	Zoology	B.Sc.

Philosophy, Aims and Objectives of Science

Philosophy
The philosophy of the Science discipline is to train graduates who will apply scientific approach through verifiable and reproducible methodologies to solving developmental needs of the society.

Objectives
The main objectives of Science Discipline are to:
1. provide students with scientific knowledge and skills from which they can proceed to further studies in specialized and/or multi- disciplinary areas;
2. provide students with a broad and balanced foundation of scientific knowledge and practical skills as may be applicable in their different programmes;
3. develop in students the ability to apply scientific knowledge and skills to solving theoretical and practical problems;
4. develop in students, a range of transferable skills that are of value in any employment and society they might find themselves;
5. provide, through training and orientation, an appreciation of the rewards inherent in inter- and multi- disciplinary approach to the solution of complex life problems; and
6. engender in students an appreciation of the fact that no nation can develop without science and its application.

Learning Outcomes

Regime of Subject Knowledge
The programmes and their curricula should give students comprehensive education and training that equip them with knowledge, decision-making and problem-solving skills in a variety of areas.

Competencies and Skills
The general skills should include competencies in computer literacy, quantitative skills, communication skills, interpersonal skills, organization skills, Information Technology skill and Entrepreneurship skills.
Administrative and Management related cognitive abilities and skills required are as follows:
1. ability to recognize and analyze management and administrative problems and evolve strategies for their solutions;
2. ability to recognize and implement good management and administrative policies.
3. computational and data processing skills, relating to administrative, financial and manpower data; and
4. ability to demonstrate knowledge and understanding of essential facts, concepts and principles, and apply theories to Administration and Management. Acquire knowledge in

problem solving through Industrial attachment, Industrial Seminars and Student Apprenticeship Scheme.

Behavioural Attributes

Graduates of these programmes should:

1. understand the social-cultural environment in which they find themselves and how such environment conditions behaviour;
2. be able to understand, explain, predict and influence human behaviour in work organizations;
3. relate the knowledge of human behaviour to the ethics of their relevant professions; and
4. understand the relationship between culture and behaviour and why a unimodal system of behaviour may not work.

Admission Requirements and Expected Duration of the Programmes

The entry requirements shall be at least passes at Credit level at Senior Certificate (SSC) or its equivalents in five subjects at not more than two sittings. Such subjects must include English Language, Mathematics and three other relevant subjects. In addition, an acceptable pass in the Unified Tertiary Matriculation Examination in (UTME) is required for admission into 100 Level.
Candidates with at least two A level passes in relevant subjects at the GCE Advanced Level/ IJMB/ JUPEB or equivalent, may be considered for admission into 200 Level, provided they satisfy the 'O' level qualifications above.

Duration

A student will not be allowed to exceed an additional 50 per cent of the duration of the programme if he/she fails to graduate within the minimum number of years.

UTME

Four (4) academic sessions or eight (8) semesters

Direct Entry

Three academic sessions or six (6) semesters. In general, no student will be allowed to exceed an additional 50% of the normal duration of the programme.

Graduation Requirements

Expected duration for UTME candidates shall be 4 years and students are required to pass a minimum of 120 units, while for Direct entry students, expected duration for graduation shall be 3 years and would be expected to pass a minimum of 90 units which must include all compulsory courses. Students in 5 years programmes are expected to pass a minimum of 150 units which must include all compulsory courses.

Course System

Credits are weights attached to a course. One credit is equivalent to one hour per week per semester of 15 weeks of lectures or three hours of laboratory/studio/workshop work per week per semester of 15 weeks.

Definition of Course System
This should be understood to mean a quantitative system of organization of the curriculum in which subject areas are broken down into unit courses which are examinable and for which students earn credit(s) if passed. The courses are arranged in progressive order of complexity or in levels of academic progress. Level 1 courses are for example 100 and 101; Level II courses are for example 200 and 202. The second aspect of the system is that courses are assigned weights allied to Units.

Units
Consist of specified number of student-teacher contact hours per week per semester. Units are used in two complementary ways: one, as a measure of course weighting, and the other, as an indicator of student workload. As a measure of course weighting for each Unit course (e.g. HIS 105, ZOO 203, ARCH 504), the credit unit to be earned for satisfactorily completing the course is specified; e.g. a 2-credit unit course may mean two 1-hour lecture per week per semester or one 1-hour lecture plus 3-hour practical per week per semester.

As a measure of workload, "One Credit Unit" means one hour of lecture or one hour of tutorial per week per semester. For other forms of teaching requiring student teacher contact, the following equivalents may apply: two hours of seminar, three hours of laboratory or field work, Clinical practice/practicum, studio practice or stadium sporting activity, six hours of teaching practice; four weeks of industrial attachment where applicable.

Normally, in Course Credit System, courses are mounted all year round, thus enabling students to participate in examinations in which they are unsuccessful or unable to participate on account of ill health or for other genuine reasons. In such a system, no special provisions are made for re-sit examinations.

The minimum number of credit units for the award of a degree is 120 units, subject to the usual Department and Faculty requirements. A student shall therefore qualify for the award of a degree when he has met the conditions.

The minimum credit load per semester is 15 credit units. For the purpose of calculating a student's cumulative GPA(CGPA) in order to determine the class of Degree to be awarded, grades obtained in all the courses whether compulsory or optional and whether passed or failed must be included in the computation.

Even when a student repeats the same course once or more before passing it or substitutes another course for a failed optional course, grades scored at each and all attempts shall be included in the computation of the GPA. Pre - requisite courses must be taken and passed before a particular course at a higher level.

Grading of Courses

Grading of courses shall be done by a combination of percentage marks and letter grades translated into a graduated system of Grade Point as shown in Table 1.2.

Table 1. 2 Grade Point System

Mark %	Letter Grade	Grade Point
70 – 100	A	5
60 – 69	B	4
50 – 59	C	3
45 – 49	D	2
40 – 44	E	1
0- 39	F	0

Grade Point Average and Cumulative Grade Point Average

For the purpose of determining a student's standing at the end of every semester, the Grade Point Average (GPA) system shall be used. The GPA is computed by dividing the total number of Units x Grade Point (TUGP) by the total number of units (TNU) for all the courses taken in the semester as illustrated in Table 1.3.

The Cumulative Grade Point Average (CGPA) over a period of semesters is calculated in the same manner as the GPA by using the grade points of all the courses taken during the period.

Table 1.3: Calculation of GPA or CGPA

Course	Units	Grade Point	Units x Grade Point (UGP)
C_1	U_1	GP_1	U_1 x GP_1
C_2	U_2	GP_2	U_2 x GP_2
-	-	-	-
-	-	-	-
C_i	U_i	GP_i	U_i x GP_i
-	-	-	-
-	-	-	-
C_N	U_N	GP_N	U_N x GP_N
TOTAL	**TNU**		**TUGP**

$$TNU = \sum_{i=1}^{N} U_i \qquad TUGP = \sum_{i=1}^{N} U_i * GP_i \qquad CGPA = \frac{TUGP}{TNU}$$

Degree Classifications

Classes of degree are to be awarded depending on the cumulative GPA obtained. The classes of degrees that may be awarded are First Class Honours, Second Class Honours (Upper Division), Second Class Honours (Lower Division) and Third Class Honours (see Table 1.4).

Table 1.4: Degree Classification

CGPA	Class of Degree
4.50 – 5.00	First Class Honours
3.50 – 4.49	Second Class Honours (Upper Division)

2.40 – 3.49	Second Class Honours (Lower Division)
1.50 – 2.39	Third Class Honours
1.00 – 1.49	Pass

Probation
Probation is a status granted to a student whose academic performance fall below an acceptable standard. A student whose Cumulative Grade Point Average is below 1.00 at the end of a particular year of study, earns a period of probation for one academic session.

Withdrawal
A candidate whose Cumulative Grade Point Average is below 1.00 at the end of a particular period of probation should be required to withdraw from the University. Where possible, consideration may be given to a student withdrawn from a programme of study for transfer to any other programme within the same university.
Subject to the conditions for withdrawal and probation, a student may be allowed to repeat the failed course Unit(s) at the next available opportunity, provided that the total number of credit units carried during that semester does not exceed 24, and the Grade Points earned at all attempts shall count towards the CGPA.

Modes of Student Assessment
All courses taken must be evaluated and a final grade given at the end of the semester. To arrive at the final grade, the evaluation must be a continuous process consisting of some or all of the following where applicable:

(i) Continuous Assessment
(ii) Examinations

Continuous Assessment
Continuous assessment shall be done through essays and tests. Scores from continuous assessment shall normally constitute 30-40 per cent of the full marks for courses which are primarily theoretical.

Examinations
In addition to continuous assessment, final examinations should normally be given for every course at the end of each semester. All courses shall be graded out of a maximum of 100 marks comprising:
Final Examination: 60% - 70%
Continuous assessment (Quizzes, Homework, Tests and Practical): 30% - 40%

External Examiner System
The involvement of external examiners from other universities is a crucial quality assurance requirement for all courses in Nigerian University System. In this regard, external examiner should go beyond mere moderation of examination questions to examining of examination papers to scope and depth of examination questions vis a vis the curricular expectation.

Students' Evaluation of Courses
There should be an established mechanism to enable students to evaluate courses delivered to them at the end of each semester. This should be an integral component of the course credit

system to serve as an opportunity for feedback on the effectiveness of course delivery. Such an evaluation which should be undertaken by students at the end of each course, should capture, among others:

1. improvement in the effectiveness of course delivery;
2. continual update of lecture materials to incorporate emerging new concepts;
3. effective usage of teaching aids and tools to maximize impact of knowledge on students;
4. improvement in students' performance through effective delivery of tutorials, timely in; and
5. presentation of continuous assessment and high-quality examination.

It is very important that students' evaluation of courses be administered fairly and transparently through the use of well-designed questionnaires. The completed questionnaires should be professionally analyzed and results discussed with the course lecturer(s) towards improvement in course delivery in all its ramifications.

SIWES Rating and Assessment

All students taking any degree in the Sciences must undergo industrial training to earn a minimum of 3 credit units. The minimum duration of the Students Industrial Work Experience Scheme (SIWES) should be 12 weeks. Students should be assessed using the Logbook, a report and a Seminar.

B.Sc. Applied Geophysics

Overview

Applied Geophysics deals with methodologies for extracting geological information out of geophysical datasets. The subject mostly covers potential fields (gravity and magnetic methods) because these datasets are readily available. However, it also visits seismic and electrical geophysical methods including the controlled source electromagnetic techniques. Applied Geophysics focuses on physics concepts and how they can be used to understand geology. Students work with industry standard software (e.g. (Petrel E &P, Petrolog, Surfer, Arc GIS, Geoprobe, ProMax, Win Resist, Dippro^{tm} 4.0 inversion software), which performs the mathematics in the background. Topics covered include: maps, projection systems, datum and GPS; theory, acquisition, processing and interpretation steps involved for gravity and magnetic methods; image enhancement and qualitative interpretation techniques; quantitative style 2.5D geophysical modelling; seismic theory, acquisition, processing and how this integrates with geophysical wire-line well logging; radiometric acquisition/interpretation and electrical geophysical techniques such as resistivity, induced polarisation, self-potential, electromagnetics and magneto telluric.

The Applied Geophysics Programme is designed with a view to producing quality, entrepreneurial or job-ready graduates through training and exposure to all aspects of Applied Geophysics. The programme aims to achieve this goal through the offering of a robust curriculum, supported with competent staff and excellent teaching and research facilities, within the confines of an ambient environment. Prospective students will also be exposed to hands-on learning experiences through supervised/independent (practical) field work and industrial training. The programme and training style do not only make the graduates competitive in the current labour market in the 21st century, but will also prepare them adequately for possible career pursuits in the academia, government, or relevant industry (such as Oil & Gas/extractive industries, Iron & Steel, Environmental, Innovative Clean Energy Technology and engineering problem)

Philosophy

The programme is intended to provide mission-oriented geosciences knowledge and expertise to all the students that go through the programme and equip them with the necessary skills to have adequate knowledge of the composition of the earth's subsurface and be able to fully exploit the earth's natural resources for national development. The programme also aims at bringing together the ingredients necessary for a well-paid career as required in the mineral/oil industry and engineering/groundwater-related areas of the national economy and in the relevant government establishments. Opportunities for the attainment of academic excellence through effective teaching and research in all aspects of Applied Geophysics are also provided.

Objectives

The specific objectives of the programme are among others are to:

1. impact basic and fundamental knowledge in all areas of Applied Geophysics;
2. provide the necessary training and exposure in all aspects of Applied Geophysics that is in the forefront of development such as in hydrocarbon and groundwater exploration, environmental pollution, Dam site Roads and other Civil Engineering construction site investigations;

3. provide opportunity for a better appreciation of fields with the use of integrated Applied Geophysics at maximizing growth and technological development in all aspects of explorations;
4. develop the necessary manpower needed for industrial, technological, research and academic development of the country in all aspects of Applied Geophysics;
5. provide effective teaching, research and practical oriented/field work programme that is required in all the fields of Applied Geophysics; and
6. offer the opportunities for the full development of Applied Geophysics to meet the ever-growing challenges as is applicable in the industry, private sector and government services, for the overall growth and development of the country and mankind in general.

Unique Features of the Programme

The unique features of the programme include:

1. being able to apply the principles of physics, mathematics, geology, computer science, chemistry and engineering into procedures, processing, systems, and methodologies of geophysical engineering and create or modify models in solving complex engineering problems in the fields of environment, settlement, marine and energy with the concept of sustainable development;
2. the introduction of the control source electromagnetic techniques, which is new in the oil/gas and extraction industries;
3. being able to find the source of engineering problems through the process of investigation, analysis, interpretation of data and information based on the principles of geophysical engineering;
4. capable of using the last technology in carrying out geophysical engineering work in the field of environment, settlement, marine and energy;
5. being able to recognise the difference of land and sea exploration field characteristics that can be effected into the quality of measurement data;
6. being able to organise data and present them again by utilizing information technology at their disposal; and
7. capable of reading maps and satellite imagery, determining map orientation in the field using GPS, compass and satellite data.

Employability Skills

1. Oil, gas and mining in the extraction industries.
2. Applied Geophysicists for engineering investigations.
3. Meteorology, seismology and other departments of solid earth geophysics.
4. Archaeology and mapping agricultural fields for crop yield analysis.
5. Earth to the high atmosphere (ionosphere), which includes our oceans, atmosphere and cryosphere.
6. Remote sensing techniques such as seismology, gravity, magnetics and electromagnetic methods.
7. Wide usage in geology (solid earth), meteorology, oceanography, glaciology, climatology and many more.

21st Century Skills

1. Collaboration
2. Communication and Information Literacy
3. Creativity and Innovation
4. Critical Thinking
5. Computational Thinking
6. Media Literacy
7. Leadership and responsibility
8. Technology Literacy
9. Flexibility

Admission and Graduation Requirements

Admission Requirements

The entry requirements for candidates for a four-year degree programme shall be at least credit level passes in five subjects including English Language, Mathematics, Physics and Chemistry to form the core subjects with credit in any other relevant science subject at the Senior Secondary Certificate (SSC) or its equivalent. In addition, an acceptable pass in the UTME (Unified Tertiary Matriculation Examination) is required. UTME subjects are English, Chemistry, Physics and Mathematics. Candidates with a minimum of two 'A' level passes at the GCE/IJMB Advanced Level in two relevant subjects (Chemistry, Mathematics and Physics) may be admitted into 200level through Direct Entry.

Graduation Requirements

To earn a degree in Applied Geophysics, UTME Students must obtain a minimum of 120 credits while Direct entry students must obtain and pass a minimum of 90 credits units.

Global Course Structure

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 107	General Physics Practical I	1	C	-	45
PHY 108	General Physics Practical II	1	C	-	45
CHM 101	General Chemistry I	2	C	30	-
CHM 102	General Chemistry II	2	C	30	-
CHM 107	General Chemistry Practical I	1	C	-	45
GEY 101	Introduction to Geology I	2	C	15	45
GEY 102	Introduction to Geology II	2	C	15	45

	Total	**26**			

100 level

200 Level

Course Code	**Course Title**	**Unit(s)**	**Status**	**LH**	**PH**
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	30	-
PHY 204	General Physics VI (Waves and Optics)	3	C	45	-
PHY 205	Thermal Physics	2	C	30	-
PHY 207	Practical Physics III	1	C	-	45
PHY 208	Practical Physics IV	1	C	-	45
GEY 210	Geological Map Interpretation	2	C	15	45
GEY 212	Introduction to Geological Field Mapping	2	C	15	45
GPH 201	Introduction to Earth Physics	2	C	30	-
GPH 211	Geomathematics	2	C	30	-
	Total	**19**			

300 Level

Course Code	**Course Title**	**Unit(s)**	**Status**	**LH**	**PH**
GST 312	Peace and Conflict Resolutions	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
GPH 305	Geophysical Field Method & Instrumental Analysis	1	C	-	45
GPH 307	Magnetic Prospecting Methods	1	C	15	-
GPH 308	Seismic Refraction Prospecting Methods	2	C	30	-
GPH 309	Gravity Prospecting Methods	1	C	15	-
GPH 311	Principles of Geophysics	2	C	30	-
GPH 312	Electrical & Electromagnetic Methods	2	C	15	45
GPH 322	Introduction to software modelling	1	C	15	-
GPH 398	Entrepreneurship in Applied Geophysics	1	C	15	
GPH 399	Industrial Training II/Field Work (12 Weeks) (4 Year Programme only)	3	C	-	135
	Total	**18**			

400 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GEY 408	Petroleum Geology	2	C	30	-
GEY 415	Geology of Nigeria	2	C	-	90
GPH 401	Research Project	6	C	-	270
GPH 405	Engineering Geophysics	1	C	15	-
GPH 408	Geophysical Seminar	1	C		45
GPH 409	Radiometric and Well Logging Methods	2	C	15	45
GPH 410	Geophysics and Geothermal Energy	1	C	15	-
GPH 411	Seismic Reflection Prospecting Methods	2	C	15	45
GPH 412	Groundwater Geophysics	1	C	15	
GPH 413	Borehole Geophysics	2	C	30	-
GPH 414	Environmental Geophysics	1	C	15	-
GPH 499	Industrial Attachment (24weeks) (5-year Programme only)	6	C	-	270
	Total	**21**			

Note: GPH 499 is applicable to a 5-year programme

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. identify possible sound patterns in English language;
2. list notable language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English language (phonetics and phonology, vowels and consonants). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations and many more.). Sentence in English (types: structural and functional, simple and complex). Grammar and usage (tense, mood, modality, concord and aspects of language use in everyday life). Logical and critical thinking and reasoning methods (Logic and syllogism, inductive and deductive argument and reasoning methods, analogy, generalisation and explanations). Ethical considerations, copyright rules and infringements. Writing activities: (Pre-writing, writing, post writing/editing and proofreading; paragraphing, types of writing, summary, essays, letters, curriculum vitae, report writing, note making and mechanics of writing). Comprehension

strategies (Reading and types of reading, comprehension skills, 3RsQ). Information and Communication Technology in modern language learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of trade, economic and self-reliance status of the Nigerian people towards national development;
5. enumerate the challenges of the Nigerian State towards nation building;
6. analyse the role of the judiciary in upholding people's fundamental rights;
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture, and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria, Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914, formation of political parties in Nigeria, nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics and Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system, indigenous apprenticeship system among Nigeria people, trade, skill acquisition and self-reliance). Social justices and national development (law: definition and classification). Judiciary and fundamental rights. Individual norms and values (basic Nigeria norms and values, patterns of citizenship acquisition, citizenship and civic responsibilities, indigenous languages, usage and development, negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation). Re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption (WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;

4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic definition of set, subset, union, intersection, complements and use of venn diagram;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify the various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements and venn diagrams. Real numbers, integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations and binomial theorem. Complex numbers, algebra of complex numbers, the argand diagram. De-Moivre's theorem, nth roots of unity. circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning and function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Functions of a real variable, graphs, limits and idea of continuity. The derivative, as limit of rate of change. Techniques of differentiation. Extreme curve sketching, integration as an inverse of differentiation. Methods of integration, definite integrals. Application to areas and volumes.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes
Upon the completion of course, the student should be able to:
1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents
Space and time. Units and dimension, vectors and scalars, differentiation of vectors: displacement, velocity and acceleration. Kinematics; Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). relative motion. Application of Newtonian mechanics. equations of motion. conservation principles in physics, conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass. Rotational motion. torque, vector product, moment, rotation of coordinate axes and angular momentum, polar coordinates. conservation of angular momentum; Circular motion. Moments of inertia, gyroscopes and precession. gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General Physics II (Electricity & Magnetism) (2 Units C: LH 30)

Learning Outcomes
On completion, the student should be able to:
1. describe the electric field and potential and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;
5. describe electromagnetic induction and related concepts and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters; and
8. determine the characteristics of ac voltages and currents in resistors, capacitors and inductors.

Course Contents
Forces in nature, electrostatics, electric charge and its properties, methods of charging Coulomb's law and superposition, electric field and potential, Gauss's law, capacitance, electric dipoles, energy in electric fields, conductors and insulators, current, voltage and resistance, Ohm's law and analysis of DC circuits, magnetic fields, Lorentz force, Biot-Savart and Ampère's laws, magnetic dipoles, dielectrics, energy in magnetic fields, electromotive force, electromagnetic induction, self and mutual inductances, Faraday and Lenz's laws, step up and step down transformers, Maxwell's equations, electromagnetic oscillations and waves, AC voltages and currents applied to inductors, capacitors, resistance and combinations.

PHY 107: General Practical Physics I (1 Unit C: PH 45)

Learning Outcomes
On completion, the student should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasizes quantitative measurements. Experimental techniques. The treatment of measurement errors. Graphical analysis. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc. (covered in PHY 101, 102, 103 and PHY 104). However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis, and deduction.

PHY 108: General Practical Physics II (1 Unit C: PH 45)

Learning Outcomes
On completion, the student should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data; and
6. prepare and present practical reports.

Course Contents
This practical course is a continuation of PHY 107 and is intended to be taught during the second semester of the 100 level to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements, the treatment of measurement errors, and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

CHM 101: General Chemistry I **(2 Units C: LH 30)**

Learning Outcomes
At the end of this course, the students should be able to:
1. define atom, molecules, and chemical reactions;
2. discuss the modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. illustrate shapes of simple molecules and hybridized orbitals;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure, and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. determine the rate of reactions and its dependence on concentration, time and temperature

Course Contents
Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence forces and structure of solids. Chemical equations and stoichiometry, chemical bonding and intermolecular forces and kinetic theory of matter. Elementary thermochemistry; rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II **(2 Units C: LH 30)**

Learning Outcomes
At the end of this course, the students should be able to:
1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reaction;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. describe basic properties of Transition metals.

Course Contents
Historical survey of the development and importance of Organic Chemistry; Fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures, nano chemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols,

ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids, and derivatives. The chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. differentiate between primary and secondary standards;
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents
Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify and carry out preliminary tests which includes ignition, boiling point, melting point, test on known and unknown organic compounds;
5. execute solubility tests on known and unknown organic compounds;
6. execute elemental tests on known and unknown compounds; and
7. conduct functional group/confirmatory test on known and unknown compounds which could be acidic / basic / neutral organic compounds.

Course Contents
Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

GEY 101: Introduction to Geology I (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the structure and composition of the earth;
2. identify the major minerals and rocks; and
3. recognise and explain driving forces within the earth and the manifestations.

Course Contents
Elements of physical geology and physiographic features of the earth. The solar system. Origin and characteristics of the atmosphere and hydrosphere. Classification, properties and description of major minerals, rock types and occurrence of economic minerals. History of the earth and universe. Earth's internal structure: plate tectonics and earthquakes.

GEY 102: Introduction to Geology II (2 Units C: LH 15; PH 45)

Learning Outcomes
On completion, students should be able to:
1. describe how fossils are formed;
2. state the uses of fossils in geological studies;
3. define and explain key ancient geological events; and
4. discuss the evolution of organism.

Course Contents
Theory of the evolution of organism. Major uses of fossils in geology. Distribution and classification of major fossil groups and their occurrence and uses. Principles of historical geology and stratigraphy. Concepts of Paleoclimates, paleogeography, palaeoceanography, palaeomagnetism and paleoenvironment

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students should be able to:

1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents

Concept of Entrepreneurship (entrepreneurship, intrapreneurship/corporate entrepreneurship). Theories, rationale and relevance of entrepreneurship (schumpeterian and other perspectives, risk-taking, necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of entrepreneurs (opportunity seeker, risk taker, natural and nurtured, problem solver and change agent, innovator and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking and creative thinking). Innovation (concept of innovation, dimensions of innovation, change and innovation, knowledge and innovation). Enterprise formation, partnership and networking (basics of business plan, forms of business ownership, business registration and forming alliances and join ventures). Contemporary entrepreneurship issues (knowledge, skills and technology, intellectual property, virtual office and networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, youth and women entrepreneurship, entrepreneurship support institutions, youth enterprise networks and environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

PHY 205: Thermal Physics (2 Units C: LH 30)

Learning Outcomes

On completion, students should be able to:

1. discuss the concept of heat and temperature;
2. explain and determine thermodynamic processes;
3. explain and evaluate properties of real and ideal gases;
4. evaluate the consequences of the thermodynamic laws;
5. describe the basis of the kinetic theory; and
6. describe the statistical behaviour of gases with applications

Course Contents

Classical thermodynamics including the zeroth and definition of temperature, the first law, work heat and internal energy, carnot cycles and the second law, entropy and irreversibility, thermodynamic potentials and the Maxwell relations. Ideal gas equation and internal energy, including internal molecular modes, qualitative discussion of phase transitions, Gibbs free energy,

Clausius-Clapeyron equation, examples of phase transitions including Van der Waals gas, kinetic theory, mean free path, equi-partition of energy, heat transfer and diffusion rate.

PHY 207/208: Practical Physics III & IV (2 Units C: PH 90)

Learning Outcomes
On completion, students should be able to:
1. verify some equations, physical laws and theorems;
2. identify apparatus and set up experiments; and
3. investigate relationships between physical quantities numerically and graphically

Course Contents
The laboratory course consists of a group of experiments drawn from diverse areas of Physics (optics, electrical and electronics, electromagnetism, mechanics and modern physics.) It is accompanied by seminar studies of standard experimental technique and the analysis of famous and challenging experiments.

GPH 201: Introduction to Earth Physics (2 Units C: LH 30)

Learning Outcomes
After completing of this course, students should be able to:
1. describe the earth's interior structure and the internal forces that take place within the earth interior, geophysical fluids and environmental hazards;
2. identify the major minerals and rocks;
3. explain the ancient key geological event; and
4. compare geomagnetic field observations and discuss the effects of magnetic storms.

Course Contents
The earth's history. The earth's interior. Seismicity and earthquake zones. The nature of the gravity field of the earth. The measurement of gravity and the figure of the earth. The Earth's magnetic field. Rock magnetism, polar wandering and the continental drift. Heat flow and geo thermometry, harmonic analysis. Fourier analysis. Statistical regression analysis, curve fitting techniques and analysis of errors. Bessel equation and legendre polynomials. Solution of matrix equations.

GEY 210: Introduction to Geological Mapping (2 Units C: LH 15; PH 45)

Learning Outcomes
At end of this course, students should be able to:
1. define geological structures;
2. represent scales of maps;
3. read topographic maps and prepare a base map;
4. prepare and interpret; and
5. geological maps.

Course Contents
Contour and contouring. Recognition of basic geological and geographic features. Geological structures. Preparation and interpretation of topographic maps and base maps. Detail interpretation of simple geological maps.

GPH 211: Geomathematics (2 Units C: LH 30)

Learning Outcomes
At end of this course, students should be able to:
1. use mathematical and statistical concepts in solving quantitative geological and geophysical problems; and
2. exhibit proficiency in using multivariate and univariate geological and geophysical data analysis and processing.

Course Contents
Differential and integral calculus. Types of functions. Vector analysis, magnetic and gravity potential theory representation. Matrix algebra, solution of laplace equations and spherical

GEY 212: Introduction to Geological Field Mapping (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. use sample geological equipment in the field;
2. prepare a base map;
3. observe and record field geological data; and
4. prepare and interpret geological maps and write a geological report.

Course Contents
Practical: observation and recording of geological features, in particular, in sedimentary and crystalline rock terrains. Sampling and labelling of samples. Application of field techniques. Field data management. Base and geological map interpretation. Report writing.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents
Concepts of peace, conflict and security in a multi-ethnic nation. Types and Theories of conflicts: ethnic, religious, economic, geo-political conflicts. Structural Conflict Theory, Realist Theory of Conflict, Frustration-Aggression Conflict Theory. Root causes of conflict and violence in Africa: indigene and settlers phenomenon; boundaries/border disputes; political disputes; ethnic disputes and rivalries; economic inequalities; social disputes; nationalist movements and agitations. Selected conflict case studies – Tiv-Junkun; Zango Kartaf, Chieftaincy and Land disputes. Peace building, management of conflicts and security,peace &human development. Approaches to peace &conflict management --- (religious, government, community leaders and many more). Elements of peace studies and conflict resolution,conflict dynamics assessment scales:constructive &destructive. Justice and legal framework,concepts of social justice,the Nigeria Legal System. Insurgency and terrorism. Peace mediation and peace keeping. Peace &security council (international, national and local levels). Agents of conflict resolution:conventions, treaties,community policing: evolution and imperatives. Alternative Dispute Resolution, ADR: a). Dialogue b). Arbitration, c). Negotiation d). Collaboration. Roles of international organisations in conflict resolution: (a) The United Nations (UN) and its conflict resolution organs. (b) The African Union & Peace Security Council. (c) ECOWAS in peace keeping. Media and traditional institutions in peace building. Managing post-conflict situations/crisis: refugees,internally displaced persons (IDPs). The role of NGOs in post-conflict situations/crises.

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students, through case study and practical approaches, should be able to:
1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents
Opportunity identification (sources of business opportunities in Nigeria, environmental scanning, demand and supply gap/unmet needs/market gaps/market research, unutilised resources, social and climate conditions and technology adoption gap). New business development (business planning and market research). Entrepreneurial finance (venture capital, equity finance, micro finance, personal savings, small business investment organisations and business plan competition). Entrepreneurial marketing and e-commerce (principles of marketing, customer acquisition &retention, B2B, C2C and B2C models of e-commerce, first mover advantage, e-commerce business models and successful e-commerce companies). Small business management/family business, leadership &management, basic bookkeeping, nature of family business and family business growth model. Negotiation and business communication (strategy and tactics of negotiation/bargaining, traditional and modern business communication methods).

Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological solutions (the concept of market/customer solution, customer solution and emerging technologies, business applications of new technologies - *Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy, Digital Business and E-Commerce Strategies).*

GPH 305: Geophysical Field Methods and Instrumental Analysis (1 Units C: PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. describe various method of geophysical survey;
2. carry out geophysical data acquisition using seismic and electrical methods; and
3. demonstrate proficiency in common practical skills in seismology and electrical method of applied geophysics.

Course Contents
Study of the essential elements of geophysical data acquisition systems. Seismic surveys using explosives or surface sources. Signal amplification, multiplexed methods in electrical prospecting. Elements of currents and voltage measurement circuitries. Field surveys using gravimeters in electromagnetic prospecting. Field procedures for the different EM methods. Geophysical logging instruments and methods. Instrument circuitry in induced polarization prospecting methods.

GPH 307: Magnetic Prospecting Methods (1 Units C: LH 15)
Learning Outcomes
At the end of the course, students should be able to:
1. explain gravity and magnetic methods in geophysical exploration for natural resources, onshore and offshore Nigeria; and
2. describe how magnetic data is acquired, processed and interpreted for geological mapping of structures and minerals.

Course Contents
Fundamentals of magnetic dipole interactions with applications to simple mass distributions. Gauss theorem. The filed equation. Instrumentation and field procedures. Reduction of magnetic data. Anomaly separation and interpretation. Air-borne and sea-borne magnetic surveys. Data acquisition and interpretation. Applications of magnetic methods in mineral exploration and geologic mapping.

GPH 308: Seismic Refraction Prospecting Method (2 Units C: LH 30)

Learning Outcomes
On completion of the course, students should be able to:
1. map geologic structure by determining the arrival time of reflectors and deduce information about stratigraphy changes;
2. solve problems associated with pump tests, borehole geophysical techniques and mineral activities; and
3. interpret geophysical data.

Course Contents
Geophysics and mineral exploration activities. Seismic exploration. Wave types: direct, refracted and reflected wave paths. Curved ray theory and applications. Refraction for the N-layer horizontal case. Numerical solution for a refraction profile over a single dipping interface. Field techniques, processing and interpretation of modern seismic refraction sections and static correction charts.

GPH 309: Gravity Prospecting Methods (1 Unit C: LH 15)

Learning Outcomes
At the end of the course, students should be able to:
1. use gravimeter to acquire gravity data, process and interpret; and
2. Identify certain features such as faults, intrusions, minerals, ground water and geology mapping.

Course Contents
Introduction: Potential, theory of attraction and potential with applications to simple mass distributions. Theorems of Green and Gauss. The field equations, Green's formulae and equivalent surface layers, instruments and date acquisition, gravity, data reduction, regional, residual anomaly separation. Interpretation of gravity anomalies, death and total mass estimates applications of gravity method in mineral exploration, groundwater and geologic mapping.

GPH 311: Principles of Geophysics (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students are expected to:
1. explain the concepts of all the geophysical methods; and
2. process and analyse collected geophysical data.

Course Contents
Gravity and magnetic methods, data acquisition and interpretation, spontaneous potential and electrical resistively methods, concepts of electrical potential, current density and conductivity of rocks, potentials distribution in a homogeneous earth and apparent resistively and elect-interpretation.

GPH 312: Electrical and Electromagnetic Prospecting Methods
(2 Units C: LH 15; PH 45)

Learning Outcomes
A successful student in this course should be able to;
1. explain the theory and application of the electrical and electromagnetic methods in mapping the earth for mineral and hydrocarbon; and
2. apply the controlled source electromagnetic (CSEM) exploration for the determination of resistivity for hydrocarbon and minerals.

Course Contents
An introduction to the fundamentals, instrumentation, field procedure, computations, interpretation, and application of electrical exploration methods. Laboratory work with scale and mathematical models coupled with fieldwork in the areas of known geology. Magneto- telluric survey, EM applications in mineral exploration, environmental assessment and monitoring, tectonic studies and earthquakes studies. The controlled source electromagnetic in hydrocarbon exploration. Maxwell's equation.

GPH 322: Introduction to Software and Modelling (1 Unit C: LH 15)

Learning Outcomes
At the end of the course, students are expected to be able to:
1. use modern software technology to locate record, illustrate and present published data, models, hypotheses and conclusions;
2. read and interpret topographic and geophysical/geological maps and other data displays unique to geophysical such as geophysical cross sections, seismic records and geophysical logs;
3. apply existing field and laboratory procedures or devising new ones to acquire original data and use appropriate software (e.g. statistics) to analyse research data;
4. assess a geophysical model/image in terms of its information content and resolution;
5. effectively communicate the interpreted results of their work to geophysicists and the public in both oral and written form; and
6. explain public issues in the geophysical sciences and be ready and able to contribute to their resolution.

Course Contents
Appreciation and application of some relevant software (Petrel E &P, petrolog, surfer, Arc GIS, geoprobe, promax, win resist and Dippro^{tm} 4.0 inversion software)**.**

GPH 398: Entrepreneurship in Applied Geophysics (1 Unit C: LH 15)
Learning Outcomes
At the end of the course, students should be able to:
1. apply the basis of bid invitation and tenderly in applied geophysics;
2. demonstrate altitude of responsibility on geophysical survey independently; and
3. explain the concepts, principles, workshop procedures and techniques of system design, process of applied geophysics.

Course Contents
Fundamentals of geo-enterprises, business plan bid invitation and tendering. Geophysical survey method and instrumentation. Processing of minerals and fossils. Agro Geophysics.

GPH 399: Industrial Attachment II/ Field Work (12 weeks) (3 Units C: PH 135)
Learning Outcomes
On completing the industrial attachment, student should be able to:
1. handle tools and relevant equipment in the industries;
2. demonstrate practical skills in applying the theories learned in the classroom; and
3. write good technical report.

Course Contents
Students should be attached to some industrial organisations for additional 12 Weeks at the 300 level preferably during the long vacation for geological and geophysical field experience. It is important that students are attached to establishments that actively carry out geological/geophysical field studies so that the students can participate in such studies. Students are to be assessed based on seminar presentation, their reports and assessment by supervisors.

400 Level

GPH 401: Research Project (6 Units C: PH 270)

Learning Outcomes
At the end of this course, students should be able to know how to:
1. design a research work on the basis of some geophysical principles;
2. independently carry out research on any geological problem using any geophysical method; and
3. present and defence a geophysical research work.

Course Contents
Geological investigation and independent research involving field, laboratory and library studies.

GPH 405: Engineering Geophysics (1 Units C: LH 15)

Learning Outcomes
At the end of this course, students should be able to:
1. apply geophysical methods in solving engineering problems, mapping, geological structures, mineral and water resources;
2. explain the principles and applications of soil mechanics;
3. outline and describe the geotechnical techniques; and
4. write and present geophysical report.

Course Contents
Shallow geophysical techniques for evaluation of engineering parameters, elastic co-efficient, geologic structure, groundwater, seismic hazards and regulatory criteria.

GPH 408: Geophysical Seminar (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, students are expected to:
1. carry out research on any geophysical topic and have presentation skill; and
2. search and review literature.

Course Contents
Students are to make presentations on materials from personal investigation or on materials selected from geophysical literature.

GPH 409: Radiometrics and Well Logging Methods (2 Units C: LH 15; PH 45)

Learning Outcomes
After the completion of this course, students are expected to:
1. describe the fundamental concepts of well logging, interpretation and make decisions as it applies to oil/gas and underground water exploration; and
2. recognise safety issues including handling radioactive sources.

Course Contents
Fundamental principle of radioactivity, nuclear, radioactive decay processes, radioactivity of rocks and minerals. Instrumentation and data interpretation. Case histories. Concepts of the logging techniques. Electrical logging methods. Resistively, self-potential, induced polarization and E, Dip-meter. Porosity logs, sonics, gamma ray, density and neutron logs. Others: susceptibility, calliper, thermal, gravimetric logs. Instruments, data acquisition and interpretation of logs, application of geophysical logs in oil and ground water exploration.

GPH: 410 Geophysics and Geothermal Energy (1 Unit C: LH 15)

Learning Outcomes
At the end of the course, students are expected to:
1. explain geothermal energy as the vast reservoir of heat energy in the earth interior; and
2. use geophysical methods i.e., electrical/seismic to explore geothermal and hydrocarbon resources.

Course Contents
Origin and nature of heat flow from the earth. Factors that control economic aspects of geothermal energy. Descriptions of known fields. Application of heat flow measurement, electrical surveys, seismicity studies and other exploration tools for the search and evaluation of geothermal energy. Field trips.

GPH 411: Seismic Reflection Prospecting Methods (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the basic principle of seismic wave propagation and ray theory including mathematical foundations; and
2. describe seismic reflection is applied in oil/gas exploration i.e. in the acquisition, processing and interpretation of modern seismic reflection sections in onshore and offshore basin.

Course Contents
The place of geophysics in oil exploration, propagation of seismic waves. Analytical treatment of elementary seismic reflection problems. Field techniques. Processing and interpretation of modern seismic reflection sections and NMO charts.

GPH 412: Groundwater Geophysics (1 Units C: LH 15)

Learning Outcomes
A successful student in this course should be able to:
1. apply relevant geophysical methods to locate ground water aquifer in basement complex and sedimentary areas;

2. illustrate the physics of water flow and mass, chemistry of water and biological phenomenal;
3. relate the hydrological cycle; and
4. define the groundwater hydraulics and hydrodynamic laws.

Course Contents
Application of geophysical methods in groundwater exploration. Aquifer determination in basement complex and sedimentary areas. Mapping of geological structure useful to groundwater investigation. Determination of aquifer characteristics. Relevant geophysical techniques and field procedures. Borehole location strategy. Case histories.

GPH 413: Borehole Geophysics (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. list the various methods of evaluating source rock potential and define the reservoir properties using the well logs;
2. explain the theoretical basis of well logging tools that recover information about subsurface rocks and their fluids;
3. interpret the results of well logging operations using appropriate software; and
4. prepare various subsurface maps and calculate hydrocarbon reserves.

Course Contents
Concepts of the logging techniques. Electrical logging methods. Resistively, self-potential, induced Polarization, E, Dipmeter and many more. Porosity logs-sonics, gamma ray, density, neutron logs and many more. others-susceptibility, calliper, thermal, gravimetry logs. Instruments, data acquisition and interpretation of logs, application of geophysical logs in oil and ground water exploration.

GPH 414: Environmental Geophysics (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. apply the facts and concept central to earth science; and
2. apply geophysical techniques to environmental pollution studies and determination of ground water quality.

Course Contents
Applications of geophysical techniques in environmental pollution studies, saline water intrusion and mapping, determination of groundwater quality, chemical pollution at industrial sites and delineation of chemical plumes, oil spillage, pollution and its mapping.

GEY 408: Petroleum Geology (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. state the characteristics of hydrocarbons;
2. discuss the concept of source rocks;
3. explain how source rocks are formed and different types of sources;

4. list the various methods of evaluating source rock potential;
5. discuss the reservoir properties;
6. recognise and describe various types of traps and understand the trapping mechanism;
7. explain principles and application of well logs; and
8. prepare various subsurface maps and calculate reserves.

Course Contents
Forms of petroleum: solid, liquid and gaseous forms; surface and subsurface occurrence. Accumulation of organic matter and concept of source rock. Transformation of organic matter and hydrocarbon generation. Migration of hydrocarbon. Properties of petroleum reservoir, traps, and seals. Hydrocarbon traps and abnormal pressure. Exploration methods. Reserves and basin classification. Subsurface maps. Well-logging and interpretation. Examples of major oil deposits, bitumen and conventional oil deposits in Nigeria. Stages in licensing, exploration and production. Introduction to the use of relevant computer packages for data analyses and graphical presentation. Origin, occurrence and distribution of hydrocarbon deposits and fields.

GEY 415: Geology of Nigeria (2 Units C: PH 90)

Learning Outcomes
At the end of the course, students should be able to:
1. locate and describe strategic geologic sequences in Nigeria;
2. discuss the cretaceous and tertiary sequences;
3. describe the location of various Precambrian rock belts and provinces, older granites, younger granites and schist belts;
4. recognise the location of some mineralised zones, mines and quarries; and
5. recognise and field characteristics of the geological exposures.

Course Contents
Field study through 2-week excursion to major geological features and type localities within the basement complex and sedimentary domain of Nigeria.

GPH 499: Industrial Attachment (For 5-year programme) (6 Units C: PH 270)

Learning Outcomes
At the end of the programme, students are expected to:
1. describe the use of all the Geophysical methods in the exploration of solid mineral, hydrocarbon, underground water and in geotechnical evaluation; and
2. write a good technical report.

Course Contents
Students should be attached to some related industrial organisations for 24 weeks during second semester of the 400 level and the long vacation. Assessment to be based on seminar presentation, report and assessment by supervisor.

Minimum Academic Standards

Equipment

The laboratories (minimum of two) should contain some of the following equipment

1. Resistivity Meter (ABEM Tetrameter LS, ABEM Tetrameter SAS1000).
2. Magnetometer.
3. Gravimeter.
4. VLF – Electromagnetic Equipment.
5. Digital Electronic Equipment.
6. Gamma Ray Spectrometer RS -125.
7. Aeroflex Spectrum Analyser.
8. Satellite Disk.
9. Atomic Absorption Spectrometer.
10. Gas Chromatography FID.
11. FT Infrared Spectrometer.
12. Dedicated Workstation with appropriate software's for interpretations.
13. Seismograph.
14. Ground Penetrating Radar (GPR) Equipment.

Staffing

Academic Staff

For a programme such as Applied Geophysics to start, the guidelines on academic staff/student ratio 1:20 shall apply. There is need to have at least six (6) members of the academic staff. This will be in the ratio of **1:2:3**, which is translated into one coming from:

Professor/Reader	1
Senior Lecturers	2
Lecturers 1 and below	3 (at least two with Ph.D)
Laboratory Technologist	2
Laboratory Assistant	3
Laboratory Attendance	3
Secretary	1
Officer Assistants	1

This ratio can further be extended to percentages based on the available number of staff for the program. The minimum standard of staff is, therefore, Professorial Cadre should be 20%, Senior Lecturer Cadre should be 35% and other categories of Lecturers should be 45%, respectively. The pyramid can change status, if it is too heavy.

Administrative Support Staff

The services of the administrative support staff are indispensable in the proper administration of departments and faculty offices. It is important to recruit very competent and computer literate senior staff.

Technical Support Personnel

The services of technical support staff, which are indispensable in the proper running of laboratories and workshops, are required. It is important to recruit very competent senior

technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of development in equipment operation and maintenance.

Library

The University Library Service should provide access to a wide range of resources, services and study spaces, as well as professional expertise to help students to be successful in their studies and research. There should be an adequate number of recent books, subscriptions to journals and provision of access to more e-books in the programme under review. There should be a dedicated departmental library with internet facilities.

Library search can be used to locate books, journal articles and a lot more information using a single search. The Library's Subject Guides bring together tailored, subject-specific information and resources for your specific discipline. Online subject guide should be provided and published to bring together all the key resources for the subject together with a variety of guides on topics such as referencing.

Online library help should be made available 24/7. Staff can help students to find the information they need, as well as help them improve their academic and research skills.

Classrooms, Laboratories, Workshops and Office Space

The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

B.Sc. Biochemistry

Overview

Biochemistry programme is designed to enable graduates acquire broad based knowledge on chemical processes in living organisms ranging from single to multi- cellular organisms, both plants and animals. The first year of the programme is designed to prepare the students to acquire sound background knowledge of relevant science subjects, which would be a foundation to prepare them for specialized knowledge of Biochemistry. During the second and third year, the programme will expose the students to fundamental constituents (macro and micro) that constitute life processes and their dynamics. This will prepare them to appreciate the consequences of various deviations from normal during the final year.

Philosophy

Biochemistry programme provides broad based education that explains chemical processes that take place in living organisms and the causes of various deviations, which can invariably lead to pathological conditions. It also provides basis for manipulation of normal processes to achieve desired outcome. Products of the programme will be suitable for employment in health, food and related industries. They can also be self- employed.

Objectives

The main objectives of the degree programme in biochemistry would be to:

1. provide students with a broad and balanced foundation of biochemical knowledge and practical skills;
2. develop in students the ability to apply knowledge and skills to solving theoretical and practical problems in biochemistry;
3. develop in students, a range of transferable skills that are of value in biochemical and non-biochemical employment
4. provide students with knowledge and skills base from which they can proceed to further studies in specialised areas of biochemistry or multi-disciplinary areas involving biochemistry;
5. provide, through training and orientation, an appreciation of the rewards of inter- and multi-disciplinary approach to the solution of complex life problems; and
6. generate in students an appreciation of the importance of biochemistry in industrial, economic, environmental, technological and social development.

Unique Features of the Programme

The unique features of the programme include:

1. development, in the students, of high cognitive abilities and skills related to biochemistry and other life sciences;
2. students would be introduced to properties of flora and fauna, which are abundant in the tropics that may enable their use as candidates for drug development;
3. graduates would be capable of exhibiting practical skills in biochemistry, including knowledge of safety issues in laboratories and instrumentation;
4. graduates would be able to develop scientific information literacy skills to support independent learning and industrial knowledge; and
5. graduates would be able to demonstrate critical thinking skill to solve problems relating to biochemistry and other life sciences.

Employability Skills

1. Graduates would be familiar with various biochemical processes used in industries.
2. They will imbibe a sense of enthusiasm for biochemistry as central to other life sciences.
3. Appreciation of biochemical application in different other related fields.
4. They can be self-employed by establishing relevant small and medium scale enterprises.

21st Century Skills

1. Critical thinking, problem solving, reasoning, analysis, interpretation and synthesizing information.
2. Predictability skills without using live specimen.
3. Creativity, imagination, innovation and personal expression.
4. Research skill and practices and interrogative questioning.
5. Oral and written communication.
6. ICT literacy, data interpretation and analysis.

Admission and Graduation Requirements

Admission Requirements

1. The entry requirements for a four-year degree programme shall be senior secondary certificate (SSC) credit passes (WASC; NECO or equivalent) in five subjects at not more than two sittings. Such subjects shall include English language, Mathematics, Biology, Chemistry and Physics. In addition, an acceptable pass in the Unified Tertiary Matriculation Examination (UTME) is required for admission into 100 Level.

2. Candidates with five SSCE (or equivalent) credit passes with at least two at the GCE Advanced Level or IJMB or JUPEB in Biology and Chemistry, may be considered for admission into 200 Level.

Graduation Requirements

Expected duration for UTME candidates shall be 4 years and students are required to pass a minimum of 120 units, while for direct entry students, expected duration for graduation shall be 3 years and would be expected to pass a minimum of 90 units which must include all compulsory courses.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
BIO 101	General Biology I	2	C	30	-
BIO 102	General Biology II	2	C	30	-
BIO 107	General Biology Practical I	1	C	-	45
BIO 108	General Biology Practical II	1	C	-	45
CHM 101	General Chemistry I	2	C	30	-
CHM 102	General Chemistry II	2	C	30	-
CHM 107	General Chemistry Practical I	1	C	-	45

Course Code	Course Title	Unit(s)	Status	LH	PH
CHM 108	General Chemistry Practical II	1	C	-	45
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 107	General Physics Practical I	1	C	-	45
PHY 108	General Physics Practical II	1	C	-	45
	Total	**29**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
BCH 201	General Biochemistry I	2	C	30	-
BCH 202	General Biochemistry II	2	C	30	-
BCH 203	General Biochemistry Practical	1	C	-	45
STA 221	Statistics for Agriculture & Biological Sciences	3	C	45	-
	Total	**12**			

300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and conflict Resolution	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
BCH 301	Enzymology	2	C	30	-
BCH 302	Metabolism of Carbohydrates	2	C	30	-
BCH 303	Metabolism of Lipids	2	C	30	-
BCH 304	Metabolism of Amino Acids & Proteins	2	C	30	-
BCH 305	Metabolism of Nucleic Acids	2	C	30	-
BCH 306	Analytical Methods in Biochemistry	3	C	30	45
BCH 307	Membrane Biochemistry	2	C	30	-
BCH 308	Bioenergetics	1	C	15	-
BCH 309	Inorganic Biochemistry	1	C	15	-
BCH 399*	Industrial Attachment	3	C	-	12 Weeks
	Total	**24**			

***** To take place during the long vacation between 300 and 400 Levels

400 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
BCH 401	Advanced Enzymology	2	C	30	-
BCH 402	Molecular Biochemistry	2	C	30	-
BCH 403	Metabolic Regulations	2	C	30	-
BCH 404	Biochemical Reasoning	1	C	15	-
BCH 405	Plant Biochemistry	2	C	30	-
BCH 406	Research Project	6	C	-	270
BCH 407	Bioinformatics	2	C	30	-
BCH 408	Biochemical Entrepreneurship	2	C	30	-
	Total	**19**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. identify possible sound patterns in English language;
2. list notable language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages and collocations). Sentence in English (types, structural and functional, simple and complex). Grammar and usage (tense, mood, modality, concord and aspects of language use in everyday life). Logical and critical thinking and reasoning methods (logic and syllogism, inductive and deductive argument and reasoning methods, analogy, generalisation and explanations). Ethical considerations, copyright rules and infringements. Writing activities: (Pre-writing, writing, post writing, editing and proofreading, brainstorming, outlining, paragraphing, types of writing, summary, essays, letter, curriculum vitae, report writing, note making and mechanics of writing). Comprehension strategies (reading and types of reading, comprehension skills, 3RsQ). Information and communication technology in modern language learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of trade, economic and self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards nation building;
6. analyse the role of the Judiciary in upholding people's fundamental rights;
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture, and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria and colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914, formation of political parties in Nigeria, nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics and Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system, indigenous apprenticeship system among Nigeria people, trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification. judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition, citizenship and civic responsibilities, indigenous languages, usage and development, negative attitudes and conducts, cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation; re-orientation strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption (WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. explain basic definition of set, subset, union, intersection, complements and use of venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify the various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents

Elementary set theory, subsets, union, intersection, complements and venn diagrams. Real numbers, integers, rational and irrational numbers, mathematical induction, real sequences and

series, theory of quadratic equations and binomial theorem. Complex numbers, algebra of complex numbers and the argand diagram. De-Moivre's theorem, nth roots of unity. circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative, as limit of rate of change. Techniques of differentiation. Extreme curve sketching, integration as an inverse of differentiation. Methods of integration and definite integrals. Application to areas and volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

BIO 101: General Biology I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. explain cell structure and organizations;

2. summarize functions of cellular organelles;
3. characterize living organisms and state their general reproduction;
4. describe the interrelationship that exists between organisms;
5. discuss the concept of heredity and evolution; and
6. enumerate habitat types and their characteristics.

Course Contents
Cell structure and organisation, functions of cellular organelles, characteristics and classification of living things, chromosomes, genes their relationships and importance, general reproduction, interrelationships of organisms (competitions, parasitism, predation, symbiosis, commensalisms, mutualism, saprophytism); heredity and evolution (introduction to Darwinism and Lamarkism, Mendelian laws, explanation of key genetic terms), elements of ecology and types of habitat.

BIO 102: General Biology II (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures, students should be able to:
1. list the characteristics, methods of identification and classification of Viruses, bacteria and fungi;
2. state the unique characteristics of plant and animal kingdoms;
3. describe ecological adaptations in the plant and animal kingdoms;
4. explain nutrition, respiration, excretion and reproduction in plants and animals; and
5. describe growth and development in plants and animals.

Course Contents
Basic characteristics, identification and classification of viruses, bacteria and fungi.
A generalized survey of the plant and animal kingdoms based mainly on the study of similarities and differences in the external features. Ecological adaptations. Briefs on physiology to include nutrition, respiration, circulatory systems, excretion, reproduction, growth and development.

BIO 107: General Biology Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. outline common laboratory hazards;
2. provide precautions on laboratory hazards;
3. state the functions of the different parts of microscope;
4. use the microscope and describe its maintenance;
5. draw biological diagrams and illustrations; and
6. apply scaling and proportion to biological diagrams.

Course Contents
Common laboratory hazards. prevention and first aid. measurements in biology. uses and care of microscope. compound and dissecting microscope. Biological drawings and illustration, scaling, accuracy and proportion. use of common laboratory apparatus and laboratory experiments designed to illustrate the topics covered in **BIO 101.**

BIO 108: General Biology Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the anatomy of flowering plants;
2. differentiate types of fruit and seeds;
3. state ways of handling and caring for biological wares;
4. describe the basic histology of animal tissues; and
5. identify various groups in the animal kingdom.

Course Contents
Anatomy of flowering plants, primary vegetative body. stem, leaf and root to show the mature tissues namely parenchyma, collenchyma, sclerenchyma, xylem and phloem. Types of fruits and seeds. Care and use of dissecting kits and other biological wares. Dissection and general histology of animal tissues based on vertebrate forms. Morphology and functions of epithelial, muscular, nervous and connective tissues. Examination of various groups of lower invertebrates under microscopes, identification of various groups of organisms in Animal Kingdom. Andany experiment designed to emphasize the practical aspects of topics in BIO 102.

CHM 101: General Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. define atom, molecules and chemical reactions;
2. discuss the modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. illustrate shapes of simple molecules and hybridized orbitals;
7. identify the characteristics of acids, bases and salts and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents
Atoms, molecules, elements, compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence forces and structure of solids. Chemical equations and stoichiometry, chemical bonding and intermolecular forces and kinetic theory of matter. Elementary thermochemistry, rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reaction;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. describe basic properties of transition metals.

Course Contents
Historical survey of the development and importance of organic chemistry, fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures and nano chemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The Chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiment;
3. identify the basic glassware and equipment in the laboratory;
4. tell the differences between primary and secondary standards;
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse data to arrive at scientific conclusions.

Course Contents
Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify the general laboratory rules and safety procedures;
2. collect scientific data and correctly carry out chemical experiments;
3. identify the basic glassware and equipment in the laboratory;

4. identify and carry out preliminary tests which includes ignition, boiling point, melting point, test on known and unknown organic compounds;
5. execute solubility tests on known and unknown organic compounds;
6. execute elemental tests on known and unknown compounds; and
7. conduct functional group/confirmatory test on known and unknown compounds which could be acidic/basic/neutral organic compounds.

Course Contents
Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes
On completion of the course, students should be able to:
1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents
Space and time. units and dimension. vectors and scalars. differentiation of vectors: displacement, velocity and acceleration. Kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). relative motion. Application of Newtonian mechanics. equations of motion. conservation principles in physics, conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass. Rotational motion. torque, vector product, moment, rotation of coordinate axes and angular momentum, polar coordinates. conservation of angular momentum; Circular motion. Moments of inertia, gyroscopes and precession. gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General Physics II (Electricity &Magnetism) (2 Units C: LH 30)

Learning Outcomes
On completion of the course, students should be able to:
1. describe the electric field and potential and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distribution using Coulomb's law, Gauss's law and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;

5. describe electromagnetic induction and related concepts and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters; and
8. determine the characteristics of ac voltages and currents in resistors, capacitors and inductors.

Course Contents
Forces in nature, electrostatics, electric charge and its properties, methods of charging, Coulomb's law and superposition, electric field and potential, Gauss's law, capacitance, electric dipoles, energy in electric fields, conductors and insulators, current, voltage and resistance, Ohm's law and analysis of DC circuits, magnetic fields, Lorentz force, Biot-Savart and Ampère's laws, magnetic dipoles, dielectrics, energy in magnetic fields, electromotive force, electromagnetic induction, self and mutual inductances, Faraday and Lenz's laws, step up and step down transformers. Maxwell's equations, electromagnetic oscillations and waves, AC voltages and currents applied to inductors, capacitors, resistance and combinations.

PHY 107: General Practical Physics I (1 Unit C: PH 45)

Learning Outcomes
On Completion of the course, students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasizes quantitative measurements, the treatment of measurement errors and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat and viscosity covered in PHY 101. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

PHY 108: General Practical Physics II (1 Unit C: PH 45)

Learning Outcomes
On Completion of the course, students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasizes quantitative measurements, the treatment of measurement errors and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and

mechanical resonant systems, light, heat, viscosity and many more, covered in PHY 102. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge; and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding and many more

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents
Concept of entrepreneurship (entrepreneurship, intrapreneurship /corporate entrepreneurship). Theories, rationale and relevance of entrepreneurship (schumpeterian and other perspectives, risk-taking, necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of entrepreneurs (opportunity seeker, risk taker, natural and nurtured, problem solver and change agent, innovator and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking, and creative thinking). Innovation (concept of innovation, dimensions of innovation, change and innovation, knowledge and innovation). Enterprise formation, partnership and networking (basics of business plan, forms of business ownership, business registration and forming alliances and joint ventures). Contemporary entrepreneurship issues (knowledge, skills and technology, intellectual property, virtual office, networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, youth and women entrepreneurship, entrepreneurship support institutions, youth enterprise networks and environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

BCH 201: General Biochemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the structure of different macromolecules in biological system;
2. identify types of chemical reactions involving these macromolecules;
3. explain the various methods of isolation of these macromolecules;
4. estimate the effects of acids and alkalis on the macromolecules;
5. describe purification of macromolecules; and
6. discuss quantification of the various macromolecules.

Course Contents
Introductory chemistry of amino acids, their properties, reactions and biological functions. Classification of amino acids: neutral, basic and acidic; polar and non-polar; essential and non-essential amino acids. Peptides. Introductory chemistry and classification of proteins. Biological functions of proteins. Methods of their isolation, purification and identification. Primary, secondary, tertiary and quaternary structures of proteins. Basic principles of tests for proteins and amino acids. Introductory chemistry of carbohydrates, lipids and nucleic acids. Nomenclature of nucleosides and nucleotides, effects of acid and alkali on hydrolysis of nucleic acids.

BCH 202: General Biochemistry II (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the structure of the cell including its components;
2. discuss the interrelationship between different organelles of the cell;
3. recognize the differences between plant and animal cells;
4. isolate the various organelles of both plant and animal cells; and
5. describe the influence of hydrogen ion concentration on cellular function.

Course Contents
The cell theory. Structures and functions of major cell components. Cell types, constancy and diversity. Cell organelles of prokaryotes and eukaryotes. Chemical composition of cells.

Centrifugation and methods of cell fractionation. Structure, function and fractionation of extra-cellular organelles. Water, total body water and its distribution. Regulation of water and electrolyte balance. Disorder of water and electrolyte balance. Acidity and alkalinity, pH and pK values and their effects on cellular activities.

BCH 203: General Biochemistry Practical (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students will be able to understand the various laboratory procedures used in the study of various biochemical processes described in BCH 201 and 202.
Course Contents
Laboratory experiments designed to reflect the topics covered in BCH 201 and BCH 202. Introduction to laboratory methods and procedures employed in studying biochemical processes.

STA 201: Statistics for Agriculture and Biological Sciences (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the scope for statistical methods in biology and agriculture;
2. define the measures of location, partition and dispersion;
3. explain the elements of probability; probability distributions: binomial, poisson, geometric, hypergeometric, negative binomial and normal, Student's t and chi-square distributions;
4. differentiate point from interval estimation and could be able to tests for hypotheses concerning population means, proportions and variances;
5. compute for regression and correlation as well as conduct some Non–parametric tests with reference to Contingency table analysis; and
6. explain the elements of design of experiments and Analysis of variance.

Course Contents
Scope for statistical method in Biology and Agriculture. Measures of location, partition and dispersion. Elements of probability. Probability distributions: binomial, Poisson, geometric, hyper geometric, negative binomial and normal, Student's t and chi-square distributions. Estimation (point and interval) and tests of hypotheses concerning population means, proportions and variances. Regression and correlation. Non–parametric tests. Contingency table analysis. Introduction to design of experiments. Analysis of variance.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents
Concepts of peace, conflict and security in a multi-ethnic nation. Types and theories of conflicts: ethnic, religious, economic, geo-political conflicts; structural conflict theory, realist theory of conflict and frustration-aggression conflict theory. Root causes of conflict and violence in Africa: indigene and settlers phenomenon; boundaries/boarder disputes; political disputes; ethnic disputes and rivalries; economic inequalities; social disputes; nationalist movements and agitations; selected conflict case studies – Tiv-Junkun; Zango Kartaf, chieftaincy and land disputes many more. Peace building, management of conflicts and Security, peace and human development. Approaches to peace &conflict management-(religious, government, community leaders and many more). Elements of peace studies and conflict resolution: conflict dynamics assessment scales, constructive and destructive. Justice and legal framework: concepts of social justice. The Nigeria legal system. Insurgency and terrorism. Peace mediation and peace keeping. Peace &security council (international, national and local levels). Agents of conflict resolution: conventions, treaties, community policing, evolution and imperatives. Alternative Dispute Resolution (ADR) : a). Dialogue b). Arbitration, c). Negotiation d). Collaboration and many more Roles of International Organisations in conflict resolution: (a). The United Nations, UN and its conflict resolution organs; (b). The African Union & Peace Security Council (c). ECOWAS in peace keeping. Media and traditional institutions in peace building. Managing post-conflict situations/crisis: refugees, internally displaced persons (IDPs). The role of NGOs in post-conflict situations/crisis.

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students, through case study and practical approaches, should be able to:
1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents
Opportunity identification (sources of business opportunities in Nigeria, environmental scanning, demand and supply gap/unmet needs/market gaps/market research, unutilised resources, social and climate conditions and technology adoption gap). New business development (business planning and market research). Entrepreneurial finance (venture capital, equity finance, micro finance, personal savings, small business investment organisations and business plan competition). Entrepreneurial marketing and e-commerce (principles of marketing, customer acquisition &retention, B2B, C2C and B2C models of e-commerce, first mover advantage, e-commerce business models and successful e-commerce companies). Small business management/family business, leadership &management, basic bookkeeping, nature of family

business and family business growth model. Negotiation and business communication (strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological solutions (the concept of market/customer solution, customer solution and emerging technologies, business applications of new technologies - *Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy and many more. Digital Business and E-Commerce Strategies).*

BCH 301: Enzymology (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students will be able to:

1. discuss why enzymes are grouped into different classes;
2. explain the basis of classification of enzyme;
3. identify the role vitamins in the cellular system;
4. illustrate the basis and mechanism of enzyme- catalysed reactions;
5. derive equations governing enzyme reactions in cellular systems; and
6. explain the effect of various factors on enzyme reactions.

Course Contents

Discovery, classification and nomenclature of enzymes. Vitamins: fat and water soluble vitamins and co-enzymes, minerals in enzyme biochemistry. Structures and functions of vitamins and co-enzymes. Kinetics of enzymes. Mechanisms of enzyme-catalysed reactions. Effects of temperature, pH, ions and inhibitors on enzyme catalysed reactions. Enzyme inhibition. Derivation and significance of Michaelis-Menten equation. Allosteric/Regulatory enzymes. Active sites of enzymes. Estimation of kinetic parameters of enzyme activities. Zymogen activation, digestive enzymes and many more Production, isolation, purification and characterization of enzymes. Marker enzymes. Recent advances in enzymology.

BCH 302: Metabolism of Carbohydrates (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students will be able to:

1. explain the structure and functions of various polysaccharides;
2. describe the various pathways polysaccharides could be broken down in cellular systems;
3. discuss how the end product of carbohydrate metabolism is attained;
4. explain the central importance of TCA cycle in cellular metabolism; and
5. predict consequences of disorders of carbohydrate metabolism.

Course Contents

Chemistry and function, isolation and purification of polysaccharides. Molecular weight determination and analytical methods for structural determination of polysaccharides. Biochemistry of important disaccharides, oligosaccharides and polysaccharides; degradation and digestion of carbohydrates - sugars, storage polysaccharides and cell walls. Glycolysis, the tricarboxylic acid cycle, the phosphogluconate pathway, the glycoxylate pathway; the pentose phosphate pathway and the cori cycle, the calvin pathway. Gluconeogenesis and glycogenesis,

glycogenolysis, metabolism of fructose, Polyol pathway. Regulation of carbohydrate metabolism. Disorders of carbohydrate metabolism.

BCH 303: Metabolism of Lipids (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students will be able to:

1. describe how various types of lipids (fats and oil) are synthesized;
2. discuss the implication of unsaturation in lipids and oils;
3. explain the mechanism of their degradation;
4. describe the importance of the various pathways of lipid metabolism; and
5. explain the implication of disorder in metabolism to the cellular systems.

Course Contents

Classification of lipids - fatty acids, triglycerides, glycosylglycerols, phospholipids, waxes, prostaglandins. lipid micelles, monolayers and bilayers. Oxidation of fatty acids. Microsomal peroxidation of polyunsaturated fatty acids. Metabolism of unsaturated fatty acids: essential and non-essential. Metabolism of acylglycerols. Metabolism of phospholipids. Cholesterol biosynthesis and breakdown. Metabolism of ketone bodies. Integration of lipid metabolism. Acetic acid as a central precursor for biosynthesis of lipids. Lipoprotein metabolism and transport of lipids. Adipose tissue metabolism.

BCH 304: Metabolism of Amino Acids & Proteins (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students will be able to:

1. illustrate why and how proteins are broken in cellular systems;
2. explain how to determine the molecular weight of proteins;
3. recognise the relationship between the urea cycle and other pathways of protein metabolism;
4. describe the differences between ketogenic and glucogenic amino acids; and
5. identify the role of inorganic nitrogen in protein synthesis and breakdown.

Course Contents

Amino acids as building blocks of proteins and the peptide bond as covalent backbone of proteins. Forces involved in the stabilization of protein structure. Protein isolation, fractionation, purification and characterization. Amino acid analysis of peptides and proteins. Methods for the determination of the sequence of amino acids in proteins. Protein biosynthesis, molecular weight determination of proteins. Techniques in protein biochemistry. Oxidative degradation of amino acids and metabolism of one carbon units. Ammonia toxicity and urea formation. Ketogenic and glucogenic amino acids. Biosynthesis of amino acids and some derivatives, the urea cycle; metabolism of inorganic nitrogen. Disorders of amino acid metabolism and polyamines.

BCH 305: Metabolism of Nucleic Acids (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students will be able to:

1. explain the levels of organisation of nucleic acids;
2. discuss the three- dimensional structure of nucleic acids;

3. interpret how information encoded in genes are able to direct protein synthesis;
4. describe the structure of proteins from nucleic acid composition of the gene; and
5. identify the various implications of disorders in nucleic acid metabolism.

Course Contents
Structure and function of nucleic acids. The genetic code and protein synthesis. Metabolism of purines and pyrimidines, nucleosides and nucleotides. Degradation of purine and pyrimidine nucleotides. DNA replication and DNA repairs. Disorders and abnormalities of nucleic acid metabolism-gout, Lesch-Nyhan syndrome, hypouricaemia, orotic aciduria, Reye's syndrome, *Xeroderma pigmentosus* and skin cancer.

BCH 306: Analytical Methods in Biochemistry (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the principles of instrumentation in biochemistry;
2. describe how the level of precision attained in analysis is dependent on the method employed;
3. discuss why a method is preferred in a particular biochemical investigation;
4. explain the theoretical basis of major instruments used in biochemical analyses; and
5. perform some specific analytical investigations.

Course Contents
Tissue and cell culture techniques, immunoassays, blotting and isotopic techniques. Principles, methodologies, instrumentation and applications of electrophoresis, manometry and centrifugation techniques. Chromatographic techniques including paper, thin layer, column, gas, and high-performance chromatographic techniques. Spectroscopic techniques including uv-visible, infra-red, nuclear magnetic resonance and mass spectrometry. Fluorimetry, polarographic including potentiometric and electrometric measurements. State-of-the-art equipment: gas chromatography-mass spectrometry, thermocycler, high performance liquid chromatography, nuclear magnetic resonance, fourier-transform infrared spectroscopy. This course includes laboratory practical classes, which will provide students the opportunity to practice the various techniques and familiarise themselves with the types of equipment used for the techniques.

BCH 307: Membrane Biochemistry (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the role of membrane as gatekeeper of cells;
2. describe the make-up of membranes;
3. identify the models used to explain the arrangement of molecules contained in membranes; and
4. discuss the mechanism of transportation of molecules into and out of cells.

Course Contents
Structure, composition and functions of biological membranes. Isolation, characterization and classification of membranes; chemistry and biosynthesis of membranes. Molecular organisation of membrane components. Natural and artificial membrane bilayers - the unit membrane

hypothesis and fluid mosaic model. Membrane transport system - active versus passive transport systems. Transport of sugars and amino acids.

BCH 308: Bioenergetics (1 Unit C: LH 15)

Learning Outcomes
At the end of the course, students will be able to:
1. illustrate how biological energy is generated in the cells;
2. explain the concept of 'fuel molecules'; and
3. imbibe comprehensive knowledge of biological energy transformation and utilisation.

Course Contents
High-energy compounds. Chemical thermodynamics, Oxidations and reductions. Chemical potentials, Electrochemical potentials, Electron transport system and oxidative phosphorylation. Uncouplers of oxidative phosphorylation. Shuttle systems for oxidation of extra-mitochondrial NADH, ATP Cycle, Regulation of ATP production.

BCH 309: Inorganic Biochemistry (1 Unit C: LH 15)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the roles of inorganic ions in biological systems;
2. discuss the functions of ions in enzyme actions; and
3. describe the importance of nitrogen and sulphur cycles in living systems.

Course Contents
Relationship between the physicochemical properties and biological functions of inorganic ions. Ligand complexes and their biochemical significance. Trace elements in biological systems. Electrolyte metabolism. Nitrogen cycle and sulphur cycle.

BCH 399: Industrial Attachment (For 4 year Programme - 12 weeks)
(3 Units C: PH 135)

Learning Outcomes
At the end of the course, students will be able to:
1. explain how theoretical principles in biochemistry are employed in industrial production; and
2. describe the clinical application of various metabolic abnormalities for those in clinical laboratories.

Course Contents
Students should be attached to some relevant industrial organisations for 12 Weeks at the end of 300 Level during the long vacation before commencement of 400 Level. Assessment to be based on seminar presentation, report and assessment by their industry and university supervisors.

400 Level

BCH 401: Advanced Enzymology (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the concept and necessity for multi- enzyme actions;
2. describe the chemistry of catalysis;
3. discuss the role of active sites in enzymatic reactions;
4. illustrate various methods that could be used for enzyme assays; and
5. relate the mechanism of regulation of enzyme action and its synthesis.

Course Contents
Chemistry of enzyme catalysis. Steady state enzyme kinetics. Transient kinetic methods. Ligand binding and its application to enzymology. Kinetics of multiple binding sites. Mechanisms of two substrate systems. Molecular models of allosterism. Enzyme models of allosterism. Multi-enzyme complexes. Enzyme assays and techniques in enzymology. Criteria for determining purity of enzymes. Enzyme reconstitution. Regulation of enzyme activity and synthesis.

BCH 402: Molecular Biochemistry (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. explain how genes can be sequenced to determine the structure of DNA contained therein;
2. illustrate the mechanism of replication of DNA in both procaryotic and eucaryotic organisms;
3. describe how genes can be influenced to obtain a pre-determined outcome;
4. discuss the mechanism of action of gene- specific chemical compounds; and
5. explain the bias of human genome project.

Course Contents
Gene structure and function. Nucleic acid function and biological function. DNA sequencing and restriction endonucleases. DNA repair mechanisms. Nucleic acid replication. Regulation of nucleic acid synthesis. Genetic code and gene-protein relationship. Eukaryotic transcription. Control of gene expression. Functional analysis of the replicator structure of bacteriophage DNA. Drug-nucleic acid interactions. Initiation factor for viral DNA replication. Genetic control of viral replication. Model systems used for studying embryology at the molecular level. Model systems in differentiation studies. Cell cycle, Control of cell proliferation. Genetic engineering and recombinant DNA Technology. Polymerase chain reaction, human genome project and gene therapy.

BCH 403: Metabolic Regulations (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the central role of Kreb's cycle in macromolecular metabolism;
2. identify the inter-relationship between metabolic pathways of macromolecules;
3. describe how a product of one cycle can inhibit another pathway; and
4. identify the need to regulate various metabolic pathways and how the cell does it.

Course Contents
The relationship of Krebs' Cycle to protein, carbohydrate, lipid and nucleic acid metabolism. Integration of metabolic pathways. Turn-over rates and metabolic pools. Regulation of enzymes of metabolic pathways-feedback inhibition versus enzyme synthesis. Catabolite repression, end product repression. Identification of different regulatory mechanisms in metabolic pathways.

BCH 404: Biochemical Reasoning (1 Unit: C LH 15)

Learning Outcomes
At the end of the course, students will be able to:
1. apply their broad knowledge of biochemistry to explain any problem they confront; and
2. write scientific papers for conferences and publication.

Course Contents
Evaluation and design of experimental biochemistry from available information and data. Analysis, interpretation and inference: drawing from biochemical research data.

BCH 405: Plant Biochemistry (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. describe the metabolic pathways that are peculiar to plants;
2. explain the concept of secondary metabolites and their application for medicinal purposes;
3. discuss the chemical processes involved in photosynthesis as basis of life; and
4. identify the importance of hormones of plant origin.

Course Contents
Organisation of plant cells. The plant cell wall structure, formation and growth. Biochemistry of plant development. Lignin formation. The biochemistry of important plant processes and metabolic pathways. Photosynthesis. Secondary metabolites. Plant hormones and structure-activity relationship of plant hormones. Biosynthesis of carotenoid pigments. Synthetic growth regulators and herbicides. Indigenous plants of medicinal importance. Recent advances in medicinal plant biochemistry.

BCH 406 Research Projects (6 Units C: PH 270)

Learning Outcomes
At the end of the course, students will be able to:
1. explain laboratory procedures including safety precautions;
2. carry out independent researches that will lead to tangible outcomes; and
3. present outcome of their researches in seminars and conferences.

Course Contents
Independent research findings into selected areas/topics of interest to the supervising academic staff. Students will be required to carry out literature survey on the topics, perform experiments and produce reports (preferably at the end of second semester). Students will be subjected to both seminar and oral examination on the projects undertaken.

BCH 407: Bioinformatics (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. identify the use of computational methods to predict life processes; and
2. explain various programmes applicable to life sciences.

Course Contents
An overview of bioinformatics, history of bioinformatics, genome sequencing projects, database searching algorithms (BLAST, FAST A), pair wise and multiple sequence alignments, phylogenetic analysis, data mining in novel genomes, current topics in bioinformatics and use of perl to facilitate biological analysis.

BCH 408: Biochemical Entrepreneurship (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. explain how to apply their theoretical knowledge to start small/ medium scale production facilities;
2. describe the application of enzymes in industrial processes; and
3. discuss the importance of value chain in biochemical processes.

Course Contents
Entrepreneurship skills related to biochemistry, creation of new ventures/business, writing and designing business plans, feasibility studies, financial planning and management, production of local diagnostic kits, soap/detergents, crude commercial enzymes, quality vegetable oils, bread, confectionery, food processing/packaging and preservation, production of ointments and medicinal plant extracts. Students will be grouped in areas of interest.

Minimum Academic Standards

Equipment

1. Water Bath (Thermostatic)
2. Drying Oven (Thermostatic)
3. Spectrophotometers and Colorimeters
4. pH Meters
5. Electrophoresis Units
6. Centrifuges (Bench- Top & High Speed)
7. Incubators
8. Hot Plates and Heaters
9. Test-Tube Mixers
10. Gas Cylinders, Valves and Tubings
11. Distillers (All Glass)
12. Deionizers
13. Fraction Collector
14. Micro-Kedhjal Apparatus
15. Column Chromatography Equipment
16. Thin Layer Chromatography Equipment
17. Rotary Evaporator
18. Glass wares

Staffing

Professor/Reader	1
Senior Lecturer	2
Lecturers 1 and below	3 (at least 2 with PhD)
Laboratory Technologist	2
Laboratory Assistant	3
Laboratory Attendants	3
Secretary	1
Office Assistant	1

Library

The University Library is expected to stock at least 3 copies each hard-copy text books on biochemistry (both general and specialized), depending on number of students on the programme. There should also be hard copies of subject specific journals, both national and international. The library is also expected to subscribe to data bases that will make numerous text books and journals on biochemistry available as e-resources.

Classrooms, Laboratories, Workshops and Office Space

The NUC recommends the following physical space requirements:

Description		**Size m²**
Professor's Office	-	18.50

Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

B.Sc. Biology

Overview
The current B.Sc. Biology curriculum has undergone several reviews and modifications to satisfy the needs of the 21st century. This curriculum contains the basic concepts and principles of Biology from the simple structure and function of the cell to more complex tissues, organs, systems, organisms and their relationships with the biosphere.

At the 100 and 200 Levels, special emphasis has been given to basic units of life, the interaction of these units and the challenges encountered and their adaptiveness to our ecosystem, in an evolutionary manner. At the 300 and especially 400 level, the curriculum gradually moves and encourages student on the use of scientific processes to thinking critically and how to go about conducting research, to reporting accordingly, and how their findings can be applied to satisfy varied needs of the biotic and abiotic components of the ecosystem. This paradigm shift has been achieved by introducing courses such as bioinformatics, applied biotechnology, bio-entrepreneurial options, animal in prophylactics and therapeutics, amongst others. Such courses will enable graduates of Biology to become an entrepreneur or competent employable individual in any organisation or a researcher/graduate student elsewhere in the world.

Philosophy
To produce graduates that will apply scientific knowledge and skills that are of biological values in solving problems and developmental needs of mankind and the environment.

Objectives
The objectives of the degree programme in Biology are to:
1. equip students with a broad and balanced foundation of biological knowledge and practical skills;
2. cultivate in students the ability to apply knowledge and skills to solving theoretical and practical problems in biology;
3. develop in students, a range of transferable skills that are of value in biological and non biological employment;
4. provide students with knowledge and skills base from which they can proceed to further studies in specialized areas of biology or multi-disciplinary areas involving biology;
5. prepare, through training and orientation, an appreciation of the solitary rewards of inter- and multi-disciplinary approach to the solution of complex life problems;
6. generate in students an appreciation of the importance of biology in industrial, economic, environmental, technological and social development;
7. instil in students a sense of enthusiasm for biology, an appreciation of its application in different contexts and to involve them in an intellectually stimulating and satisfying experience of learning, discovering and innovating; and
8. Provide expert advice and consultancy services to local, national and international organisations on general biology issues.

Unique Features of the Programme
The unique features of the programme include:
1. incorporation of biotechnology to solving ecological problems and human needs;
2. infusion of bioinformatics to enhance students understating of molecular biology;

3. incorporation of prophylactic and therapeutic plants and animals in promoting public health;
4. exploring the analytical skills of students in handling and processing biological data; and
5. grooming students into bio-entrepreneurship options.

Employability Skills and Opportunities

1. B.Sc. Biology programme prepares graduates for entrepreneurship in agroactivities, animal production systems, science school proprietorship, establishing and running analytical science laboratories, development and marketing of bio-products, bio-consultancy, establishing and running environmental NGOs, farming (Fish, poultry, horticulture, heliciculture etc).
2. B.Sc. Biology programme also provides employment opportunities in:
   i. nongovernmental organisations (NGOs) at national and international levels such as Nigerian Conservation Foundation (NCF), International Union for Conservation of Nature (IUCN) and World Wildlife Fund (WWF) etc.
   ii. Intergovernmental organisations such as UNICEF, UNIDO, WHO, UNDP etc.
   iii. Research institutions such as International Institute of Tropical Agriculture (IITA), National Veterinary Research Institute (NVRI), National Horticultural Research Institute (NHORT), National Root Crops Research Institute (NRCRI) etc.
   iv. The private sector as science journalist, researcher, analyst, publisher, environmentalist, commercial farming etc. and
   v. Government organizations as science teacher, researcher, political adviser on science education, analyst, environmentalist, technocrats in ministry, conservationist with National Parks Service or State Game Reserves, medical, paramilitary and military establishment and many more.

21st Century Skills

1. Information technology and self-motivation to succeed in this century.
2. Analytical and problem-solving ability.
3. Critical thinking.
4. Collation and synthesizing data.
5. Research skills, including imaginative, innovative and writing/publishing skills.

Admission and Graduation Requirements

UTME Entry Mode

4-year degree programme

The entry requirements shall be, at least, credit in five subjects including English language and Mathematics as the core subjects, with credits in three other relevant science subjects, preferably Biology, Chemistry and Physics. Agricultural science and Chemistry at the Senior Secondary Certificate (SSC) or its equivalent may be considered with, at least, a credit in Physics. In addition, an acceptable pass in the University Tertiary Matriculation Examination (UTME) into 100-level is required.

Direct entry mode

Five SSC (or equivalent) credit passes in relevant subjects, two of which are at the Advanced Level.

Graduation Requirements

Expected duration for Direct Entry (DE) candidates with two A level passes (graded A-E) at the Advanced Level or its equivalent, in relevant subjects (Biology, Botany, Zoology, Chemistry, Mathematics and Physics) may undertake the three-year degree programme beginning from 200-level.
Students are required to complete a minimum of 120 units for graduation, 60 of which must come from the relevant option areas in Biology.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
BIO 101	General Biology I	2	C	30	-
BIO 102	General Biology II	2	C	30	-
BIO 107	General Biology Practical I	1	C	-	45
BIO 108	General Biology Practical II	1	C		45
CHM 101	General Chemistry I	2	C	30	-
CHM 102	General Chemistry II	2	C	30	-
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
	Total	**25**			

200 Level

Course Code	Course Title	Units	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
BIO 201	Genetics I	2	C	30	-
BIO 203	General Physiology	2	C	30	-
BIO 205	Introductory Developmental/Cell Biology	2	C	30	-

Course Code	Course Title	Units	Status	LH	PH
BIO 202	Introductory Ecology	2	C	15	45
BIO 204	Biological Techniques	2	C	15	45
BIO 206	Hydrobiology	2	C	15	45
BIO 208	Biostatistics	2	C	30	-
	Total	**18**			

300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
BIO 300	Industrial Attachment (SIWES)	3	C	-	-
BIO 301	Genetics II	2	C	15	45
BIO 302	Population Biology and Evolution	2	C	30	-
BIO 303	Biogeography and Soil Biology	2	C	30	
BIO 304	Nigerian Flora and Fauna	2	C	30	45
BIO 306	Systematic Biology	2	C	15	45
BIO 307	Field Course	1	C	-	
	Total	**18**			

400 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
BIO 400	Project	6	C	-	270
BIO 402	Principles of Plant and Animal Breeding	2	C	30	-
BIO 403	Wildlife Conservation and Management	2	C	30	-
BIO 404	Nigerian Plants and Animals in Prophylactics & Therapeutics	2	C	30	45
BIO 406	Principles of Pest Management	2	C	30	-
BIO 407	Field Course II	1	C	-	45
BIO 408	Applied Biotechnology	2	C	15	30
BIO 410	Bio-Entrepreneurship Options	2	C	30	
BIO 413	Bioinformatics	2	C	30	-
BIO 414	Molecular Biology	2	C	15	45

	Total	**23**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. identify possible sound patterns in English Language;
2. list notable language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English language (phonetics and phonology, vowels and consonants). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations and many more). Sentence in English (types: structural and functional, simple and complex). Grammar and usage (tense, mood, modality, concord and aspects of language use in everyday life). Logical and critical thinking and reasoning methods (Logic and syllogism, inductive and deductive argument and reasoning methods, analogy, generalisation and explanations). Ethical considerations, copyright rules and infringements. Writing activities: (Pre-writing, writing, post writing/editing and proofreading; paragraphing, types of writing, summary, essays, letters, curriculum vitae, report writing, note making and many more. and mechanics of writing). Comprehension strategies (Reading and types of reading, comprehension skills, 3RsQ). Information and Communication Technology in modern language learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112- Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of Trade, Economic and Self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building
6. analyse the role of the Judiciary in upholding people's fundamental rights
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents
Nigerian history, culture, and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria, Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914, formation of political parties in Nigeria, nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics and Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system, indigenous apprenticeship system among Nigeria people, trade, skill acquisition and self-reliance). Social justices and national development (law: definition and classification). Judiciary and fundamental rights. Individual norms and values (basic Nigeria norms and values, patterns of citizenship acquisition, citizenship and civic responsibilities, indigenous languages, usage and development, negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation). Re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption (WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic definition of Set, Subset, Union, Intersection, Complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify various types of numbers; and
5. solve some problems using Binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements and venn diagrams. Real numbers, integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations and binomial theorem. Complex numbers, algebra of complex numbers and the argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of Function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative, as limit of rate of change. Techniques of differentiation. Extreme curve sketching and integration as an inverse of differentiation. Methods of integration and definite integrals. Application to areas and volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

BIO 101: General Biology I (2 units C: LH 30)

Learning Outcomes
At the end of lectures, students should be able to:
1. explain cells structures and organisations;
2. summarize functions of cellular organelles;
3. characterize living organisms and state their general reproduction;
4. describe the interrelationship that exists between organisms;
5. discuss the concept of heredity and evolution; and
6. enumerate habitat types and their characteristics.

Course Contents
Cell structure and organisation, functions of cellular organelles. characteristics and classification of living things. chromosomes, genes; their relationships and importance. general reproduction. interrelationships of organisms (competitions, parasitism, predation, symbiosis, commensalisms,

mutualism, saprophytism). heredity and evolution (introduction to Darwinism and Lamarkism, Mendelian laws, explanation of key genetic terms). elements of ecology and types of habitat. //

BIO 102: General Biology II (2 Units C: LH 30)

Learning Outcomes

At the end of the lectures, students should be able to:

1. List the characteristics, methods of identification and classification of Viruses, bacteria and fungi;
2. state the unique characteristics of plant and animal kingdoms;
3. describe ecological adaptations in the plant and animal kingdoms;
4. explain nutrition, respiration, excretion and reproduction in plants and animals; and
5. describe growth and development in plants and animals.

Course Contents

Basic characteristics, identification and classification of viruses, bacteria and fungi.
A generalized survey of the plant and animal kingdoms based mainly on the study of similarities and differences in the external features. Ecological adaptations. Briefs on physiology to include nutrition, respiration, circulatory systems, excretion, reproduction, growth and development.

BIO 107: General Biology Practical I (1 Unit C: PH 45)

Learning Outcomes

At the end of this course students should be able to:

1. outline common laboratory hazards;
2. provide precaution on laboratory hazards;
3. state the functions of the different parts of microscope;
4. use the microscope and describe its maintenance;
5. draw biological diagrams and illustrations; and
6. apply scaling and proportion to biological diagrams.

Course Contents

Common laboratory hazards. prevention and first aid. measurements in biology. uses and care of microscope. compound and dissecting microscope. Biological drawings and illustration, scaling, accuracy and proportion. use of common laboratory apparatus and laboratory experiments designed to illustrate the topics covered in **BIO 101.**

BIO 108: General Biology Practical II (1 Unit C: PH 45)

Learning Outcomes

At the end of this course, students should be able to:

1. describe the anatomy of flowering plants;
2. differentiate types of fruit and seeds;
3. state ways of handling and caring for biological wares;
4. describe the basic histology of animal tissues; and
5. identify various groups in the animal kingdom.

Course Contents
Anatomy of flowering plants, primary vegetative body. stem, leaf and root to show the mature tissues namely parenchyma, collenchyma, sclerenchyma, xylem and phloem. Types of fruits and seeds. Care and use of dissecting kits and other biological wares. Dissection and general histology of animal tissues based on vertebrate forms. Morphology and functions of epithelial, muscular, nervous and connective tissues. Examination of various groups of lower invertebrates under microscopes, identification of various groups of organisms in Animal Kingdom. Andany experiment designed to emphasize the practical aspects of topics in BIO 102.

CHM 101: General Chemistry I (2 Units: C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. define atom, molecules and chemical reactions;
2. discuss the Modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. illustrate shapes of simple molecules and hybridized orbitals;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents
Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence Forces and structure of solids. Chemical equations and stoichiometry, chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry, rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reaction;

7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements and
9. describe basic properties of Transition metals.

Course Contents
Historical survey of the development and importance of organic chemistry, fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures and nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The Chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes
On completion, the students should be able to:
1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents
Space and time. Units and dimension. Vectors and scalars. Differentiation of vectors (displacement, velocity and acceleration). Kinematics. Newton laws of motion (Inertial frames, impulse, force and action at a distance, momentum conservation). Relative motion. Application of Newtonian mechanics. Equations of motion. Conservation principles in physics (conservative forces, conservation of linear momentum, kinetic energy and work, potential energy). System of particles. Centre of mass. Rotational motion (torque, vector product, moment, rotation of coordinate axes and angular momentum). Coordinate systems. Polar coordinates. Conservation of angular momentum. Circular motion. Moments of inertia (gyroscopes, and precession). Gravitation (Newton's Law of Gravitation, Kepler's laws of planetary motion, gravitational potential energy, escape velocity, satellites motion and orbits).

PHY 102: General Physics II (Electricity & Magnetism) (2 Units C: LH 30)

Learning Outcomes
On completion of the course, students should be able to:
1. describe the electric field and potential, and related concepts, for stationary charges;

2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law, and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;
5. describe electromagnetic induction and related concepts and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters;
8. determine the characteristics of ac voltages and currents in resistors, capacitors, and Inductors.

Course Contents

Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and resistance. Ohm's law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes

A student who has successfully gone through this course should be able to:

1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents

Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, and many more.

ENT 211 – Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students should be able to:

1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa, and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents

Concept of entrepreneurship (entrepreneurship, intrapreneurship/corporate entrepreneurship). Theories, rationale and relevance of entrepreneurship (Schumpeterian and other perspectives, risk-taking, necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of entrepreneurs (opportunity seeker, rRisk taker, natural and nurtured, problem solver and change agent, innovator and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking and creative thinking). Innovation (concept of innovation, dimensions of innovation, change and innovation, nowledge and innovation). Enterprise formation, partnership and networking (basics of business plan, forms of business ownership, business registration and forming alliances and join ventures). Contemporary entrepreneurship issues (knowledge, skills and technology, intellectual property, virtual office, networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, youth and women entrepreneurship, entrepreneurship support institutions, youth enterprise networks and environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

BIO 201: Genetics I (2 Units C: LH 30)

Learning Outcomes

At the end of this course, students should be able to:

1. distinguish between heritable and non-heritable characteristics;
2. explain the likelihood of genetic events (probability) and how well those events
3. (results) fit into a set of observation;
4. discuss polygenic variations; and
5. describe concepts in population genetics.

Course Contents

Hereditable and non-hereditable characteristics. Probability and tests of goodness of fit. Quantitative inheritance. variation in genome structure. introduction to population genetics.

BIO 202: Introductory Ecology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the lectures in this course, students should be able to:
1. explain various concepts and terminologies associated with the ecosystem;
2. list and explain features of various habitat types;
3. explain natural destruction/disaster, community and natural cycles; and
4. explain and describe factors responsible for changes in population.

Course Contents
Concept and definition of ecosystem. ecology at community level. ecological classification of habitat types. terrestrial and aquatic biomass. specific features of each, biotic components of habitat. Natural destruction. factors of communities, success of community interaction. natural cycle and dynamics of population.

BIO 203: General Physiology (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the chemistry of organic compounds and their biological importance;
2. state the general characteristics of enzymes;
3. describe nutrition, digestion and absorption in plants and animals;
4. discuss the cell membrane structure and list its functions;
5. summarize osmoregulation, excretion and transport in animals
6. enumerate growth hormones in plants and their functions;
7. explain the homeostasis, their coordination and functions in animals; and
8. explain the plant water relation, growth and growth regulation.

Course Contents
Chemicals of life: the chemistry of carbohydrates, lipids, proteins and nucleic acids and their biological importance. General characteristics of enzymes. Nutrition. digestion and absorption in plants and animals. Biosynthesis, photosynthesis and protein synthesis. Cell membrane structure and function.
A general study of osmoregulation, excretion, transport. growth hormones and enzymology. homeostasis and their co-ordination in animals. Plant water relation. growth and growth regulation.

BIO 204: Biological Techniques (2 Unit C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. list the different parts of a light microscope and state their functions;
2. state and explain the stages involved in preparation of slides;
3. describe the basic principles of spectrophotometry, colorimetry, photometry;
4. describe polarimetry, chromatography, refractometry, melting points and colligative

properties;
5. describe the basic collection and preservation processes of plant and animal materials and their preservation in herbarium and museum respectively; and
6. explain the need for experimental design, basis of report writing and presentations.

Course Contents
Microscopy. handling of microscopes. preparation of microscope slides (microtomy) for microscopic examinations. use of hand lens. biological drawings and diagrams. Spectrophotometry. Colorimetry. Photometry. Polarimetry. Chromatography. Refractometry. melting points and colligative properties. Herbarium and museum techniques. Experimental designs, report writing and presentations.

BIO 205: Introductory Developmental/Cell Biology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the lectures in this course, students should be able to:
1. illustrate the detail structure of plant and animal cells and state the functions of the
2. organelles;
3. summarize and state the differences and similarities between mitosis and meiosis;
4. describe cell differentiation and its growth; and
5. explain the molecular basis of cell structure and development.

Course Contents
History and present trends in cell biology. Ultra-structure of the plant and animal cells. organelles and their basic structures and functions. mitosis and meiosis. cell differentiation and growth of cells. A brief study of the molecular basis of cell structure and development.

BIO 206: Hydrobiology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the lectures in Hydrobiology, students should be able to:
1. discuss the physical properties of water;
2. explain the thermal stratification of lakes;
3. summarize the importance and interplay of oxygen, carbon-dioxide and pH in water,
4. describe fresh water communities;
5. list factors influencing the distribution and productivity of aquatic macrophytes, phytoplanktons, benthic algae and zooplanktons;
6. discuss the importance and adaptive features of Estuarine communities; and
7. explain colonisation and succession in aquatic ecosystem.

Course Contents
Principles of aquatic biology with particular reference to limnology. The physical properties of water and their biological significance. Thermal stratification of lakes. waves and currents and their effects on substratum. dissolved oxygen, carbon-dioxide and inorganic ions in freshwater. the carbonate-bicarbonate system and pH. oligotrophic and Eutrophic lakes. The chemical composition of African lake waters. freshwater communities. factors influencing the distribution and productivity of aquatic macrophytes, phytoplanktons, benthic algae. zooplanktons in

freshwater. marine brackish water/estuarine communities and their chemical factors. Colonisation and succession in aquatic ecosystems. adaptations and inter-relationships.

BIO 208: Biostatistics (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures in this course, students should be able to:
1. differentiate between continuous and discontinuous data;
2. explain sampling procedures in biology;
3. summarize and present biological data;
4. describe measures of central tendency and probability theory; and
5. conduct ANOVA, Chi-square, t-tests and F-tests and state their importance.

Course Contents
Variability in biological data: continuous and discontinuous variables. statistical sampling procedures. observations and problems of estimation. representation and summarization of biological data. frequency distribution. measures of central tendency and dispersion. Probability theory. normal, binomial and Poisson distribution. t-test, f-test and chi-square test. analysis of variance (ANOVA) and covariance. principles of experimental design. correlation, linear and curvilinear regression and transformation.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building

Course Contents
Concepts of peace, conflict and security in a multi-ethnic nation. Types and theories of conflicts: ethnic, religious, economic and geo-political conflicts. Structural conflict theory, realist theory of conflict and frustration-aggression conflict theory. Root causes of conflict and violence in Africa: indigene and settlers' phenomenon, boundaries/boarder disputes, political disputes, ethnic disputes and rivalries, economic inequalities, social disputes, nationalist movements and agitations, selected conflict case studies – Tiv-Junkun, Zango Kartaf, chieftaincy and land disputes and many more. peace building, management of conflicts and security, peace & human development. Approaches to peace & conflict management: (religious, government, community leaders and many more.). Elements of peace studies and conflict resolution, conflict dynamics assessment scales: constructive & destructive. Justice and legal framework and concepts of social justice. The Nigeria legal system. Insurgency and terrorism. Peace Mediation and Peace Keeping.

Peace and security council (international, national and local levels). Agents of conflict resolution: conventions, treaties, community policing, evolution and imperatives. Alternative dispute resolution (ADR): a). dialogue b). arbitration c). negotiation d). collaboration and many more Roles of international organizations in conflict resolution: (a). The United Nations (UN) and its conflict resolution organs. (b). The African Union & Peace Security Council (c). ECOWAS in peace keeping. Media and traditional institutions in peace building. Managing post-conflict situations/Crises: refugees. internally displaced persons (IDPs). The role of NGOs in post-conflict situations/Crises.

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students, through case study and practical approaches, should be able to:

1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical
3. location;
4. state how original products, ideas and concepts are developed;
5. develop business concept for further incubation or pitching for funding;
6. identify key sources of entrepreneurial finance;
7. implement the requirements for establishing and managing micro and small enterprises;
8. conduct entrepreneurial marketing and e-commerce;
9. apply a wide variety of emerging technological solutions to entrepreneurship; and
10. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity identification (sources of business opportunities in Nigeria, environmental scanning, demand and supply gap/unmet needs/market gaps/market research, unutilised resources, social and climate conditions and technology adoption gap). New business development (business planning and market research). Entrepreneurial finance (venture capital, equity finance, micro finance, personal savings, small business investment organisations and business plan competition). Entrepreneurial marketing and e-commerce (principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first mover advantage, e-commerce business models and successful e-commerce companies,). Small business management/family business, leadership & management, basic bookkeeping, nature of family business and family business growth model. Negotiation and business communication (strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions and idea pitching). Technological solutions (the concept of market/customer solution, customer solution and emerging technologies, business applications of new technologies - *Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy and many more Digital Business and E-Commerce Strategies).*

BIO 301: Genetics II **(2 Units C: LH 30; PH 45)**

Learning Outcomes
At the end of the lectures in this course, students should be able to:
1. summarize various aspects of human genetics and pedigree analysis;
2. discuss various aspects of gene interactions, biochemical mutants;
3. describe the types and functions of nucleic acids and nucleotides;
4. explain DNA replication and mutation;
5. discuss proteins and regulation of gene expression; and
6. describe the importance and processes involved in DNA technology and how it influences genetic engineering.

Course Contents
Aspects of human genetics and pedigree analysis. Further consideration of various deviations from basic principles. Gene interactions including biochemical mutants. nucleic acids and nucleotides. DNA replication. mutation of DNA. proteins and regulation of gene expression. DNA technology and genetic engineering.

BIO 302: Population Biology and Evolution **(2 Units C: LH 30)**

Learning Outcomes
At the end of the lectures in Population genetic, students should be able to:
1. explain the concept of natural selection;
2. summarize evolution of some organisms;
3. discuss how organisms adapt to their environment;
4. apply mathematical formulae and models to genetic variations and predictions in population; and
5. describe factors responsible for population changes.

Course Contents
Biological properties of species. natural selection. variations, isolation mechanisms (including their breakdown resulting in hybridization, adaptation, origin of life, origin of species and adaptive radiation, evolution of selected groups of plants and animals, including humans). Population dynamics. factors affecting population growth.

BIO 303: Biogeography and Soil Biology **(2 Units C: LH 30)**

Learning Outcomes
At the end of this course, students should be able to:
1. explain the theories related to Gondwanaland, continental drift and land bridges;
2. outline the world key flora and fauna groups and reasons for their distribution;
3. explain succession, colonisation and dispersal of plants and animals;
4. describe the concept of endemicity, refugia and Island biogeography;
5. discuss physical and chemical nature of soil;
6. summarise the cycling of minerals and nutrients;
7. explain soil and animal soil water relationship; and
8. outline the causes of soil erosion and alleviation methods.

Course Contents
Gondwanaland and theory of continental drift. theory of land bridges. distribution of world key floral and faunal groups including factors affecting distribution. phyto- and zoogeographyical regions of the world. Relationships between plants and animal distributions (emphasising local examples). Concept of succession, colonisation and dispersal in terrestrial plants and animals. Concept of endemicity and refugia. Island biogeography.
Physical and chemical nature of soil. Detritus organisms. Cycling of minerals and nutrient pools. Plant and animal soil water relationship. soil sampling techniques. Causes of soil erosion and alleviation methods/techniques.

BIO 304: Nigerian Fauna and Flora (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures in Nigerian Fauna and Flora, students should be able to:
1. identify Nigerian plants and animals, and associate them with habitats;
2. confirm identified plants and animals with Herbarium and Museum specimens respectively;
3. describe the life histories strategies of selected plants and animals; and
4. discuss the prospects, problems and problem alleviation strategies of protected areas in Nigeria.

Course Contents
Field identification of Nigerian plants and animals. plant and animal indicators of Nigerian biomes (i.e. association of habitats with specific plants and animals). Identification of plants through preserved herbarium specimens and keys. identification of animals through signs left by them e.g. footprints, trails, scats, runways. museum specimens. life history strategies of selected Nigerian plants and animals. Nigerian protected area system, their prospects, problems and problem alleviation strategies.

BIO 306: Systemic Biology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. describe the re-Linnaean, Linnaean and Darwinian taxonomic concepts of species;
2. explain the binomial system of nomenclature;
3. classify organisms based on the binomial system of nomenclature; and
4. explain the concept of keys and keying and their applications.

Course Contents
Historical background, pre-Linnaean, Linnaean and Darwinian taxonomic hierarchies. species concept, categories below species and categories above species. biological nomenclature, new systematics; numerical and binomial taxonomy. keys and keying.

BIO 307: Field Course I (1 Units C: PH 45)

Learning Outcomes
At the end of this field trip, students should be able to:
1. conduct basic field sampling techniques in terrestrial, aquatic and aerial environment;

2. collect plant and animal materials for identification, classification and preservation in the Herbarium and Museum respectively; and
3. explain the importance of the institutes and industries visited to Biology.

Course Contents
Sampling techniques in local habitats (i.e., not more than 20 km radius of the university). Also involve visits to research institutes, industries and many more. This should cover several areas of specialisation in Biology. Assessment by examination (objectives, short answer questions, fill in the gaps) in addition to group report.

BIO 300: SIWES (3 Units C: PH 135)

Learning Outcomes
At the end of this experience, students should be able to:
1. describe their place of industrial attachment;
2. know the industrial processes and production;
3. provide technical knowledge and principle of major tools equipment used; and
4. be able to relate their industrial experiences to the study of Biology.

Course Contents
Industrial field experience in any one of the following:
Aquatic Pollution (3CU). Pest Control (3CU). Public Health (3CU). Zoological gardens. Wildlife parks. Fish farms. Integrated farms. Biotechnology centres. Abattoirs. Sewage treatment plants. Laboratories.

400 Level

BIO 400: Research Orientation and Project (6 Units C: PH 270)

Learning Outcomes
At the end of this orientation, students should be able to:
1. appreciate the fundamentals of research and its application to the society;
2. acquire technical and procedural skills related to the project;
3. maintain accurate and comprehensive record of methods observation and data;
4. acquire ability to generate, analyse and interpret data;
5. write a coherent and logical scientific report;
6. acquire ability to communicate with appropriate content, structure and visual aids using power points; and
7. respond professionally and scientifically to any question on the project.

Course Contents
Each final year student is required to carry out an original research project under the supervision of an academic staff member. The findings of the research are presented by the student at a departmental seminar. A project report is prepared, bound and submitted by the student for evaluation by the department and is defended in a viva voice before an external examiner.

BIO 402: Principles of Plant and Animal Breeding (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures, students should be able to:
1. explain principles of plant and animal breeding;
2. enumerate the importance of heterosis, sterility and inbreeding consequences;
3. state management strategies for pests and diseases;
4. possess ability to conduct breeding exercises in plants and animals;
5. develop appropriate management practices required for plant and animal breeding; and
6. keep adequate farm records.

Course Contents
Importance of plant and animal breeding with examples. Cytogenetic principles of breeding. Heterosis. inbreeding consequences. incompatibility mechanisms. Sterility. breeding methods. disease and pest resistance and their management. major domestic plants and animals' breeding practices and desired traits used to sustain their qualities. General management and farm record keeping.

BIO 403: Wildlife Conservation and Management (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures in population genetic, students should be able to:
1. state the principles/glossaries of wildlife management;
2. outline wildlife diseases;
3. identify problems and prospects in wildlife resources;
4. outline conservation policies related to wildlife; and
5. explain the impact of climate change on wildlife resources.

Course Contents
General principles/glossaries of ecosystem management. Biological gardens. Wildlife diseases. principles of wildlife management. Wildlife in Nigeria: conservation policies. problems and prospects. World wildlife resources and their protection. Conflicts related to wildlife resources. climate change and wildlife resources. International and national laws related to wildlife resources. Fire as tool in terrestrial wildlife management.

BIO 404: Nigerian Plants and Animals in Prophylactics and Therapeutics (2 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the lectures in this course, students should be able to:
1. explain the historical development of plants and animals in prophylatics and therapeutics (Phamacognosy);
2. define some terminologies used in pharmacognosy;
3. appreciate the classification and uses of plants and animals in prophylatics and therapeutics in Nigeria;
4. explain crude traditional methods of preparation and uses;
5. identify and describe modern methods of preparation and uses of plants and animals as prophylatics and therapeautics; and

6. account for the evaluation and adulteration of crude drugs, and the need for quality control

Course Contents
Historical development and scope of plants and animals in prophylatics and therapeutics (Phamacognosy). Some terminologies used in pharmacognosy. Classification and uses of plants and animals in prophylatics and therapeutics in Nigeria. Crude traditional methods of preparation and uses. Modern methods of preparation and uses of plants and animals as prophylatics and therapeautics. Evaluation and adulteration of crude drugs (extraction methods, identification of phytochemicals, proximate analysis, minerals, organoleptic, microscopic, physical, chemical and biological). Deterioration and adulteration of crude drugs. Quality control.

BIO 414: Molecular Biology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the lectures in this course, students shall be able to:
1. describe the structure and roles of DNA and RNA;
2. discuss Gene regulation, DNA replication, genetic transformation and recombinant DNA technology;
3. summarize the roles of Nucleic acids and proteins in the cell division, growth and development; and
4. list the importance and application of Molecular Biology in food production, medicine and genetic engineering.

Course Contents
Structure and role of DNA. Structure and role of RNA.
Describe gene regulation, DNA replication, genetic transformation and recombinant DNA technology. Describe biological systems at the molecular level. Nucleic acids and proteins and how they interactively regulate cell division, growth and development. Evolution of genomes. Practical applications of the knowledge of molecular Biology (in alleviation of food shortages, plant breeding, disease resistant crops, animal breeding, marriage, medicine, genetic engineering and many more).

BIO 406: Principles of Pest Management (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures, the students should be able to:
1. state the characteristics of pests;
2. summarize the methods commonly used in assessing the population of plant and animal pests;
3. explain the effect of plant pest on crop and animal production;
4. describe control methods and strategies for plant and animal pests; and
5. provide the consequences related to different control methods.

Course Contents
A survey of plant and animal pests. The characteristics of pest species. Methods of assessing population of plants and animal pest. the estimation of crop and animal losses from pest, assessment and damage. Plant and animal pest control by exclusion, eradication and control (to

include use of pesticides, biological control etc.). The general consequences of pest control (resistance and breeding resistant varieties).

BIO 407: Field Course II (1 Unit C: PH 45)

Learning Outcomes
At the end of the field course, the students should be able to:
1. explain the various field aspects of biology;
2. demonstrate ability to plan and conduct a series of simple field experiments and collection of data;
3. develop the ability, to record, summarize, classify and preserve specimens collected from the field;
4. develop thin working and individual skills, learn to manage time effectively; and
5. write biological and field reports with appropriate presentation.

Course Contents
Field trips should be conducted to meet the requirements of various aspects of biology taught in the classroom. The field course should add to and fulfil other practical aspects of ecology, hydrobiology, wildlife and forestry, taxonomy and systematics.
Guided field visits by students to observe plants and animals, learn sampling techniques as related to plants and animals, collect samples, classify, preserve in herbarium and museum accordingly. Conduct field researches, collect data and analyse. Visit to industries, wildlife parks, zoological gardens, afforestation fields/woodlot parks, reservoirs /dams, farms, environmental control establishments and sites and other areas of biological importance. Field projects (individual or grouped), report writing and examination.

BIO 408: Applied Biotechnology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the lectures in this course, students should be able to:
1. conduct DNA extraction from different tissues;
2. quantify DNA and proteins;
3. outline the types of chromatography;
4. describe DNA amplification;
5. apply the knowledge of biotechnology to protein engineering, medicine, food and forensic science; and
6. incorporate the knowledge of biotechnology in the treatment of wastes.

Course Contents
Extraction of DNA and proteins from various tissues, quantification of DNA and proteins. Molecular biology techniques including chromatography (paper and thin layer). Electrophoresis. amplification of DNA using polymerase chain reaction. Identification and genomic sequencing. Introduction of DNA IUTA and cloning in cell. Application of biotechnology in protein engineering and production, medicine and forensic science, bio-industrial production of genetically engineered

medicinal and food products using living factories. Environmental protection and cleansing through biotechnological treatment of solid, liquid, chemical and nuclear waste.

BIO 410: Bio-Entrepreneurial Options (2 Unit C: LH 30)

Learning Outcomes

At the end of the lectures in this course, students should be able to:

1. explain the background, appropriate theory and methods relating to any of the chosen topics;
2. appraise and discuss how knowledge acquired can be used to become an independent entrepreneur;
3. discuss project cycle, financial sourcing and management; and
4. design and plan how any of the products can be produced on a large scale for national and international markets.

Course Contents

Students are required to take 2 Units of direct studies in any one of the areas listed below. Availability of each area depends on staff on the ground. Examples of these options include but not limited to Mushroom farming. Tissue culture. Apiculture. Weed management and control. Introduction to ornithology/poultry production. Environmental impact assessment. Horticulture/Applied horticulture and landscape ecology. Orchards / Production of vegetables. Herpetology. Introduction to Vaccine and anti-venom production. Heliciculture. Techniques in disease diagnosis. Production of slides and Photomicrography. Production and management of ruminants/monogastric animals.

BIO 413: Bioinformatics (2 Units C: LH 30)

Learning Outcomes

At the end of the lectures, the students should be able to:

1. explain the history of bioinformatics;
2. identify basic instruments required in bioinformatics;
3. Outline DNA and protein databases; and
4. describe genomics and proteomics.

Course Contents

Introduction to computer based analyses and management applications of molecular biological data. history of bioinformatics. Instrumentation: PC applications, resources, introduction to DNA and protein databases. data storage. file formats and information retrieval. genomics and proteomics.

Minimum Academic Standards

Equipment

1. Skeletal System
2. Muscular System
3. Brain and Nervous System
4. Circulatory System
5. Digestive System
6. Eye and Vision
7. Skin and Excretory Organs
8. GB 28 Concealing and Warning Adaptations
9. Ice Cube Maker
10. Incubator/Sterilizer
11. Embedding Bath
12. Micrometer
13. Water Baths
14. Autoclaves
15. Weighing Balances
16. Hot Plates
17. Incubators
18. Field Binoculars
19. Binocular Microscopes
20. Field Cameras
21. Stereo Microscopes
22. Refrigerators
23. Shakers
24. pH Meters
25. PCR Thermocyclors
26. Gel Photo Documentation Equipment
27. Gel Electrophoresis Systems
28. ELISA Kits
29. Sahli's Heamoglobinometer
30. Distillers (All Glass)
31. R. Humidity with Thermometer
32. Embedding Oven
33. Ovens
34. Thermostatic Incubator
35. Microtome
36. Veneer Callipers
37. Retort Stand
38. Automatic Tissue Processor
39. Tissue Embedding Centre

40. Air Pumps (Diaphragm)
41. Vacuum Pumps
42. Tissue Grinder Glass
43. Photometer and Atometer
44. Shadon Unit Kit No. 1
45. Barothermograph
46. Kymograph Muscle
47. Spirometer
48. Colorimeter
49. Lamina flow
50. Glucometer
51. Digital Blood Pressure Monitor
52. Insect Light Traps
53. Insect Boxes
54. Slide Projector
55. Over-head Projector
56. Bench Centrifuges
57. Micro Refrigerated Centrifuges
58. Steel Frame Aquaria
59. Auxanometer
60. Oxygen Meter
61. Glass Wares/Micropipettes

Additional Facilities for B.Sc. Biology
Museum
Herbarium
Biological Garden

Staffing

Academic Staff
The guidelines on academic staff/student ratio of 1:20 for Science Programmes shall apply.
To start any programme in science, there should be a minimum of six academic staff. There is need to have a reasonable number of staff with Ph.D degrees accounting for at least 70% of the total number and having adequate teaching experience for every programme in the discipline.

Administrative Support Staff
The services of the administrative support staff are indispensable in the proper administration of departments and faculty offices. It is important to recruit very competent and computer literate senior staff.

Technical Support Personnel

The services of technical support staff, which are indispensable in the proper running of laboratories and workshops, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

Classrooms, Laboratories, Workshops and Office Space

The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

Library

Universities should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition, well stock and current hardcopies of reference and other textual materials should be provided centrally at the level of the faculty. A well network digital library should serve the entire university community. Availability of wireless facilities (Wifi) with adequate bandwidth should enhance access to these electronic resources.
In any case, there should be internet ready workstations available in the library for least 25% of the total student enrolled in each academic programme. The funding of the library should be in line with NUC guidelines.

B.Sc. Biotechnology

Overview
Biotechnology is an inter-disciplinary field, encompassing all biological sciences, agricultural sciences, medical and pharmaceutical sciences as well as aspects of engineering and computational sciences and business studies. Graduates of the programme will be exposed to broad based and multi-disciplinary theoretical and practical knowledge to impart competitive skills that meet the needs of the society and the world at large in industrial, governmental, academic and private work settings.

Philosophy
The Biotechnology programme provides balanced and broad based training in technologies that utilise biological systems for development or creation of different products and for acquisition of skills required of graduates who are qualified to practice as scientists in the industries and in the academia.

Objectives
The objectives of the programme are to:
1. impart basic and fundamental scientific knowledge in biotechnology to students;
2. equip students with critical thinking and problem solving ability in the various multidisciplinary settings of biotechnology;
3. equip students to undertake result-oriented and exploratory research activities for industrial and academic development;
4. develop and apply biotechnological principles in solving societal problems in agriculture, forestry, fishery, health and environment;
5. develop in the students a range of transferable skills that are of value to the society and relevant for gainful employment; and
6. produce graduates who will be leaders in biotechnological based industries, government agencies, research institutes, universities and in self employment.

Unique Features of the programme
The unique features of the programme include:
1. Development of innovative biotechnological skills for sustainable food production, improved health care delivery and sustainable utilisation of environmental bioresources;
2. Production of graduates with capacity to develop new bioprocesses towards new product formation and generation of biotechnological high value-added products;
3. Production of graduates with high proficiencies for needed impacts in gene technologies, personalised healthcare and green biotechnology; and
4. Production of graduates with proficiencies in biotechnology based modern information and communication technologies and data analyses.

Employability Skills
1. Graduates of this programme shall possess and demonstrate practical, analytical, verbal, writing and problem solving skills for professional delivery of career expectations in various bio-based industries, research outfits, tertiary institutions as well as possess skills for self-employment.

21st Century Skills

1. Critical thinking, problem solving, reasoning, analysis, interpretation, synthesizing information.
2. Creativity, imagination, innovation, personal expression.
3. Research skill and practices, interrogative questioning.
4. Oral and written communication, public speaking and presenting, listening.
5. Leadership, teamwork, collaboration, cooperation, capacity for virtual workspaces.
6. ICT literacy, media and internet literacy, data interpretation and analysis.

Admission and Graduation Requirements

Admission Requirements

The entry requirements for a four-year degree programme shall be senior secondary certificate (SSC) credit passes (WASC; NECO or equivalent) in five subjects at not more than two sittings. Such subjects shall include English language, Mathematics, Biology, Chemistry and Physics. In addition, an acceptable pass in the Unified Tertiary Matriculation Examination (UTME) is required for admission into 100 Level.

Candidates with five SSCE (or equivalent) credit passes with at least two passes in Biology, Chemistry, Mathematics or Physics at the GCE Advanced Level or IJMB or JUPEB may be considered for admission into 200 Level. Expected duration for Direct Entry (DE) candidates shall be three (3) years.

Graduation Requirements

To be eligible for the award of a Bachelor's Degree in Biotechnology, a student must obtain a minimum of 120 credit units for UTME and 90 credits for direct entry.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication In English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
BIO 101	General Biology I	2	C	30	-
BIO 102	General Biology II	2	C	30	
BIO 107	General Biology Practical I	1	C	-	45
BIO 108	General Biology Practical II	1	C	-	45
CHM 101	General Chemistry I	2	C	30	-
CHM 102	General Chemistry II	2	C	30	-
CHM 107	General Chemistry Practical I	1	C	-	45
CHM 108	General Chemistry Practical II	1	C	-	45
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 107	General Physics Practical I	1	C	-	45

Course Code	Course Title	Unit(s)	Status	LH	PH
PHY 108	General Physics Practical II	1	C	-	45
	Total	**29**			

200 Level

Course Code	Course Title	Units	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
BCH 201	General Biochemistry I	2	C	30	-
MCB 221	General Microbiology I	2	C	15	45
STA 201	Statistics for Agriculture & Biological Sciences	3	C	45	-
BTG 202	Introduction to Biotechnology	2	C	30	-
	Total	**13**			

300 Level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace And Conflict Resolution	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
BTG 301	Molecular Genetics	2	C	30	-
BTG 302	Molecular Cell Biology	2	C	15	45
BTG 304	Genetic Engineering	2	C	15	45
BTG 305	Techniques in Biotechnology	2	C	15	45
BTG 309	Food Biotechnology	2	C	30	
BTG 311	Plant and Animal Cells Tissue Culture	2	C	15	45
BTG 313	Biotechnology for Animal Production	2	C	15	45
BTG 315	Bioinformatics	2	C	30	
BTG 399*	Industrial Attachment (12 Weeks) (**4 year programme only**)	3	C	-	-
	Total	**23**			

***** To take place during the long vacation between 300 and 400 Levels

400 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
BTG 401	Biotechnology Seminar	2	C	30	-
BTG 402	Bio-safety and Bioethics	1	C	30	-
BTG 403	Environmental Biotechnology	2	C	15	45
BTG 404	Medical Biotechnology	2	C	30	
BTG 405	Industrial Biotechnology	2	C	15	45
BTG 406	Plant Biotechnology	2	C	15	45
BTG 407	Research Project in Biotechnology	6	C	-	270

Course Code	Course Title	Unit(s)	Status	LH	PH
BTG 433	Biotechnology Entrepreneurship	2	C	30	-
BTG 499*	Industrial Attachment (**5year Programme only)**	6*	C	-	24 Weeks
	Total	**19**			

*Not added to total of 4 year programme; to take place during second semester of 400 Level and Long vacation between 400 and 500 Levels for 5 year programme

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. identify possible sound patterns in English Language;
2. list notable Language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English Language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and Deductive Argument and Reasoning Methods, Analogy, Generalisation and Explanations). Ethical considerations, Copyright Rules and Infringements. Writing Activities: (Pre-writing , Writing, Post writing, Editing and Proofreading; Brainstorming, outlining, Paragraphing, Types of writing, Summary, Essays, Letter, Curriculum Vitae, Report writing, Note making and Mechanics of writing). Comprehension Strategies: (Reading and types of Reading, Comprehension Skills, 3RsQ). Information and Communication Technology in modern Language Learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;

3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of Trade, Economic and Self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building;
6. analyse the role of the Judiciary in upholding people's fundamental rights;
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents
Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification. Judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation; Re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption(WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart

boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic definition of Set, Subset, Union, Intersection, Complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify the various types of numbers; and
5. solve some problems using Binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, venn diagrams. Real numbers; integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers; algebra of complex numbers; the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of Function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative, as limit of rate of change. Techniques of differentiation. Extreme curve sketching; Integration as an inverse of differentiation. Methods of integration, Definite integrals. Application to areas, volumes.

BIO 101: General Biology I (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
7. explain cell structure and organizations;
8. summarize functions of cellular organelles;
9. characterize living organisms and state their general reproduction;
10. describe the interrelationship that exists between organisms;
11. discuss the concept of heredity and evolution; and
12. enumerate habitat types and their characteristics.

Course Contents
Cell structure and organization, functions of cellular organelles. Characteristics and classification of living things. Chromosomes, genes, their relationships and importance. General reproduction. Interrelationships of organisms (competitions, parasitism, predation, symbiosis, commensalisms, mutualism, saprophytism). Heredity and evolution (introduction to Darwinism and Lamarkism, Mendelian laws, explanation of key genetic terms). Elements of ecology and types of habitats.

BIO 102: General Biology II (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures, students should be able to:
1. List the characteristics, methods of identification and classification of Viruses, bacteria and fungi;
2. state the unique characteristics of plant and animal kingdoms;
3. describe ecological adaptations in the plant and animal kingdoms;
4. explain nutrition, respiration, excretion and reproduction in plants and animals; and
5. describe growth and development in plants and animals.

Course Contents
Basic characteristics, identification and classification of viruses, bacteria and fungi.
A generalized survey of the plant and animal kingdoms based mainly on the study of similarities and differences in the external features. Ecological adaptations. Briefs on physiology to include nutrition, respiration, circulatory systems, excretion, reproduction, growth and development.

BIO 107: General Biology Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of this course students should be able to:
1. outline common laboratory hazards;
2. provide precaution on laboratory hazards;
3. state the functions of the different parts of microscope;
4. use the microscope and describe its maintenance;
5. draw biological diagrams and illustrations; and
6. apply scaling and proportion to biological diagrams.

Course Contents
Common laboratory hazards. prevention and first aid. measurements in biology. uses and care of microscope. compound and dissecting microscope. Biological drawings and illustration, scaling, accuracy and proportion. use of common laboratory apparatus and laboratory experiments designed to illustrate the topics covered in **BIO 101.**

BIO 108: General Biology Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. describe the anatomy of flowering plants;
2. differentiate types of fruit and seeds;
3. state ways of handling and caring for biological wares;
4. describe the basic histology of animal tissues; and
5. identify various groups in the animal kingdom.

Course Contents
Anatomy of flowering plants, primary vegetative body. stem, leaf and root to show the mature tissues namely parenchyma, collenchyma, sclerenchyma, xylem and phloem. Types of fruits and seeds. Care and use of dissecting kits and other biological wares. Dissection and general histology of animal tissues based on vertebrate forms. Morphology and functions of epithelial, muscular, nervous and connective tissues. Examination of various groups of lower invertebrates under microscopes, identification of various groups of organisms in Animal Kingdom. Andany experiment designed to emphasize the practical aspects of topics in BIO 102.

CHM 101: General Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. define atom, molecules and chemical reactions;
2. discuss the Modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. illustrate shapes of simple molecules and hybridized orbitals;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents
Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence Forces; Structure of solids. Chemical equations and stoichiometry; Chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry; rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reaction;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. describe basic properties of Transition metals.

Course Contents
Historical survey of the development and importance of Organic Chemistry; Fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures, nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The Chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify the differences between primary and secondary standards;
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents
Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;

4. identify and carry out preliminary tests which includes ignition, boiling point, melting point, test on known and unknown organic compounds;
5. execute solubility tests on known and unknown organic compounds;
6. execute elemental tests on known and unknown compounds; and
7. conduct functional group/confirmatory test on known and unknown compounds which could be acidic / basic / neutral organic compounds.

Course Contents
Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents
space and time. units and dimension. vectors and scalars. differentiation of vectors: displacement, velocity and acceleration. Kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). relative motion. Application of Newtonian mechanics. equations of motion. conservation principles in physics, conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass. Rotational motion. torque, vector product, moment, rotation of coordinate axes and angular momentum, polar coordinates. conservation of angular momentum; Circular motion. Moments of inertia, gyroscopes and precession. gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General Physics II (Electricity & Magnetism) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the electric field and potential, and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;

5. describe electromagnetic induction and related concepts, and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters; and
8. determine the characteristics of ac voltages and currents in resistors, capacitors, and Inductors.

Course Contents

Forces in nature. Electrostatics, electric charge and its properties. methods of charging. Coulomb's law and superposition. electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields; Conductors and insulators, current, voltage and resistance, Ohm's law and analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. magnetic dipoles, Dielectrics, Energy in magnetic fields, Electromotive force. Electromagnetic induction, Self and mutual inductances. Faraday and Lenz's laws, Step up and step down transformers: Maxwell's equations; Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, resistance, and combinations.

PHY 107: General Practical Physics I (1 Unit C: PH 45)

Learning Outcomes

At the end of the course, students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents

This introductory course emphasizes quantitative measurements, the treatment of measurement errors, and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, and many more covered in PHY 101, 102, 103 and PHY 104. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

PHY 108: General Practical Physics II (1 Unit C: PH 45)

Learning Outcomes

At the end of the course; students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data; and
6. prepare and present practical reports.

Course Contents
This practical course is a continuation of PHY 107 and is intended to be taught during the second semester of the 100 level to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements, the treatment of measurement errors, and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding and many more.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;
2. state the characteristics of an entrepreneur;
3. analyze the importance of micro and small businesses in wealth creation, employment, and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents
Concept of Entrepreneurship (Entrepreneurship, Intrapreneurship/Corporate Entrepreneurship,). Theories, Rationale and relevance of Entrepreneurship (Schumpeterian and other perspectives, Risk-Taking, Necessity and opportunity-based entrepreneurship and Creative destruction). Characteristics of Entrepreneurs (Opportunity seeker, Risk taker, Natural and Nurtured, Problem solver and change agent, Innovator and creative thinker). Entrepreneurial thinking (Critical thinking, Reflective thinking, and Creative thinking). Innovation (Concept of innovation, Dimensions of innovation, Change and innovation, Knowledge and innovation). Enterprise formation, partnership and networking (Basics of Business Plan, Forms of business ownership, Business registration and Forming alliances and joint ventures). Contemporary Entrepreneurship Issues (Knowledge, Skills and Technology, Intellectual property, Virtual office, Networking). Entrepreneurship in Nigeria (Biography of inspirational Entrepreneurs, Youth and women entrepreneurship, Entrepreneurship support institutions, Youth enterprise networks and Environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

BCH 201: General Biochemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures, students should be able to:
1. explain the structure of different macromolecules in biological system;
2. identify types of chemical reactions involving these macromolecules;
3. explain the various methods of isolation of these macromolecules;
4. estimate the effects of acids and alkalis on the macromolecules;
5. describe purification of macromolecules; and
6. discuss quantification of the various macromolecules.

Course Contents
Introductory chemistry of amino acids; their properties, reactions and biological functions. Classification of amino acids: neutral, basic and acidic; polar and non-polar; essential and non-essential amino acids. Peptides. Introductory chemistry and classification of proteins. Biological functions of proteins. Methods of their isolation, purification and identification. Primary, secondary, tertiary and quaternary structures of proteins. Basic principles of tests for proteins and amino acids. Introductory chemistry of carbohydrates, lipids and nucleic acids. Nomenclature of nucleosides, and nucleotides; effects of acid and alkali on hydrolysis of nucleic acids.

MCB 221: General Microbiology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the basic concepts and scope of microbiology;
2. describe layout of a microbiology laboratory, equipment and reagents in a microbiology laboratory; and
3. discuss the theory behind basic protocols in a microbiology laboratory.

Course Contents
History of the Science of Microbiology. Classification of organisms into prokaryotes and eukaryotes; Classification of prokaryotes into Archaea and eubacteria Anatomy and cytochemistry of bacteria and fungi. Shapes, groupings and colonial morphology of bacteria and fungi. Structure

of viruses. Sterilization and disinfection; Structure, ecology and reproduction of representative microbial genera. Culture of micro-organisms. Isolation of micro-organisms; isolation of bacteria, viruses, fungi (yeasts and moulds. Nutrition and biochemical activities of micro-organisms. Antigens and antibodies. Identification and economic importance of selected microbial groups. Microbial variation and heredity. Study of laboratory Equipment. Introduction to microbiology of air food, milk, dairy products, water and soil. Staining techniques, antibiotic sensitivity tests, serological tests, antimicrobial agents

STA 201: Statistics for Agriculture and Biological Sciences (3 Units C: LH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. explain the scope for statistical methods in biology and agriculture;
2. define the measures of location, partition and dispersion;
3. explain the elements of probability; probability distributions: binomial, poisson, geometric, hypergeometric, negative binomial and normal, Student's t and chi-square distributions;
4. differentiate point from interval estimation and could be able to tests for hypotheses concerning population means, proportions and variances;
5. compute for regression and correlation as well as conduct some Non–parametric tests with reference to Contingency table analysis; and
6. explain the elements of design of experiments and analysis of variance.

Course Contents

Scope for statistical method in Biology and Agriculture. Measures of location, partition and dispersion. Elements of probability. Probability distributions: binomial, Poisson, geometric, hypergeometric, negative binomial and normal, Student's t and chi-square distributions. Estimation (point and interval) and tests of hypotheses concerning population means, proportions and variances. Regression and correlation. Non–parametric tests. Contingency table analysis. Introduction to design of experiments. Analysis of variance.

BTG 202: **Introduction to Biotechnology (2 Units C: LH 30)**

Learning Outcomes

At the end of the course, students should be able to:

1. explain the historical development of biotechnology and its relevance in the modern world;
2. describe the applications of biotechnology in agriculture, medicine, pharmaceuticals and the environment;
3. explain the role of biotechnology in industrial processes;
4. demonstrate skills and knowledge of the steps in DNA fingerprinting and its applications;
5. estimate the population density of cells in a medium;
6. demonstrate thin sectioning of cells, stain and view;
7. illustrate aseptic protocol, extract DNA from a cell and view after gel electrophoresis; and
8. explain PCR principles, primer design and the concept of cloning.

Course Contents

Historical developments. Principles and applications of biotechnology. Implications of molecular biology in the modern world, including ethical and social controversies. Introductory aspects of microbial biotechnology, medical biotechnology, environmental biotechnology, pharmaceutical

biotechnology, agricultural biotechnology and industrial biotechnology. Biotechnological production of industrial materials: biofuels and antibiotics. DNA cloning, DNA fingerprinting and the use of DNA in forensics. Practical would include measurement of cell size using micrometer, measurement of cell concentrations (microscopic enumeration, fresh weight, dry weight, packed cell volume); microtome sectioning and microscopy; aseptic techniques and autoclaving; different DNA extraction methods, gel electrophoresis, polymerase chain reaction techniques, primer design, overview of DNA cloning.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building

Course Contents

Concepts of Peace, Conflict and Security in a multi-ethnic nation. Types and Theories of Conflicts: Ethnic, Religious, Economic, Geo-political Conflicts; Structural Conflict Theory, Realist Theory of Conflict, Frustration-Aggression Conflict Theory. Root causes of Conflict and Violence in Africa: Indigene and settlers Phenomenon; Boundaries/boarder disputes; Political disputes; Ethnic disputes and rivalries; Economic Inequalities; Social disputes; Nationalist Movements and Agitations; Selected Conflict Case Studies – Tiv-Junkun; ZangoKartaf, Chieftaincy and Land disputes and many more. Peace Building, Management of Conflicts and Security: Peace & Human Development. Approaches to Peace & Conflict Management --- (Religious, Government, Community Leaders and many more.). Elements of Peace Studies and Conflict Resolution: Conflict dynamics assessment Scales: Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice; The Nigeria Legal System. Insurgency and Terrorism. Peace Mediation and Peace Keeping. Peace & Security Council (International, National and Local levels) Agents of Conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration and many more. Roles of International Organizations in Conflict Resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping. Media and Traditional Institutions in Peace Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis

ENT 312: Venture Creation **(2 Units C: LH 15; PH 45)**

Learning Outcomes

At the end of the course, students should be able to:

1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/Market Research, Unutilised resources, Social and climate conditions and Technology adoption gap). New business development (business planning, market research). Entrepreneurial Finance (Venture capital, Equity finance, Micro finance, Personal savings, Small business investment organizations and Business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, Customer Acquisition & Retention, B2B, C2C and B2C models of e-commerce, First Mover Advantage, E-commerce business models and Successful E-Commerce Companies,). Small Business Management/Family Business: Leadership & Management, Basic book keeping, Nature of family business and Family Business Growth Model. Negotiation and Business communication (Strategy and tactics of negotiation/bargaining, Traditional and modern business communication methods). Opportunity Discovery Demonstrations (Business idea generation presentations, Business idea Contest, Brainstorming sessions, Idea pitching). Technological Solutions (The Concept of Market/Customer Solution, Customer Solution and Emerging Technologies, Business Applications of New Technologies - *Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy and more more.* Digital Business and E-Commerce Strategies).

BTG 301: **Molecular Genetics** **(2 Units C: LH 30)**

Learning Outcomes

At the end of the course, students should be able to:

1. explain molecules conferring genetic properties and hereditary to organisms;
2. describe the genetic codes, translation, transcription and regulatory mechanisms;
3. explain different types of mutations in cells, causes, mechanisms, recombination and cellular repair process;
4. describe DNA and RNA replications, transformation, conjugation and transduction; and
5. demonstrate some experimental skills in molecular genetics.

Course Contents

Fundamental principles of genetics at the molecular level. Chemical nature of hereditary material. The genetic code, regulatory mechanisms, the molecular basis of mutation. DNA replication and

recombination. Molecular genetics at the level of DNA sequence: point mutation, frame-shift mutation, depurination, deamination. The roles of genes in the control of hereditary, cell development, cellular metabolism, and functions of the organisms. Transposons and insertion sequences. Gene expression in prokaryotic and eukaryotic organisms; regulation of gene expression. Transcription, translation, regulation, promoters, other regulatory sequences, replication, repair, eukaryote genomes, introns and exons.

BTG 302: Molecular Cell Biology (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. describe functions and activities of genes, their structure, variation and translation and transcription;
2. explain the molecular anatomy and physiology of plants and animal cells;
3. describe the structure of DNA and RNA, the nucleotide bases, amino acid codons and expression of genes as proteins;
4. interpret genomic, proteomic, transcriptomic and metabolomic information; and interpret data obtained from such processes.

Course Contents

The structure and ultrastructure of cells. Differences and similarities between prokaryotic and eukaryotic cells. Microscopy methods for structural analysis of the prokaryotic and eukaryotic cells. Organelles and membrane systems; their structure and function. Cell division: mitosis, meiosis. Intracellular protein sorting and secretion, endocytosis and exocytosis. Cytoskeleton and cell motility. Apoptosis, cancer and processes that regulate the development of multicellular organisms. Extra- and intracellular signal transduction. The gene concept, gene structure and function, DNA replication and repair, DNA fingerprinting and DNA typing, DNA sequencing, mapping and quantifying of transcripts. Genomics: Structural, Functional and Comparative; genomics of genes, proteomics, metabolomics, transcriptomics, DNA Micro-arrays. The relationship between DNA, RNA and protein. Assaying DNA-protein interactions, knock-outs; determination of three dimensional protein structures using experimental techniques and computer simulation.

BTG 304: Genetic Engineering (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. describe mechanisms of genetic engineering and define genetically modified organisms;
2. explain how genes are cut and ligated and how chimeric or recombinant cells are produced; and
3. explain the use of genetic engineering principles for gene targeting, transformation of plants and animals and production of hormones, insulin and biological insecticides.

Course Contents

Isolation of DNA and RNA from plant, animal and microbial cells (extraction of pure samples of DNA). Introduction to genetic engineering, fundamentals of gene cloning and genetic engineering principles. Fragmentation of DNA, restriction endonuclease digestion, enrichment for specific DNA sequences. Analysis of DNA fragment sizes, joining DNA molecules together, cloning vectors-

types and characteristics. Selection of host cells, introduction of DNA into the host cells(transformation, transduction, conjugation, transfection, electroporation, microinjection, gene gun). Detection and analysis of successful clones, stability of cloned genes, manipulation of cloned genes in vitro.Gene amplification, gene knockout and disruption, gene targeting, genome editing and Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) technology. Genetically modified organisms, genetic modification of industrial microorganisms. Insulin, antibodies, vaccinesand hormone production technologies. Hormone replacement therapy.Genetic diagnosis and gene therapy. Transgenic animals, transgenic plants, transformation of plants using *Agrobacterium tumefaciencs*. Organic insecticide, *Bacillus thuringiensis*, FLAVR SAVR Tomato. The Human Genome Project, prospects and consequences.

BTG 305: Techniques in Biotechnology (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. demonstrate in-depth knowledge of analytical techniques including PCR, Southern, Northern and Western blot and the applications; and
2. demonstrate skills in the use of modern analytical tools/equipment and ability to solve problems in various areas of biotechnology.

Course Contents

Principles of instrumentation. Principles and techniques of radioisotope techniques, chromatographic methods, electrophoresis, centrifugation techniques, Ultracentrifugation. Dialysis and Ultra-filtration, spectroscopic techniques, polymerase chain reaction (PCR), DNA hybridization, DNA sequencing techniques, Enzyme linked Immunosorbent assays (ELISA). Random Amplified Polymorphic DNAs (RAPDs); Restriction fragment length polymorphisms (RFLPs); Simple Sequence Repeats (SSR); DNA Micro array, Ribotyping.Southern, Northern, and Western blot methods of protein and DNA and identifications. SDS-PADE, DGGE. Physical methods of gene transfer. Optical microscopy; Review of modern analytical techniques (radiochemical methods). Fluorimetric instrumentation types-GLC, NMR, X-ray diffraction.

BTG 309: Food Biotechnology (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. explain the different classes of food and describe food processing steps and the science behind it;
2. explain food spoilage and food intoxication and proffer ways for prevention and preservation of different types of food;
3. describe different types of fermented African food and ways through which it can be processed biotechnologically for global acceptability; and
4. explain biotechnological production of natural food ingredient and lab cultured food.

Course Contents

Food Classes – carbohydrates, fats, proteins, vitamins, minerals, water, fibre. Food Groups – tubers, cereals, fruits, legumes, meat, fish, leafy vegetables and many more. Fermented African foods and beverages (traditional processing techniques) – palm wine, garri, burukutu, ogi and many more. Food pigments; confectioneries – configuration and conformation of sugar. Food

contaminants – toxic substances in foods, food poisoning and intoxication – prevention and cure. Biotechnology of food processing, preservation and storage. Deterioration and spoilage agents of foods. Biotechnological methods to increase shelf lives of food crops, food produce and ready to eat foods. Biotechnological production of natural ingredients for food industry. New applications of biotechnology in food industry - genetically engineered α-amylase, lipase and condiments. Genetically engineered crops and animals, ethical, biosafety and socio-cultural challenges.Promoting local food production and processing for global acceptability. World food problems, hunger eradication/elimination. Novel sources of proteins, neglected and underutilized animal and plant protein sources. Laboratory cultured meat, plant based meat production.

BTG 311: Plant and Animal Cells Tissue Culture (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. describe plant and animal tissue culture techniques; and
2. explain the preparation and composition of culture media for propagation of various plants and animal cells.

Course Contents

Microscopic structure of organisms, introductory microtechniques. Plant tissue culture and animal cell culture techniques. Media used for tissue cultures, media composition (phyto-hormones, vitamins, growth factors etc); sterility. Procedures for micro propagation of plants (callus culture, meristem culture, organ culture), germ-plasm storage, morphogenesis, concept of totipotency, micropropagation through organogenesis, somatic embryogenesis, protoplast culture and fusion, embryogenesis, isolation and maintenance of various animal/insect cell lines. Culture methods for animal cells/tissues, measurement of animal and plant cell growth.Microalgal biotechnology: microbial photosynthesis, photoautotrophic, heterotrophic and photoheterophic cultivation of photosynthetic cells.

BTG 313: Biotechnology for Animal Production (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. explain issues of food security and concepts in animal breeding;
2. describe steps and demonstrate knowledge in up scaling animal protein production from various sources;
3. demonstrate knowledge on the structure of *animal* genes and genomes and explain the control of gene expression;
4. describe basic principles and techniques in genetic manipulation for diagnostic purposes towards detection and management of animal diseases and for vaccine production; and
5. discuss the emerging issues of public concern and proffer ways for management.

Course Contents

Principles of animal breeding, marker assisted selection and breeding, artificial insemination, embryo transfer, embryo splitting and embryosexing. Cloning, in-vitro fertilization and embryo rescue, multiple ovulation embryo techniques for farm animals. Applications of animal tissue cultures in livestock breeding. Conservation of genetic resources, genetic engineering of farm animals for better growth. Monoclonal antibodies, recombinant DNA technology for development

of diagnostics reagents for detection of animal diseases, animal vaccine production. Biotechnology in animal health and survival, biotechnology in animal nutrition. Emerging issues: ethical concerns, industry and public concerns, management of issues of concern.

BTG 315: Bioinformatics (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the importance of bioinformatics and its significance in biotechnology;
2. explain the different methods for biological data analysis, retrieval, classification and management;
3. explain basics of sequence alignment and analysis;
4. describe biological databases and database search tools;
5. build phylogenetic trees and perform molecular phylogeny; and
6. describe various software used in biotechnological data processing and assessments.

Course Contents
Definitions and scope of bioinformatics for biotechnology. Computer science and biotechnology, computational biology. Use of computer for data analysis and processing, process optimization. Databases: searching, construction and retrieving information from database. Biological information systems: Gene Database (GenBank), Molecular Databases, Literature Databases, Annotated sequence database, genome and organism-specific database, miscellaneous database, Data retrieval with ENTREZ and DBGET/LinkDB, Data retrieval with sequence similarity searches (SRS), Transcription Regulatory Regions Database (TRRD). Applications of Bioinformatics: study of phylogenetics, building phylogenetic trees, molecular phylogeny, pharmainformatics, cheminformatics, protein interaction informatics. Biological macromolecular structures and structure prediction methods. Introduction of various software used in biotechnology research and development.

BTG 399: Industrial Attachment (12 Weeks) (3 Units C: PH 135)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the experience gained during the exposure period of 12 weeks of internship; and
2. relate the classroom experience with the industrial exposure and describe how the knowledge in the classroom is applied in the industry.

Course Contents
Students should be attached to relevant industrial organizations for 12 Weeks preferably during the long vacation for appropriate experience. Students should be assessed based on seminar presentations, written reports and supervisors' assessments.

400 Level

BTG 401: Biotechnology Seminar (2 Units C: LH 30)
Learning Outcomes
At the end of the course, students should be able to:
1. demonstrate deep knowledge and understanding of a topic in Biotechnology; and

2. display good presentation skills with clear exhibition of communication prowess, good appearance and mastery of the subject matter.

Course Contents
Development of communication skills needed by professionals in the field of biotechnology through students' oral presentations. Topics should address contemporary issues in biotechnology. They may be topics taught in the class or seminar topics given by academic staff. Topics are to be presented orally in a centre of guided studies made of departmental academic staff, students and the interested populace. Three copies of such well-articulated work should be bound and presented to the department.

BTG 402: Bio-safety and Bioethics (1 Unit C: LH 15)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the fundamentals and the impacts of biosafety and bioethics on all forms of lives;
2. describe the importance of biosafety practices and guidelines in the laboratories, for research and the industries; and
3. describe the benefits and demerits of genetic modification technologies on living things and the environment.

Course Contents
Biosafety: History, evolution and concept of biosafety. Application of biosafety in laboratories and industries. Biosafety guidelines and regulations. National and international standards of biosafety. Implementation of biosafety standards and guidelines. Biosafety levels, design of clean rooms, biosafety cabinets, risk assessment and containment levels. Biohazard and hazardous wastes. Biosafety protocol to protect nature. Good laboratory practice, good manufacturing practice, use of genetically modified organisms and their release, risks of GMOs for human and the environment.
Bioethics: Introduction and need of bioethics, its relation with other branches. Risk assessment and management in bio-industries, safety guideline in biotechnology laboratories and industries. Types of risks associated with genetically modified organisms, ethical issues in GMOs, ethics related to human cloning, human genome project, prenatal diagnosis, animal rights, data privacy of citizens' health. Ethical issues in various biotechnology products and services, sperm bank; sperm/ovule donation (sales), designer babies, organ donation/sale. Social economic impact of biotechnology.

BTG 403: Environmental Biotechnology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the sources of different pollutants, their effects on the living components of the biosphere and the environment at large;
2. describe how to prevent, reduce and recycle anthropogenic waste and how to convert organic waste into useful products;
3. demonstrate high knowledge of remediation strategies for different pollutants; and
4. describe the concept of green biotechnology and proffer solutions to the menace of plastic pollution.

Course Contents
Air pollution, sources of air pollution. Geen house gases, sources and properties. Biofixation of atmospheric carbon dioxide, NOx, SOx, and other air pollutants. Air filtration systems. Consequences of air pollution: global warming- meaning, mechanisms and consequences. Water pollution, sources, effects and consequences. Pollution of underground water. Biodetoxification of polluted water. Plastic pollution of the environment, impacts and consequences on the aquatic biodiversity and ecosystems. Wastewater treatment systems (trickling filters, oxidation pounds, anaerobic sludge digestion, activation processes and many more). Soil pollution: types and sources of soil pollutants. Bio-degradation, bio-detoxification, bio-adsorption, and bio-accumulation of contaminants. Bioremediation of contaminated soils (bio-stimulation, bio-augmentation), phyto-remediation, mycoremediation. Solid wastes: disposal, composting and recycling. Green biotechnology: concepts and definition, zero emission systems, closed life support systems, waste recycling, production of bio-degradable plastics, bio-insecticides, bio-fertilizers. Prevention of erosion and desertification through breeding for tolerance to abiotic factors. Contemporary issues in environmental biotechnology. Biotechnological control of green house gases and emissions. Biotechnology in combating and mitigating climate change.

BTG 404: Medical Biotechnology (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain production of different vaccines and biotechnological drugs production;
2. demonstrate knowledge of stem cell culture and artificial cell and organs production;
3. explain in-vitro fertilization and embryo transplant, delivery and molecular medical diagnosis;
4. describe gene therapy models used in the treatment of liver and lung diseases as well as in cancer and autoimmune diseases; and
5. describe other medical biotechnological concepts including vaccine vectors, synthetic DNA, tissue engineering, cell adhesion therapy and drug delivery.

Course Contents
Industrial production of monoclonal antibodies. Vaccine production. ELISA and PCR – based diagnostic kits; other molecular biology-based medical diagnosis. Bioengineering of drugs, drug delivery systems, tissue culture and grafting. Stem cell culture and transplanting, bone marrow cell culture and transplanting, cartilage cell culture and transplanting. Production of artificial cells and artificial organs, biocompatible polymer production. Gene and diseases, gene therapy. Reproduction biotechnology: sperm and ovule preservation, in-vitro fertilization and embryo transplanting, artificial womb.

BTG 405: Industrial Biotechnology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the techniques for isolation and maintenance of microorganisms of industrial importance and also describe how they can be selectively improved upon through mutations and genetic manipulation for better performance; and
2. describe methods for industrial production of biofertilisers, biopesticides, enzymes, amino acids, organic acids vitamins and antibiotics.

Course Contents
Micro-organisms of industrial importance and their roles, culture techniques and maintenance of selected strains, improvement of strains through mutation, gene amplification, hybridization, protoplast fusion and transformation & DNA techniques and future impact. An overview of bio-industries; production of various classes of useful metabolites (health care products, food and beverage products (distilled and non-distilled alcoholic beverages; fermented milk products such as cheese and yoghurt), industrial chemicals and bio-chemicals (amino acids, organic acids, vitamins, antibiotics, colouring agents), single cell proteins, bio-insecticides, biofertilisers. Fermentation economics. Development and prospects of enzyme technology. Bioconversion of waste into useful industrial products.

BTG 406: Plant Biotechnology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain various concepts in plant biotechnology including recombinant DNA technology, plant genomics, gene transfer and steps for production of transgenic crops;
2. describe production of healthier and more weather resilient and disease resistant crops;
3. explain non-regulated transgenics and regulatory consideration for transgenics; and
4. describe public perception of transgenic plant and describe ways through which escape of transgene can be halted.

Course Contents
Organization of plant cells. Photosynthesis: light and dark phases of photosynthesis; the C_3 and C_4 plants and their pathways. Phyto-hormones and other plant regulators. Plants tissue culture, techniques for rapid multiplication of planting materials, clonal propagation. Plant breeding objectives, traits of interest for field crops, traits of interest for fruits and vegetable crops, traits of interest for ornamentals and medicinal. Feasibility of trait, choice of cultivar type. The cycle of selection, gains from selection, development of inbred cultivars, development of commercial hybrids. Engineering of crops for improved yield, improve seedlings, diseases, pest and herbicide resistance, improved resistance to abiotic factors (droughts, salt, soil acidity, nutritional deficiency). Non-regulated commercial transgenics**,** FlavrSavr tomato history, roundup-ready soybeans**,** BT cotton and corn, virus-resistant papaya**,** other deregulated products. Commercial transgenics, herbicide resistant crops, trends and future direction. Regulatory considerations for transgenics: laboratory and commercial, State and federal regulations for transgenics, intellectual property, public perception of genetically modified plants, horizontal gene transfer and transgene escape, registration and commercialization – procedures and costs.

BTG 407: Research Project in Biotechnology (6 Units C: PH 270)

Learning Outcomes
At the end of the course, students should be able to:
1. demonstrate knowledge in a biotechnology research area and produce dissertations from hands on experiments; and
2. explain the research concepts with clear description of research problems and how the objectives have been met to a project defence panel.

Course Contents
Independent research findings undertaken by students into selected areas of biotechnology. Students will be required to survey on the topics, perform experiments and produce a written reports at the end of the semester. Students will be examined on the project undertaken orally. Projects embarked upon should emphasis biochemical principles and mechanics.

BTG 433: Biotechnology Entrepreneurship (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain how to set up a biotechnological firm, how to administer and manage a biotechnological start-up company, raise money or generate equity from various sources including the capital market and describe what intellectual property transfer entails; and
2. explain inventory and stock taking and describe strategic business decision making as well as describe in details who an entrepreneur is.

Course Contents
Definitions and concepts in biotechnology entrepreneurship. Going from biotech bench to marketplace. Compilation of the different products of biotechnological origin with applications in agriculture, pharmaceuticals, medicine and the environment. How to write a biotechnological specific business plan. Market surveys, turning community specific problem to business opportunity. Raising funds for start-ups. Procurement processes. Industrial production of biotechnological products and scale up steps. Role and functions of scientists in the biotechnology industry. Entrepreneurship: role of universities in supporting academic entrepreneurship, limiting factors on biotechnology entrepreneur. Firm development instruments. Biotechnology intellectual property, models and technology transfer. Marketing biotechnological patents, pitching and investor wooing strategies. The biotechnological value chain of a model business (biopharmaceutical). Business strategy models of biotechnological firms, strategic alliances, and acquisitions of biotechnology firms, strategic decision making. Financing aspects of biotechnology entrepreneurship, equity, shares and options, raising money, going public, networking. Inventory and stock taking; media & public relations; risk management and Insurance.

Minimum Academic Standards

Equipment
1. Micro Centrifuge
2. Tabletop Centrifuge
3. Ultra-Centrifuge
4. Personal Minifuges
5. Electronic Balance
6. Horizontal Electrophoresis Gel Box
7. Micropipettes
8. Power Supply For Electrophoresis
9. Spectrophotometer
10. UV Transilluminator
11. Blue Light LED Transilluminator
12. Autoclave

13. Milli-Q Water System
14. Ice Machine
15. Dry Ice Chamber
16. Ultra Low Temperature Freezers
17. Freezers
18. Refrigerators
19. Shaker Incubators
20. Cell Sorter
21. Microarray Scanner
22. Microplate Reader
23. Ultra Sonicator
24. Nanodrop Spectrophotometer UV-Vis
25. PCR Mastercycler - Gradient
26. Fluorescent Microscope - with digital camera
27. Scanning confocal microscope
28. Vortex Mixers
29. Electroporation System
30. Multi Vortexer
31. Thermo-mixers
32. Shaker Water Baths
33. Water Baths
34. Vacuum concentrator
35. Hybridization Oven
36. Thermo-block incubator with rotating wheel (37°C)
37. Incubator with rotating wheel (30°C)
38. Incubator with rotating wheel (42°C)
39. Rocking platform
40. Orbital shaker
41. Desktop computers
42. Carbon-nitrogen analyzer
43. High Pressure Liquid Chromatography - HPLC
44. UHPLC (Ultra-High Pressure Liquid Chromatography) System
45. UV-Vis Spectrophotometer
46. UV Thin film system
47. Ultrasound system
48. Mini spray dryer
49. Encapsulator B-390
50. Microfluidizer
51. Evos XL core imaging system RNA/DNA workstation
52. CO_2 incubator
53. Gel imaging system
54. Benchtop fermentation bioreactor
55. Personal genome machine
56. Optical microscope
57. Micro Ball Mill Mm 400
58. Plate sealer
59. Protein analyser
60. Pulsed Field Electrophoresis System

61. Automatic colony counter
62. Anaerobic chamber
63. Handheld automated cell counter
64. Clean Bench Laminar flow
65. Gas Chromatograph (HP)
66. DNA Analyzer
67. Bench Top Freeze Dryer
68. Dissecting microscope
69. Automated rotatory microtome machine

Staffing

Academic Staff

The guidelines on academic staff/student ratio of 1:20 for science programmes shall apply.
To start a biotechnology degree programme, there should be a minimum of six academic staff. There is need to have a reasonable number of staff with PhD degrees accounting for at least 70% of the total number and having adequate teaching experience. The various specialties of the biotechnology programme must be reflected in the staffing with experts in Plant, Animal, Microbial, Medical, Pharmaceutical, Environmental, Molecular, Computational biology and Agricultural biotechnology. The staff should cover the various cadres below:

- *Assistant Lecturer*
- *Lecturer II*
- *Lecturer I*
- *Senior Lecturer*
- *Reader (Associate Professor)*
- *Professor*

Non-Academic Staff

The services of the administrative support staff are indispensable in the proper administration of departments. It is important to recruit very competent, computer literate senior and junior staff and ensure that they are on a career path with possibility of growth on the job.
There should be adequate number of qualified technical staff in the various cadres listed below, with a minimum of school certificate and National Diploma in Laboratory Technology or its equivalent. The technological cadres are presented:

- Chief Technologist
- Assistant Chief Technologist
- Senior Technologist
- Technologist I
- Technologist II

There should also be adequate number of Laboratory Assistants with a minimum of school certificate. They are to undergo regular training to keep them abreast of developments in media and reagent preparation and equipment operation and maintenance. Technical staff are to be professional members of the Institute of Science Laboratory Technologists.

Library

There should be a departmental library that can contain a minimum of 50 students and equipped with relevant biotechnological books, journal articles and many more.

Classrooms, Laboratories, Workshops and Office Space
The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

Laboratories
Specialty laboratories are expected to be provided for the following:
General Biotechnology lab
Cell and Molecular Biology lab
Tissue culture lab
Microbial Biotechnology lab
Plant Biotechnology lab
Animal Biotechnology lab
Medical Biotechnology lab
Food &Industrial Biotechnology lab
Environmental Biotechnology lab

Lecture Theatres/Rooms
There should be at least one large lecture theatre (that can take not less than 200 students) for large classes and at least three lecture rooms, 100 seating capacity, to accommodate students adequately at each level from 200 to 400 level.

B.Sc. Botany

Overview
Botany is the scientific study of plants and these ranges in the broadest sense, from the microscopic bacteria and diatoms to large forest trees. Man has always depended on plants for food, fibre, drugs, etc., and with the growing shift of emphasis to renewable resources in the face of diminishing world supplies of fossil fuels and other exhaustible materials the need for better understanding of plants, including present-day under-utilized or non-economic species, has come sharply into focus.

Philosophy
The programme has been designed to provide a sound knowledge of the concepts and methodologies of botany in key areas that meet the needs of society.

Objectives
The main objectives of the programme are to

1. enable students acquire knowledge in the skills of the discipline;
2. train and equip students in contemporary Botany procedures for better career performance;
3. broadly educate students for positions in the conservation and bio-diversity sectors;
4. produce highly qualified personnel to take up employment in plant products based industries and institutions; and
5. prepare students for graduate and professional studies in the plant sciences at the molecular level.

Unique Features of the Programme

The unique features of the programme include:

1. Creating a wide range of interest areas that now exists in botany, allowing persons with different backgrounds, attitude and temperament to select satisfactory plant-science-based careers;
2. Introducing Bioinformatics to enhance students understating plant at molecular level;
3. Producing students with bio-entrepreneurship skills; and
4. Infusion of basic skills and competencies to contribute to health and plant disease control.

Employability Skills

1. A graduate of Botany is equipped with requisite skills and understanding that would successfully launch the individual into employment in plant base Industries and Research Institutes.
2. Botany graduates are expected to develop skill that may bring gainful employment in such government agencies and allied bodies as the Federal Quarantine Service, Geological Survey, Oil Exploration Department, germplasm collection and herbaria, museums and archaeology institutes and botanical gardens, parks and reserves.
3. The cognitive skills of botanists will be applied in pharmaceutical industry, petrochemical industry, lumber industry, seed companies, food companies, fermentation industry (including breweries), and biological supply houses are pertinent example.
4. Botany graduates with research , IT and technology, monitoring and other skills may be self-employed in floriculture, mushroom production and consultancy service to agriculture, forestry, fisheries, paper mills and other users of wood and plant products.

21st Century Skills

1. Collaboration
2. Critical thinking
3. Creativity
4. Flexibility
5. Technology literacy
6. Innovation
7. teamwork
8. good problem-solving skills
9. Information and Communication Literacy

Admission and Graduation Requirements

Admission Requirements

4-year degree programme

The entry requirements shall be at least credit level passes in five subjects including English Language, Mathematics, Biology, Chemistry and Physics at the Senior Secondary Certificate (SSC)

or its equivalent. In addition, an acceptable pass in the Unified Tertiary Matriculation Examination (UTME), with relevant subject combination is required for admission into 100-level.

Candidates with five SSCE (or equivalent) credit passes with at least two passes in Biology, Chemistry, Mathematics or Physics at the GCE Advanced Level or IJMB or JUPEB may be considered for admission into 200 Level.

Graduation Requirements
To earn a degree in Botany, UTME Students must obtain a minimum of 120 credits while Direct entry students must obtain and pass a minimum of 90 credits units.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	30	-
GST 112	Nigerian Peoples and Culture	2	C	30	
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
BIO 102	General Biology II	2	C	30	-
BIO 107	General Biology Practical I	1	C	-	45
BIO 108	General Biology Practical II	1	C	-	45
CHM 101	General Chemistry I	2	C	30	-
CHM 102	General Chemistry II	2	C	30	-
CHM 107	General Chemistry Practical I	1	C	-	45
BOT 102	Introductory Botany	2	C	15	45
PHY 101	General Physics I	2	C	30	-
	Total	**24**			

200 Level

Course Code	Course Title	Units	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	30	-
BIO 201	Genetics 1	2	C	30	
BIO 203	General Physiology	2	C	30	-
BIO 204	Biological Techniques	2	C	15	45
BIO 205	Introductory Developmental/Cell Biology	2	C	15	45
BOT 202	Seedless Plants	2	C	30	-
BOT 203	Seed Plants	2	C	30	-
	Total	**16**			

300 Level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
BOT 301	Plant Taxonomy	3	C	30	45
BOT 302	Comparative Anatomy of Plant	3	C	30	45
BOT 303	Plant Physiology	3	C	30	45
BOT 304	Plant Ecology	3	C	15	90
BOT 305	Mycology	3	C	30	45
BOT 311	Medicinal Plants	3	C	15	90
BOT 399	Industrial Field Attachment (12 Weeks)	3	C	-	-
	Total	**25**			

400 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
BOT 401	Seminar	1	C		45
BOT 406	Plant Pathology	3	C	30	45
BOT 409	Plant Virology	3	C	30	45
BOT 411	Bioinformatics	3	C	45	
BOT 413	Research Project	6	C	-	270
BOT 416	Plant Cytogenesis	3	C	30	45
	Total	**19**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to
1. identify possible sound patterns in English Language;
2. list notable Language skills;
3. demonstrate an appreciable level of the art of public speaking and listening; and
4. write simple and technical reports.

Course Contents
Sound patterns in English Language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and Deductive Argument and Reasoning Methods, Analogy, Generalisation and Explanations). Ethical considerations, Copyright Rules and Infringements. Writing Activities: (Pre-writing , Writing, Post writing, Editing

and Proofreading; Brainstorming, outlining, Paragraphing, Types of writing, Summary, Essays, Letter, Curriculum Vitae, Report writing, Note making and Mechanics of writing). Comprehension Strategies: (Reading and types of Reading, Comprehension Skills, 3RsQ). Information and Communication Technology in modern Language Learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112- Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of Trade, Economic and Self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building
6. analyse the role of the Judiciary in upholding people's fundamental rights
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification. Judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation; Re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption(WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. explain basic definition of set, subsets, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify the various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers, integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers, algebra of complex numbers, the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative as limit of rate of change. Techniques of differentiation. Extreme curve sketching. Integration as an inverse of differentiation. Methods of integration. Definite integrals. Application to areas, volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word

processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

BIO 101: General Biology I **(2 Units C: LH 30)**

Learning Outcomes
At the end of lectures, students should be able to:
1. explain cells structure and organizations;
2. summarize functions of cellular organelles;
3. characterize living organisms and state their general reproduction;
4. describe the interrelationship that exists between organisms;
5. discuss the concept of heredity and evolution; and
6. enumerate habitat types and their characteristics.

Course Contents
Cell structure and organisation, functions of cellular organelles. characteristics and classification of living things. chromosomes, genes; their relationships and importance. general reproduction. interrelationships of organisms (competitions, parasitism, predation, symbiosis, commensalisms, mutualism, saprophytism). heredity and evolution (introduction to Darwinism and Lamarkism, Mendelian laws, explanation of key genetic terms). elements of ecology and types of habitat.

BIO 102: General Biology II **(2 Units C: LH 30)**

Learning Outcomes
At the end of the lectures, students should be able to:
1. list the characteristics, methods of identification and classification of Viruses, bacteria and fungi;
2. state the unique characteristics of plant and animal kingdoms;
3. describe ecological adaptations in the plant and animal kingdoms;
4. explain nutrition, respiration, excretion and reproduction in plants and animals; and
5. describe growth and development in plants and animals.

Course Contents
Basic characteristics, identification and classification of viruses, bacteria and fungi.
A generalized survey of the plant and animal kingdoms based mainly on the study of similarities and differences in the external features. Ecological adaptations. Briefs on physiology to include nutrition, respiration, circulatory systems, excretion, reproduction, growth and development.

BIO 107: General Biology Practical I **(1 Unit C: PH 45)**

Learning Outcome
At the end of this course students should be able to:
1. outline common laboratory hazards;
2. provide precaution on laboratory hazards;

3. state the functions of the different parts of microscope;
4. use the microscope and describe its maintenance;
5. draw biological diagrams and illustrations; and
6. apply scaling and proportion to biological diagrams.

Course Contents
Common laboratory hazards. prevention and first aid. measurements in biology. uses and care of microscope. compound and dissecting microscope. Biological drawings and illustration, scaling, accuracy and proportion. use of common laboratory apparatus and laboratory experiments designed to illustrate the topics covered in **BIO 101.**

BIO 108: General Biology Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. describe the anatomy of flowering plants;
2. differentiate types of fruit and seeds;
3. state ways of handling and caring for biological wares;
4. describe the basic histology of animal tissues; and
5. identify various groups in the animal kingdom.

Course Contents
Anatomy of flowering plants, primary vegetative body. stem, leaf and root to show the mature tissues namely parenchyma, collenchyma, sclerenchyma, xylem and phloem. Types of fruits and seeds. Care and use of dissecting kits and other biological wares. Dissection and general histology of animal tissues based on vertebrate forms. Morphology and functions of epithelial, muscular, nervous and connective tissues. Examination of various groups of lower invertebrates under microscopes, identification of various groups of organisms in Animal Kingdom. And any experiment designed to emphasise the practical aspects of topics in BIO 102.

CHM 101: General Chemistry I (2 Units C: LH 30)

Learning Outcomes
After studying all materials and resources presented in the course, the student will be able to:
1. define atom, molecules and chemical reactions;
2. discuss the modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. illustrate shapes of simple molecules and hybridized orbitals;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using Lechatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents
Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence Forces; Structure of solids. Chemical equations and stoichiometry; Chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry; rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II (2 Units C: LH 30)

Learning Outcomes:
At the end of this course, the students should be able to:
1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reaction;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. describe basic properties of Transition metals.

Course Contents
Historical survey of the development and importance of organic chemistry, fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures and nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The Chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes
1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify the differences between primary and secondary standards;
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents

Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes

On Completion, the Student should be able to;

1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents

space and time. units and dimension. vectors and scalars. differentiation of vectors: displacement, velocity and acceleration. Kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). relative motion. Application of Newtonian mechanics. equations of motion. conservation principles in physics, conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass. Rotational motion. torque, vector product, moment, rotation of coordinate axes and angular momentum, polar coordinates. conservation of angular momentum; Circular motion. Moments of inertia, gyroscopes and precession. gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General Physics II (Electricity & Magnetism) (2 Units C: LH 30)

Learning Outcomes

On completion, the student should be able to;

1. describe the electric field and potential, and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;
5. describe electromagnetic induction and related concepts, and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters; and
8. determine the characteristics of ac voltages and currents in resistors, capacitors, and Inductors.

Course Contents
Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and resistance. Ohm's law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

BOT 102: Introductory Botany (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. identify different classes of plants;
2. describe the vascular plants;
3. locate nonvascular plants;
4. list growth forms of plants;
5. differentiate the cell structure of monocotyledonous and dicotyledonous plants;
6. explain distinguishing features of monocot and dicot;
7. identify types of fruits and seeds;
8. illustrate botanical drawings; and
9. sketch parenchyma, collenchyma, sclerenchyma, xylem and phloem.

Course Contents
General classification of plants. Distinguishing features of Monocotyledons and Dicotyledons. Features of vascular plant, Morphology of non-vascular plants. Duration of life of plants. Plants life cycles. Growth forms of plants. Cell structure and functions. Morphology of flowering plants, primary vegetative body: stem, leaf and root to show the mature tissues of parenchyma, collenchyma, sclerenchyma, xylem and phloem. Types of fruits and seeds. Botanical drawings and use of microscope.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and

8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents

Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students should be able to:

1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;
2. state the characteristics of an entrepreneur;
3. analyze the importance of micro and small businesses in wealth creation, employment, and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents

Concept of Entrepreneurship (Entrepreneurship, Intrapreneurship/Corporate Entrepreneurship,).Theories, Rationale and relevance of Entrepreneurship (Schumpeterian and other perspectives, Risk-Taking, Necessity and opportunity-based entrepreneurship and Creative destruction). Characteristics of Entrepreneurs (Opportunity seeker, Risk taker, Natural and Nurtured, Problem solver and change agent, Innovator and creative thinker). Entrepreneurial thinking (Critical thinking, Reflective thinking, and Creative thinking). Innovation (Concept of innovation, Dimensions of innovation, Change and innovation, Knowledge and innovation). Enterprise formation, partnership and networking (Basics of Business Plan, Forms of business ownership, Business registration and Forming alliances and join ventures). Contemporary Entrepreneurship Issues (Knowledge, Skills and Technology, Intellectual property, Virtual office, Networking). Entrepreneurship in Nigeria (Biography of inspirational Entrepreneurs, Youth and women entrepreneurship, Entrepreneurship support institutions, Youth enterprise networks and Environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

BIO 201: Genetics I **(2 Units C: LH 30)**

Learning Outcomes
At the end of this course, students should be able to:
1. distinguish between heritable and non-heritable characteristics;
2. explain the likelihood of genetic events (Probability) and how well those events (results) fit into a set of observation;
3. discuss polygenic variations; and
4. describe concepts in population genetics.

Course Contents
Hereditable and non-hereditable characteristics. Probability and tests of goodness of fit. Quantitative inheritance; variation in genome structure, introduction to population genetics.

BIO 202: Introductory Ecology **(2 Units C: LH 15; PH 45)**

Learning Outcomes
At the end of the lectures in this course, students should be able to:
1. explain various concepts and terminologies associated with the ecosystem;
2. list and explain features of various habitat types;
3. explain natural destruction/disaster, community and natural cycles; and
4. explain and describe factors responsible for changes in population.

Course Contents
Concept and definition of ecosystem, ecology at community level, ecological classification of habitat types, terrestrial and aquatic biomass, specific features of each, biotic components of habitat. Natural destruction, factors of communities, success of community interaction, natural cycle, dynamics of population.

BIO 203: General Physiology **(2 Units C: LH 30)**

Learning Outcomes
At the end of this course, students should be able to:
1. explain the chemistry of organic compounds and their biological importance;
2. state the general characteristics of enzymes;
3. describe nutrition, digestion and absorption in plants and animals;
4. discuss the cell membrane structure and list its functions;
5. summarize osmoregulation, excretion and transport in animals;
6. enumerate growth hormones in plants and their functions;
7. explain the homeostasis, their coordination and functions in animals; and
8. explain the plant water relation, growth and growth regulation.

Course Contents
Chemicals of life: The chemistry of Carbohydrates, lipids, proteins and nucleic acids and their biological importance. General characteristics of enzymes; nutrition, digestion, and absorption in plants and animals. Biosynthesis: Photosynthesis and protein synthesis. Cell membrane structure and function.

A general study of osmoregulation, excretion, transport, growth hormones and enzymology, homeostasis and their co-ordination in animals. Plant water relation, growth and growth regulation.

BIO 204: Biological Techniques (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this lectures, students should be able to:
1. list the different parts of a light microscope and state their functions;
2. state and explain the stages involved in preparation of slides;
3. describe the basic principles of spectrophotometry, colorimetry, photometry;
4. describe polarimetry, chromatography, refractometry, melting points and colligative Properties;
5. describe the basic collection and preservation processes of plant and animal materials and their preservation in herbarium and museum respectively; and
6. explain the need for experimental design, basis of report writing and presentations.

Course Contents
Microscopy. handling of microscopes. preparation of microscope slides (microtomy) for microscopic examinations. use of hand lens. biological drawings and diagrams. Spectrophotometry. Colorimetry. Photometry. Polarimetry. Chromatography. Refractometry. melting points and colligative properties. Herbarium and museum techniques. Experimental designs, report writing and presentations.

BIO 205: Introductory Developmental / Cell Biology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the lectures in this course, students should be able to:
1. draw the detail structure of plant and animal cells and state the functions of the organelles;
2. summarize and state the differences and similarities between mitosis and meiosis;
3. describe cell differentiation and its growth; and
4. explain the molecular basis of cell structure and development.

Course Contents
History and present trends in cell biology. Ultra-structure of the plant and animal cells, Organelles and their basic structures and functions; mitosis and meiosis, cell differentiation and growth of cells. A brief study of the molecular basis of cell structure and development.

BOT 202: Seedless Plants (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the students should be able to:
1. describe the basic structure of fungi, algae, bryophyte and pteridophytes;
2. relate the evolutionary sequences of the seedless plants;
3. identify plants that do not possess seeds;
4. recognize the major classes in seedless plants;
5. explain the fossils plants; and
6. summarize the general characteristics of fungi, algae, bryophyte and pteridophytes.

Course Contents
Morphology and reproduction of fungi. Morphology and reproduction of algae. Morphology and reproduction of bryophytes and pteridophytes. Classifications of fungi, Algae, bryophytes and Pteridophytes. General characteristics of fungi, algae, bryophyte and pteridophytes. A study on fossils of fungi, algae, bryophytes and Pteridophytes. Evolutionary sequences of the members of Thallophytes (Bacteria, fungi and bryophytes and pteridophytes)

BOT 203: Seed plants (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. illustrate the morphology of seed plants;
2. identify the evolutionary relationships of seed plants;
3. differentiate the reproductive structures of gymnosperms and angiosperms;
4. recognize different classes in Gymnosperms and Angiosperms;
5. discuss fossilized plants; and
6. explain characteristics of Gymnosperm.

Course Contents
Characteristics of gymnosperm. Morphology of stem of Gymnosperms, Morphology of roots of Gymnosperms. Morphology of leaves of Gymnosperms. Morphology of flowers of Gynosperms. Reproduction in Gymnosperms. Classification and distribution gymnosperms. Characteristics of angiosperm. Morphology of Monocotyledons, Morphology of Dicotyledons. Reproduction and reproductive parts of Monocotyledons. Reproduction and reproductive parts of Dicotyledons. Fossil plants in Gynosperms and Angiosperms).

BOT 299: Industrial Attachment I (3 Units C: 12 weeks)
Students should be attached to industrial organisations for 12 weeks for appropriate exposure. Assessment to be based on written report, seminar presentation and referees' assessment.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents
Concepts of Peace, Conflict and Security in a multi-ethnic nation. Types and Theories of Conflicts: Ethnic, Religious, Economic, Geo-political Conflicts; Structural Conflict Theory, Realist Theory of Conflict, Frustration-Aggression Conflict Theory. Root causes of Conflict and Violence in Africa: Indigene and settlers Phenomenon; Boundaries/boarder disputes; Political disputes; Ethnic

disputes and rivalries; Economic Inequalities; Social disputes; Nationalist Movements and Agitations; Selected Conflict Case Studies – Tiv-Junkun; Zango Kartaf, Chieftaincy and Land disputes and many more. Peace Building, Management of Conflicts and Security: Peace & Human Development. Approaches to Peace & Conflict Management --- (Religious, Government, Community Leaders and many more). Elements of Peace Studies and Conflict Resolution: Conflict dynamics assessment Scales: Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice; The Nigeria Legal System. Insurgency and Terrorism. Peace Mediation and Peace Keeping. Peace & Security Council (International, National and Local levels) Agents of Conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration c). Negotiation d). Collaboration and many more. Roles of International Organizations in Conflict Resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping. Media and Traditional Institutions in Peace Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students, through case study and practical approaches, should be able to:

1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/Market Research, Unutilised resources, Social and climate conditions and Technology adoption gap). New business development (business planning, market research). Entrepreneurial Finance (Venture capital, Equity finance, Micro finance, Personal savings, Small business investment organizations and Business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, Customer Acquisition & Retention, B2B, C2C and B2C models of e-commerce, First Mover Advantage, E-commerce business models and Successful E-Commerce Companies,). Small Business Management/Family Business: Leadership & Management, Basic book keeping, Nature of family business and Family Business Growth Model. Negotiation and Business communication (Strategy and tactics of negotiation/bargaining, Traditional and modern business communication methods). Opportunity Discovery Demonstrations (Business idea generation presentations, Business idea Contest, Brainstorming sessions, Idea pitching). Technological Solutions (The Concept of Market/Customer Solution, Customer Solution and Emerging Technologies, Business Applications of New Technologies - *Artificial Intelligence (AI),*

Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy and many more. Digital Business and E-Commerce Strategies).

BOT 301: Plant Taxonomy (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. distinguish classes of plants;
2. design and construct taxonomic keys;
3. describe chemotaxonomy and cytotaxonomy;
4. identify sources of taxonomic data;
5. appraise methods of taxonomic data analysis;
6. explain binomial of nomenclature;
7. create floral diagrams; and
8. construct floral diagrams.

Course Contents
Taxonomy and its significance, principles and concepts in plant taxonomy. Construction and use of taxonomic keys. Experimental taxonomy with special emphasis on cytotaxonomy and chemotaxonomy. Sources of taxonomic data and methods of analysis.
Artificial systems, natural systems phylogenetic system, binomial nomenclature, International rules of botanical nomenclature. General principles of classification of flowering plants. Some unconventional identification methods. Polyclave identification, computerized identification. Methods of describing a flowering plant, floral formulae, floral diagram, classification

BOT 302: Comparative Anatomy of Plants (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. recognize different tissues and tissue systems;
2. illustrate the evolution of the vascular tissues;
3. assess the anatomical adaptations to specialize habitats;
4. discuss the organizations of meristems;
5. distinguish anatomy of monocots from dicots; and
6. compare anatomy various wood.

Course Contents
Characteristics and classification of tissue and tissue systems; organisation of meristems, evolution of vascular tissues, comparative wood anatomy. Anatomical adaptations to specia1ized habitats. Applied aspects of plant anatomy. Anatomy of monocot and dicot stems, roots and leaves. Anomalous secondary growth.

BOT 303: Plant Physiology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. define plant water relations;

2. identify the photosynthetic process;
3. recognize the process involve in respiration, growth, flowering, dormancy, seed germination;
4. appraise senescence in plants;
5. discuss factors affecting transpiration;
6. define mineral elements and functions;
7. relate physiology with crop yield;
8. explain glycolysis;
9. describe C_4 photosynthesis; and
10. draw Calvin cycle.

Course Contents
Plant water relation, photosynthesis, photosynthetic pigments, photochemical reaction centre, phosphorylation, Calvin cycle, Photorespiration, Crassulacean Acid metabolism, glycolysis, respiration, growth and growth regulation, flowering, dormancy, seed germination, senescence; Properties of water in relation to plant life. Transpiration. Factors affecting transpiration. Mineral nutrition. Mineral elements and their functions. Physiological aspects of crop yield. Pre -requisite -B10 203.

BOT 304: Plant Ecology (3 Units C: LH 15; PH 90)

Learning Outcomes
At the end of the course, students should be able to:
1. compare different plant communities;
2. design some ecological framework;
3. recognize different vegetation in Nigeria;
4. identify plant productivity in desert and semi desert; and
5. explain modern concepts in ecology.

Course Contents
Study of various plant communities and their ecological framework; Nigerian vegetation, desert and semi-desert plant productivity. Modern concepts in ecology.

BOT 305: Mycology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the structure and life cycles of fungi;
2. recognize fungi of economic importance;
3. explain different classes of fungi;
4. identify metabolites of fungi;
5. describe industrial;
6. identify medicinal fungi;
7. fungal nomenclature; and
8. explain fungal physiology.

Course Contents

Fungal morphology-structure of septate and coenocytic fungi. Fungal cytology Different life cycles in fungal groups, Fungal physiology. Classification of fungi. Fungal nomenclature. Characteristics of fungi. Fungi of economic importance. Metabolites of fungi, industrial uses of fungi. Fungi in medicine.

BOT 306: Plant Breeding (3 Units C: LH 15; PH 90)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the objectives of plant breeding;
2. explain the origin and domestication of plant breeding methods;
3. describe the chromosomes manipulation;
4. discuss breeding method; and
5. appraise recurrent selection.

Course Contents
The objectives of plant breeding; origin and domestication of plant breeding. Self-pollinated and cross-pollinated crops. Breeding methods, pure line breeding and mass selection; pedigree method; bulk population breeding; back cross breeding. Recurrent selection, chromosome manipulation.

BOT 311: Medicinal Plants (3 Units C: LH 15; PH 90)

Learning Outcomes
At the end of the course, students should be able to:
1. recognise and be able to classify medicinal plants;
2. appraise preparation of extracts from various organs of plants;
3. design methods to gather ethno medicinal information;
4. identify methods of collection;
5. describe preservation methods for medicinal plants; and
6. explain importance of medicinal plants

Course Contents
Description, identification and classification of medicinal plants. Preparation of extracts from various organs of plants. Gathering of ethnomedical information. Collection and preservation of medicinal plant. Importance of medicinal plants. Pharmacological properties of medicinal plants. Biodiversity convention – Rio, Glasgow and many more.

BOT 312: Conservation and Biodiversity (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. develop plant breeding concepts and methodology;
2. identify the conservation movement;
3. design the strategy for conservation; and
4. describe the use of forestry by man.

Course Contents

Plant breeding concepts and methods. Development of conservation movement, scope of conservation, strategy for conservation, man, nature and resources, principles of paces, grasslands, man's use of forestry.

BOT 399: Industrial Attachment II (3 Units C: 12 weeks)

Industrial/Field experience in anyone of the following: (a) Afforestation; (b) Applied Plant Anatomy; (c) Aquatic and Pollution Biology; (d) Horticulture; and (e) Biotechnology for a period of three months preferably during the long vacation. Students will be assessed based on seminar presentations, their reports and supervisors' assessments.

400 Level

BOT 401: Seminar (1 Unit C: PH 45)

Student reports on an assigned or chosen current topic in botany. Review of literature on the assigned topic should be included.

BOT 402: Economic Botany (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. assess some Nigerian plants with economic value;
2. recognize plants that produce oils, rubber, fibres, dyes;
3. describe the botany of the identified economic plants; and
4. evaluate the products of the economic plants.

Course Contents
A study of the botany, cultivation, processing and uses of tropical plants with particular references to Nigerian economic plants will be undertaken. Plants producing oils, rubber and wood products, fibres, dyes and leather tanning materials, sugar and pharmaceutical products.

BOT 403: Nigerian Vegetation (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the vegetation types;
2. explain the ecology of the vegetation;
3. Identify the impact of human activities on Nigerian vegetation; and
4. relate the plants to principles and concept of phytography.

Course Contents
A study of Nigerian vegetation types: mangrove, swamp forest, fresh water swamp forest, savannah grass lands and arid zones. The impact of human activities on Nigerian vegetation.

BOT 404: Soil Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. recognise different classes of soil;
2. identify the major characteristics of soil;
3. explain the chemical components of soils;
4. analyse soils and plant tissues; and
5. identify plant soil and water relations.

Course Contents
Classification and characteristics of soils. Chemical component and analysis of soils and plant tissue. Plant, soil water relationships.

BOT406: Plant Pathology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the principles and concept in plant pathology;
2. explain the disease infection;
3. design the disease triangle and its relation to pathogenicity;
4. apply biological and chemical control of diseases;
5. describe the method of studying nematodes;
6. identify the parasitic and non-pathogenic diseases;
7. appraise the methods of studying plant disease; and
8. survey diseases symptoms.

Course Contents
Principles and concepts in plant pathology. The concept of disease, infection, pathogenesis, host-pathogen relationship. Methods and theory of biological therapy and chemotherapy. Disease inciting organisms. Symptoms of plant diseases. Defence mechanisms. Principles of plant disease control. Methods of studying plant diseases. Biopesticides in deceases management. The method of studying nematodes diseases of plants.

BOT 407: Plant Reproduction (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the structure and functions of sexual organs;
2. classify different sexual and asexual mode;
3. recognize the floral structures and functions;
4. review the mechanisms of breaking seed dormancy; and
5. evaluate fissions, spore fragmentation and vegetative propagation in plants.

Course Contents
Development trends of sexual and asexual reproduction to be studied. Structure and functions of nucleus, mechanisms of cell division, mitosis and meiosis in plant reproduction. Sexual reproduction in flowering plants, emphasis on floral structure and functions (Gynoecium and Androecium), pollination, fertilization, seed and fruit formation, dispersal, seed germination, seed dormancy, mechanisms of breaking seed dormancy, physiological implications, conditions

necessary for germination, seed storage and propagation. Asexual reproduction: clones, fission, spore formation, fragmentation. Vegetative propagation of horticultural tree crops. Current techniques in bud grafting and cutting.

BOT 408: Plant Tissue Culture (3 Units C: LH 15; PH 90)

Learning Outcomes
At the end of the course, students should be able to:
1. demonstrate different tissue used in culture;
2. identify the roles of hormones and vitamins in culture;
3. evaluate various techniques in the tissue culture; and
4. appraise the application of tissue culture in plant breeding.

Course Contents
Meristem culture, organ cultivation, embryo culture. The role of plant hormones and vitamins. Techniques of plant tissue culture. Applications of plant tissue culture in plant breeding.

BOT 409: Plant Virology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the major characteristics of plant viruses;
2. discuss the method of viral multiplication;
3. review some viral diseases in plant;
4. assess various methods of viral control;
5. explain method of viral transmission;
6. viruses of economic crops; and
7. discuss nature of viruses.

Course Contents
General characteristics of plant viruses. Viral multiplication. Selected viral diseases in plants. Origin of viruses, general morphology of viruses. Classification and nomenclature. Replication of bacteriophages. Types of viral infection. Common symptoms of viral infection. Transmission of viruses. Control strategies. Nature of viruses,

BOT 411: Bioinformatics (3 Units; C LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. use search engines;
2. test for biological databases;
3. retrieve biological databases;
4. construct phylogenetic trees;
5. interpret gene predictions; and
6. review prokaryotic and eukaryotic genes.

Course Contents
Introduction to Internet world wide web Internet resources, browses, search engines, PubMed, Biological databases, and its retrieval. Nucleotide sequence databases and analysis, genes and

genome, prokaryotic and eukaryotic genes. Gene bank entry and genome database, organelle genome. gene identification with internet recourse.
Sequence alignment and construction of phylogenetic trees. Gene Predictions.

BOT 413: Research Project (6 Units C: PH 270)
Research findings into selected topics in Botany. Students will be expected to carry out literature survey on chosen topics, perform experiments and produce reports. Students will be subjected to both seminar and oral examinations on their projects.

BOT 414: Plant Molecular Biology (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. appraise fundamentals of plant molecular biology;
2. recognize the structure of nuclear genes;
3. explain the plant organelles and microbe interactions;
4. describe DNA and RNA structure;
5. distinguish golgi and mitochondria structure; and
6. demonstrate plant biotechnology.

Course Contents
Fundamental and applied aspects of plant molecular biology, structure, expression and isolation of plant nuclear genes. Biogenesis of microtubule, microfilaments. Golgi apparatus and mitochondria. Membrane and membrane interactions. Cell wall structure and properties of DNA and RNA. Molecular biology of plant development, plant organelles and plant-microbe interactions and plant biotechnology.

BOT 415: Palaeobotany and Palaeontology (3 Units C: LH 45)
Learning Outcomes
At the end of the course, students should be able to:
1. classify spores and pollen;
2. recognise the stratigraphic significance of pollen and spores;
3. delineate and correlate biozones; and
4. apply pollen and spores to basin analysis.

Course Contents
Morphology and classification of spores and pollen; their stratigraphic occurrence. palaeoclimate and palaeoenvironment environment. biozones. Application of pollen and spores to hydrocarbon exploration.

BOT 416: Plant Cytogenesis (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. identify chromosome structure and number;
2. appraise qualitative changes in substitution, invasion and translocation;
3. express quantitative change in duplication and deletion;
4. construct karyotypes and use chromosome banding;

5. reproduce cytology of autopolyploid; and
6. design cytogenetic tools such as in-situ hybridization.

Course Contents
Morphology and behaviour of Chromosomes, Chromosomal Aberrations and Polyploidy, importance of polyploidy, Population cytogenesis. Examples with reference to specific individuals. Population cytogenesis, Hardy-Weinberg law. Gene recombination, elementary probability and testing genetic ratios. Modern application of genetics, objectives and origin of plant breeding.

BOT 417: Plants and Environmental Pollution Monitoring (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. identify seedless plants and higher plants that can be used to monitor environmental pollution;
2. extrapolate the algae that can serve as indicators of aquatic pollution; and
3. diagnose merits and demerits of using various taxonomic groups as indicators.

Course Contents
The use of algae, lichens, bryophytes and higher plants in monitoring environmental pollution. The use of algae as indicators of aquatic pollution. The merits and demerits of using various taxonomic groups as indicators.

BOT 418: Host-Pathogen Relations & Plant Disease Management
(3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the mode of penetration the mode of penetration and colonization in disease plant;
2. recognize pre- and post-penetrations interactions;
3. evaluate mechanisms of damage and resistance;
4. identify the method of disease control; and
5. describe the methods of management of plant diseases.

Course Contents
Host penetration and colonization. Pre- and post-penetration interactions of the host, pathogen and environment. Mechanisms of damage and resistance. Methods of disease control and management.

BOT 419: Introduction to Mushroom Growing Technology
(3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. appraise the biology and ecology of mushrooms;
2. explain the economic importance of mushroom;

3. identify different of mushrooms;
4. describe the methods of preservation;
5. describe history of mushroom cultivation; and
6. design the method of spawn production and cropping.

Course Contents

Biology, ecology and economic importance of mushrooms. Collection, identification and preservation of mushrooms. History of mushroom cultivation. Spawn production and cropping.

Minimum Academic Standards

Equipment

1. Skeletal System
2. Muscular System
3. Brain and Nervous System
4. Circulatory System
5. Digestive System
6. Eye and Vision
7. Skin and Excretory Organs
8. GB 28 Concealing and Warning Adaptations
9. Ice Cube Maker
10. Incubator/Sterilizer
11. Embedding Bath
12. Water Baths
13. Autoclaves
14. Balances
15. Hot Plates
16. Incubators
17. Binocular microscopes
18. Stereo Microscopes
19. Refrigerators
20. Shakers
21. pH Meters
22. Sahli's Heamoglobinometer
23. Distillers (All Glass)
24. R. Humidity with Thermometer
25. Embedding Oven
26. Ovens
27. Thermostatic Incubator
28. Microtome
29. Automatic Tissue Processor
30. Tissue Embedding Centre
31. Air Pumps (Diaphragm)
32. Vacuum Pumps

33. Tissue Grinder Glass
34. Photometer and Atometer
35. Shadon Unit Kit No. 1
36. Barothermograph
37. Kymograph Muscle
38. Spirometer
39. Colorimeter
40. Insect Light Traps
41. Insect Box
42. Slide Projector
43. Over-head Projector
44. Bench Centrifuges
45. Micro Refrigerated Centrifuges
46. Steel Frame Aquaria
47. Auxanometer
48. Oxygen Meter
49. Glass wares
50. Herbarium plant press
51. Inoculating Chamber cabinet
52. Hand Cork borer
53. Sterilizing Cans

Staffing

Academic Staff
The guidelines on academic staff/student ratio of 1:20 for Science Programmes shall apply.
To start any programme in Botany, there should be a minimum of six academic staff with at least three Senior Lecturers and above. There is need to have a reasonable number of staff with PhD degrees accounting for at least 70% of the total number and having adequate teaching experience for every programme in the Discipline.

Administrative Support Staff
The services of the administrative support staff are indispensable in the proper administration of departments and faculty offices. It is important to recruit very competent, computer literate senior staff.

Technical Support Personnel
The services of technical support staff, which are indispensable in the proper running of laboratories and workshops, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

Library
Universities should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition well stock and current hardcopies of reference and other textual materials should be provided centrally at the level of the Faculty. A well network digital library should serve the entire university community. Availability of wireless facilities (Wifi) with adequate bandwidth should enhance access to these electronic resources.
In any case, there should be internet ready workstations available in the library for least 25% of the total student enrolled in each academic programme. The funding of the Library should be in line with NUC guidelines.

Classrooms, Laboratories, Workshops and Office Space
The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

B. Sc. Brewing Science and Technology

Overview
The programme uses the craft-brewing industry as its model, not only because it is one of the fastest growing industries, but because this industry is representative of the international brewing community and demonstrates a deep appreciation for the rich history of beer and brewing. Our students are encouraged to experiment with recipes and brewing regimens in order to understand how access to ingredients and tradition led to characteristic regional beer styles and how globalization of brewing ingredients has led to a renaissance of flavourful beers. The programme focuses on the brewing process itself and the science underlying it. Graduates of brewing science are expected to have the ability to apply knowledge and skills to solving theoretical and practical problems in brewing and other allied industries in relation to national and societal needs, as they will be equipped with sound basis in fundamental scientific and technological principles and their application in the context of malting, brewing and distilling, as well as the breadth and depth of knowledge in the subjects required by the industry.

The programme is developed in co-operation with senior representatives of the brewing, malting and distilling industries. Emphasis is placed on practical work and industrial training during the course of the B.Sc. programme. The first two years are spent mostly on introductory and core courses that cover the broad spectrum of the pure sciences. The programme is presented as a 5-year degree course, but a university may choose to run it as a 4-year programme in which case the industrial training courses will be run for 12 weeks at 300 level.

Philosophy
The programme provides students with academic and practical skills to excel in the malting, brewing and distilling sectors, through full understanding of the science and technology of the processes involved from cereal farming to bottling and packaging.

Objectives
The programme trains students to:
1. possess detailed knowledge and understanding of science and technology, along with the practical skills to become leaders within the food and drink sector;
2. be employed in a wide range of roles, from plant managers and operators to
3. marketing and sales. Many work at the forefront of innovation, launching new
4. breweries and distilleries and in senior roles in established companies;
5. provide strong links with industry, which consequently expose them to industry leaders and representatives of the major brewing and distilling companies;
6. have wider opportunities such as industrial placements during their degree;
7. be equipped with skills and knowledge required for a successful career;
8. be creative and adaptable, applying the wide range of expertise that they have gained from the biological, chemical and engineering fundamentals to the more technical and research aspects developed in the laboratory, micromaltings, pilot brewery and distillery facilities; and

9. broaden their perspective vis-à-vis the problems of the brewing industry in a tropical country such as Nigeria and offers sufficient theoretical depth to enable talented graduates to undertake postgraduate research work in brewing technology and related disciplines.

Employability skills

All graduates in brewing science are expected to develop the following abilities and skills:

1. Regime of Subject Knowledge;
   Cognitive abilities and skills relating to solution of problems in brewing industry and other allied and related industries;
2. Competencies and Skills;
   Practical skills relating to the conduct of laboratory and industrial work in brewing industries
3. Behavioural Attitudes; and
   General skills relating to non-subject specific competencies, communication, interpersonal, organization skills.

21st Century skills

1. Critical thinking
2. Digital literacy/communication
3. Collaboration
4. Creativity
5. Problem-solving

Unique Features of the Programme

Unique features of the programme include:

1. graduates will understand brewing at the molecular level, and as a result understand why brewing quality beer requires rigorous attention to detail at every step;
2. students will learn biotechnology: an important area within brewing technology that concerns the use of starter cultures and enzymes to create the desired products with a minimal use of resources;
3. students completing the programme will be in high demand to fill assistant brewer, head brewer, brew master, product analysis/quality control, and R & D positions in both the craft brewing and industrial brewing sectors; and
4. students would also be well prepared to start up their own microbrewery, should that be their goal.

Admission and Graduation Requirements

Admission Requirements

4-year degree programme

The entry requirements shall be, at least, credit level passes in five subjects including English Language, Mathematics, to form the core subjects with credit in three other relevant science subjects, (Biology, Chemistry, and Physics) at the Senior Secondary Certificate (SSC) or its equivalent (NECO/ GCE O/L/ NABTEB). In addition, an acceptable pass in the Unified Tertiary Matriculation Examination (UTME) is required for admission into 100 level. Any candidate who has satisfied the requirements of the university pre-degree science programme is also eligible for admission.

Direct Entry
Candidates with two (2) 'A' level passes (graded A-E) at the GCE/IJMB Advanced Level in relevant subjects (Biology, Botany, Chemistry, Mathematics and Physics) may be admitted into 200level. Candidates with National Diploma (ND, Upper credit) or Higher National Diploma (HND) in Biology, Microbiology, Biochemistry, Food Technology, Science Technology or related subjects may be considered for admission. This is in addition to fulfilling the requirement of a minimum of credit level passes in five (5) relevant subjects (English Language, Mathematics, Biology, Chemistry and Physics) at SSCE or WASCE/GCE 'O' Level as indicated above.

Graduation Requirements
To qualify for the award of the degree of Bachelor of Brewing Science and Technology, a student: Must have spent minimum of 3,4 or 5 years on the programme depending on the year of entry; Must have completed a minimum of 120 units for 4 years or 150 units for 5 years.

Global Course Structure

100 Level (4 year and 5 year programme)

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
BIO 101	General Biology I	2	C	30	-
BIO 102	General Biology II	2	C	30	-
BIO 107	General Biology Practical I	1	C	-	45
BIO 108	General Biology Practical II	1	C	-	45
CHM 101	General Chemistry I	2	C	30	-
CHM 102	General Chemistry II	2	C	30	-
CHM 107	General Chemistry Practical I	1	C	-	45
CHM 108	General Chemistry Practical II	1	C	-	45
GET 101	Engineer in Society	1	C	15	-
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 107	General Physics Practical I	1	C	-	45
PHY 108	General Physics Practical II	1	C	-	45
	Total	**30**			

200 Level (4 year and 5 year programme)

Course Code	Course Title	Units	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
BIO 201	Introductory Genetics	2	C	30	-

Course Code	Course Title	Units	Status	LH	PH
BIO 202	Introductory Ecology	2	C	15	45
BCH 201	General Biochemistry I	2	C	30	-
BST 221	Introduction to Brewing Science	2	C	15	45
BST 223	Introductory Food Engineering	2	C	30	-
BTG 202	Introduction to Biotechnology	2	C	30	-
MCB 221	General Microbiology	2	C	15	45
	Total	**18**			

300 Level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
BST 311	Raw Materials in Brewing	3	C	30	45
BST 321	Brew-House Theory and Technology	3	C	45	-
BST 325	Microbiology of Beer	3	C	30	45
BST 399	BST 399 Industrial Attachment I (12 Weeks)	3	C	-	135
	Total	**16**			

400 Level (4-year programme only)

Course Code	Course Title	Units	Status	LH	PH
BST 411	Quality Control I	3	C	45	-
BST 415	Entrepreneurship Studies in Brewing Science	2	C	15	45
BST 418	Fermentation Technology	3	C	30	45
BST 419	Wine-Making Technology	3	C	30	45
BST 420	Research Project in Brewing Science & Technology	6	C	-	270
BST 421	Seminar	2	C	30	-
BST 422	Technical Report Writing and Presentation	1	C	15	-
	Total	**20**			

300 Level (5-year programme only)

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
BST 311	Raw Materials in Brewing	3	C	30	45
BST 313	Fundamentals in Food Processing	2	C	15	45
BST 314	Food Analysis	2	C	15	45
BST 321	Brew-House Theory and Technology	3	C	45	-

BST 322	Fermentation Technology	3	C	30	45
BST 325	Microbiology of Beer	3	C	30	45
MCB 305	Fungi of Medical, Food and Industrial Importance	2	C	15	45
	Total	**22**			

400 Level (5-year programme only)

Course Code	Course Title	Units	Status	LH	PH
BST 411	Quality Control I	3	C	45	-
BST 413	Process Engineering II	3	C	45	-
BST 415	Entrepreneurship Studies in Brewing Science	2	C	15	45
BST 425	Brewhouse Contamination, Hygiene & Safety measures	2	C	15	45
BST 499	Student Industrial Experience Scheme (SIWES) (24 Weeks)	6	C	-	270
	Total	**16**			

500 Level (5-year programme only)

Course Code	Course Title	Units	Status	LH	PH
BST 412	Beer Treatment & Packaging	3	C	45	-
BST 511	Quality Control II	3	C	30	45
BST 512	Brewery Calculations & Plant Design	2	C	30	-
BST 513	Wine-Making Technology	3	C	30	45
BST 520	Research Project in Brewing Science & Technology	6	C	-	270
BST 521	Seminar	2	C	-	90
	Total	**19**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to

1. identify possible sound patterns in English Language;
2. list notable language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents

Sound patterns in English language (phonetics and phonology, vowels and consonants). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations and many more). Sentence in English (types: structural and functional, simple and complex). Grammar and usage (tense, mood, modality, concord and aspects of language use in everyday life). Logical and critical thinking and reasoning methods (Logic and syllogism, inductive and deductive argument and reasoning methods, analogy, generalisation and explanations). Ethical considerations, copyright rules and infringements. Writing activities: (Pre-writing, writing, post writing/editing and proofreading; paragraphing, types of writing, summary, essays, letters, curriculum vitae, report writing, note making and mechanics of writing). Comprehension strategies (Reading and types of reading, comprehension skills, 3RsQ). Information and Communication Technology in modern language learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112- Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of Trade, Economic and Self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building
6. analyse the role of the Judiciary in upholding people's fundamental rights
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture, and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria, Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914, formation of political parties in Nigeria, nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics and Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system, indigenous apprenticeship system among Nigeria people, trade, skill acquisition and self-reliance). Social justices and national development (law: definition

and classification). Judiciary and fundamental rights. Individual norms and values (basic Nigeria norms and values, patterns of citizenship acquisition, citizenship and civic responsibilities, indigenous languages, usage and development, negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation). Re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption (WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry) (2 Units: C LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic definition of set, subset, union, intersection, complements and use of venn diagram;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify the various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, venn diagrams. Real numbers,; integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations and binomial theorem. Complex numbers, algebra of complex numbers, and the argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning and function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Functions of a real variable, graphs, limits and idea of continuity. The derivative, as limit of rate of change. Techniques of differentiation. Extreme curve sketching, integration as an inverse of differentiation. Methods of integration, definite integrals. Application to areas and volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

BIO 101: General Biology I (2 Units C: LH 30)

Learning Outcomes
At the end of lectures, students should be able to:
1. explain cell structure and organisations;
2. summarize functions of cellular organelles;
3. characterize living organisms and state their general reproduction;
4. describe the interrelationship that exists between organisms;
5. discuss the concept of heredity and evolution; and
6. enumerate habitat types and their characteristics.

Course Contents
Cell structure and organisation, functions of cellular organelles, characteristics and classification of living things. Chromosomes, genes their relationships and importance, general reproduction, interrelationships of organisms (competitions, parasitism, predation, symbiosis, commensalisms, mutualism, saprophytism).Heredity and evolution (introduction to Darwinism and Lamarkism, Mendelian laws, explanation of key genetic terms), elements of ecology and types of habitat.

BIO 102: General Biology II (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures, students should be able to:

1. List the characteristics, methods of identification and classification of Viruses, bacteria and fungi;
2. state the unique characteristics of plant and animal kingdoms;
3. describe ecological adaptations in the plant and animal kingdoms;
4. explain nutrition, respiration, excretion and reproduction in plants and animals; and
5. describe growth and development in plants and animals.

Course Contents
Basic characteristics, identification and classification of viruses, bacteria and fungi.
A generalized survey of the plant and animal kingdoms based mainly on the study of similarities and differences in the external features. Ecological adaptations. Briefs on physiology to include nutrition, respiration, circulatory systems, excretion, reproduction, growth and development.

BIO 107: General Biology Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. outline common laboratory hazards;
2. provide precautions on laboratory hazards;
3. state the functions of the different parts of microscope;
4. use the microscope and describe its maintenance;
5. draw biological diagrams and illustrations; and
6. apply scaling and proportion to biological diagrams.

Course Contents
Common laboratory hazards, prevention and first aid, measurements in biology, uses and care of microscope, compound and dissecting microscope. Biological drawings and illustrations, scaling, accuracy and proportion; use of common laboratory apparatus and laboratory experiments designed to illustrate the topics covered in **BIO 101.**

BIO 108: General Biology Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the anatomy of flowering plants;
2. differentiate types of fruit and seeds;
3. state ways of handling and caring for biological wares;
4. describe the basic histology of animal tissues; and
5. identify various groups in the animal kingdom.

Course Contents
Anatomy of flowering plants, primary vegetative body: stem, leaf and root to show the mature tissues namely parenchyma, collenchyma, sclerenchyma, xylem and phloem. Types of fruits and seeds. Care and use of dissecting kits and other biological wares. Dissection and general histology

of animal tissues based on vertebrate forms. Morphology and functions of epithelial, muscular, nervous and connective tissues. Examination of various groups of lower invertebrates under microscopes, identification of various groups of organisms in animal kingdom. And any experiment designed to emphasize the practical aspects of topics in BIO 102.

CHM 101: General Chemistry I (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

1. define atom, molecules and chemical reactions;
2. discuss the Modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. illustrate shapes of simple molecules and hybridized orbitals;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents

Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence Forces andstructure of solids. Chemical equations and stoichiometry,chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry,; rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reaction;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. describe basic properties of Transition metals.

Course Contents
Historical survey of the development and importance of organic chemistry,fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures and nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify the differences between primary and secondary standards;
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents
Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify and carry out preliminary tests which includes ignition, boiling point,
5. melting point, test on known and unknown organic compounds;
6. execute solubility tests on known and unknown organic compounds; and
7. execute elemental tests on known and unknown compounds.

Course Contents
Conduct functional group/confirmatory test on known and unknown compounds, which could be acidic/basic/neutral organic compounds.

GET 101: Engineer in Society (1 Unit C: LH 15)

Learning Outcomes

After studying the course, the students are expected to be able to:

1. differentiate between Science, Engineering and Technology, and relate them to
2. innovation;
3. explain the different cadres of Engineering – Engineers, Technologists, Technicians and Craftsmen and their respective roles and competencies;
4. describe and differentiate between the relevant professional bodies in engineering;
5. identify goals of global development or SDGs;
6. recognise and evaluate safety and risk; and
7. invite guest lecturers from different engineering bodies.

Course Contents

History, evolution and philosophy of science, engineering and technology. The Engineering profession – engineering family (engineers, technologists, technicians and craftsmen). Professional bodies and societies. engineers' code of conduct and ethics, and engineering literacy. Sustainable development - goals (SDGs), innovation, infrastructures and nation building - economy, politics, business. Safety and risk analysis in engineering practice. Engineering competency skills – curriculum overview, technical, soft and digital skills. Guest seminars and invited lectures from professional associations.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes

On completion, the student should be able to:

1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents

space and time. units and dimension. vectors and scalars. differentiation of vectors: displacement, velocity and acceleration. Kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). relative motion. Application of Newtonian mechanics. equations of motion. conservation principles in physics, conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass. Rotational motion. torque, vector product, moment, rotation of coordinate axes and angular momentum, polar coordinates. conservation of angular momentum; Circular motion. Moments of inertia, gyroscopes and precession. gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General Physics II (Electricity &Magnetism) (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe the electric field and potential, and related concepts, for stationary charges.
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law and electric potential.
3. describe and determine the magnetic field for steady and moving charges.
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law.
5. describe electromagnetic induction and related concepts, and make calculations using Faraday and Lenz's laws.
6. explain the basic physical of Maxwell's equations in integral form.
7. evaluate DC circuits to determine the electrical parameters.
8. determine the characteristics of ac voltages and currents in resistors, capacitors and inductors.

Course Contents
Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and resistance. Ohm's law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

PHY 107: General Practical Physics I (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasizes quantitative measurements. Experimental techniques. The treatment of measurement errors. Graphical analysis. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity and many more (covered in PHY 101, 102, 103 and PHY 104). However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis, and deduction.

PHY 108: General Practical Physics II (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data;
6. prepare and present practical reports.

Course Contents
This practical course is a continuation of PHY 107 and is intended to be taught during the second semester of the 100 level to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements, the treatment of measurement errors, and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding and many more

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking
2. state the characteristics of an entrepreneur;

3. analyse the importance of micro and small businesses in wealth creation, employment and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents
Concept of entrepreneurship (entrepreneurship, intrapreneurship/corporate entrepreneurship). Theories, rationale and relevance of entrepreneurship (Schumpeterian and other perspectives, risk-taking, necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of entrepreneurs (opportunity seeker, rRisk taker, natural and nurtured, problem solver and change agent, innovator and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking and creative thinking). Innovation (concept of innovation, dimensions of innovation, change and innovation, nowledge and innovation). Enterprise formation, partnership and networking (basics of business plan, forms of business ownership, business registration and forming alliances and join ventures). Contemporary entrepreneurship issues (knowledge, skills and technology, intellectual property, virtual office, networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, youth and women entrepreneurship, entrepreneurship support institutions, youth enterprise networks and environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

BST 221: Introduction to Brewing Science (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the processes by which the raw ingredients are transformed during the brewing process;
2. describe the processes that are used in beer formulation and creation;
3. demonstrate in-depth knowledge in the production of spirits by pot distillation and continuous distillation; and
4. evaluate the range of technologies available to produce distilled spirits.

Course Contents
Historical background of brewing process. Definition and scope of Brewing Science, interrelationship with other sciences. Traditional brewing processes. Importance of beer. Beer and health. Beer production, its supply and world economy, quality and safety. Principles and application of brewing science. Physiology and biochemistry of cereals (barley, sorghum, maize, rice, millet) including the local ones used in brewing. Definition of malting. Malting barley – selection, handling, storage stability and treatment. Taxonomy, cultivation, harvesting, evaluation and purchase of cereals. The metabolism of ethanol and its effects. Modern brewing processes for beer, wines and potable spirits. Other uses of barley malt.

BST 223: Introductory Food Engineering (2 Units C: LH 30)

Learning Outcomes
At the completion of this course, students should have the ability to:
1. describe the concept, framework of the food system and identify its main stakeholders (the public sector, food industry, and civil society), current issues and regulatory framework;
2. explain the role of innovation in the food system;
3. define the duties and responsibilities of a food engineer; awareness of professional and academic ethics;
4. discuss the role of food engineering education in the current national and global context;
5. utilize principles of units and dimensions to solve basic engineering calculations;
6. recognise the significance of information technologies in food engineering; and
7. identify sources of information and utilize resources to access information effectively and assess the impacts of food engineering applications on health, environment and safety.

Course Contents
Units and dimensions, mass and energy balance. Fluid flow, fluids in motion and flow patterns. Energy and momentum relationship. Flow of incompressible fluids in pipes and channels. Flow measurement. Heat transfer. Mass transfer. Liquid-solid separation (filtration, sedimentation). Evaporation. All topics using a unit operations approach, descriptive and problem-solving methods to provide students with insight into the application of engineering concepts to the design of processes and equipment for food industry.

BIO 201: Genetics I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. distinguish between heritable and non-heritable characteristics;
2. explain the likelihood of genetic events (Probability) and how well those events (results) fit into a set of observation;
3. discuss polygenic variations; and
4. describe concepts in population genetics.

Course Contents
Hereditable and non-hereditable characteristics. Probability and tests of goodness of fit. Quantitative inheritance; variation in genome structure, introduction to population genetics.

BIO 202: Introductory Ecology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the lectures in this course, students should be able to:
1. explain various concepts and terminologies associated with the ecosystem;
2. list and explain features of various habitat types;
3. explain natural destruction/disaster, community and natural cycles; and
4. explain and describe factors responsible for changes in population.

Course Contents
Concept and definition of ecosystem. ecology at community level. ecological classification of habitat types. terrestrial and aquatic biomass. specific features of each, biotic components of habitat. Natural destruction. factors of communities, success of community interaction. natural cycle and dynamics of population.

BCH 201: General Biochemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures, students should be able to:
1. explain the structure of different macromolecules in biological system;
2. identify types of chemical reactions involving these macromolecules;
3. explain the various methods of isolation of these macromolecules;
4. estimate the effects of acids and alkalis on the macromolecules;
5. describe purification of macromolecules; and
6. discuss quantification of the various macromolecules.

Course Contents
Introductory chemistry of amino acids, their properties, reactions and biological functions. Classification of amino acids: neutral, basic and acidic; polar and non-polar; essential and non-essential amino acids. Peptides. Introductory chemistry and classification of proteins. Biological functions of proteins. Methods of their isolation, purification and identification. Primary, secondary, tertiary and quaternary structures of proteins. Basic principles of tests for proteins and amino acids. Introductory chemistry of carbohydrates, lipids and nucleic acids. Nomenclature of nucleosides, and nucleotides; effects of acid and alkali on hydrolysis of nucleic acids.

BTG 202: **Introduction to Biotechnology (2 Units C: LH 30)**

Learning Outcomes
Upon the successful completion of this course, students would be able to:
1. explain the historical development of biotechnology and its relevance in the modern world;
2. describe the applications of biotechnology in agriculture, medicine, pharmaceuticals and the environment.
3. explain the role of biotechnology in industrial processes; and
4. demonstrate skills and knowledge of the steps in DNA fingerprinting.

Course Contents
Historical developments. Principles and applications of biotechnology. Implications of molecular biology in the modern world, including ethical and social controversies. Introductory aspects of microbial biotechnology, medical biotechnology, environmental biotechnology, pharmaceutical biotechnology, agricultural biotechnology and industrial biotechnology. Biotechnological production of industrial materials: biofuels and antibiotics. DNA cloning, DNA fingerprinting and the use of DNA in forensics.

MCB 221: General Microbiology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students will be able to;

1. explain the basic concepts and scope of microbiology;
2. describe the layout of a microbiology laboratory, equipment and reagents in a microbiology laboratory; and
3. discuss the theory behind basic protocols in a microbiology laboratory.

Course Contents
History of the science of microbiology. Classification of organisms into prokaryotes and eukaryotes. Classification of prokaryotes into archaea and eubacteria anatomy and cytochemistry of bacteria and fungi. Shapes, groupings and colonial morphology of bacteria and fungi. Structure of viruses. Sterilization and disinfection; structure, ecology and reproduction of representative microbial genera. Culture of micro-organisms. Isolation of micro-organisms, isolation of bacteria, viruses fungi (yeasts and moulds, nutrition and biochemical activities of micro-organisms. Antigens and antibodies. Identification and economic importance of selected microbial groups. Microbial variation and heredity. Study of laboratory equipment. Introduction to microbiology of air food, milk, dairy products, water and soil. Staining techniques, antibiotic sensitivity tests, serological tests, antimicrobial agents.

300 Level

GST 312: Peace and Conflict Resolution (2 Unit C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents
Concepts of peace, conflict and security in a multi-ethnic nation. Types and theories of conflicts: ethnic, religious, economic and geo-political conflicts. Structural conflict theory, realist theory of conflict and frustration-aggression conflict theory. Root causes of conflict and violence in Africa: indigene and settlers' phenomenon, boundaries/boarder disputes, political disputes, ethnic disputes and rivalries, economic inequalities, social disputes, nationalist movements and agitations, selected conflict case studies – Tiv-Junkun, Zango- Kartaf, chieftaincy and land disputes and many more. peace building, management of conflicts and security, peace &human development. Approaches to peace &conflict management: (religious, government, community leaders etc.). Elements of peace studies and conflict resolution, conflict dynamics assessment scales: constructive &
destructive. Justice and legal framework and concepts of social justice. The Nigeria legal system. Insurgency and terrorism. Peace Mediation and Peace Keeping. Peace and security council (international, national and local levels). Agents of conflict resolution: conventions, treaties, community policing, evolution and imperatives. Alternative dispute resolution (ADR):a). dialogue b). arbitration c). negotiation d). collaboration and many more. Roles of international organizations in conflict resolution: (a). The United Nations (UN) and its conflict resolution organs.

(b). The African Union & Peace Security Council (c). ECOWAS in peace keeping. Media and traditional institutions in peace building. Managing post-conflict situations/Crises: refugees. internally displaced persons (IDPs). The role of NGOs in post-conflict situations/Crises.

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students, through case study and practical approaches, should be able to:

1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical
3. location;
4. state how original products, ideas and concepts are developed;
5. develop business concept for further incubation or pitching for funding;
6. identify key sources of entrepreneurial finance;
7. implement the requirements for establishing and managing micro and small enterprises;
8. conduct entrepreneurial marketing and e-commerce;
9. apply a wide variety of emerging technological solutions to entrepreneurship; and
10. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity identification (sources of business opportunities in Nigeria, environmental scanning, demand and supply gap/unmet needs/market gaps/market research, unutilised resources, social and climate conditions and technology adoption gap). New business development (business planning and market research). Entrepreneurial finance (venture capital, equity finance, micro finance, personal savings, small business investment organisations and business plan competition). Entrepreneurial marketing and e-commerce (principles of marketing, customer acquisition &retention, B2B, C2C and B2C models of e-commerce, first mover advantage, e-commerce business models and successful e-commerce companies,). Small business management/family business, leadership &management, basic book keeping, nature of family business and family business growth model. Negotiation and business communication (strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions and idea pitching). Technological solutions (the concept of market/customer solution, customer solution and emerging technologies, business applications of new technologies - *Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy and many more. Digital Business and E-Commerce Strategies).*

BST 311: Raw Materials in Brewing (3 Units C: LH 30; PH 45)

Learning Outcomes

By the completion of this course, students are able to:

1. discuss the role of the major raw ingredients in beer composition and its sensory properties;
2. have a detailed theoretical understanding of the role of the raw ingredients of beer production (water, fermentable materials, flavouring materials, yeasts and bacteria); and
3. learn from the compulsory visits to industrial sites including maltings and large and small-scale breweries.

Course Contents
Barley: morphology of barley plant. The biochemistry of the grain. Nature of barley varieties. Classification of barley. The position of barley within the Graminae. Malting: Objectives of malting. Processes of malting – sleeping, germination, kilning. Enzymatic reactions and biochemical changes occurring during malting. The technology of malt production. Types of malt. Brewing water, composition, influence of solutes in water on brewing, treatment of brewing water. Adjuncts, selection, storage and handling especially of corn, rice, sorghum, sugars and syrups. Hops harvesting, storage, chemistry, products – extracts and pellets.

BST 313: Fundamentals in Food Processing (2 Units C: LH 15; PH 45)

Learning Outcomes
At the completion of this course, students are able to:
1. have an in depth knowledge of the basic methods of food processing and preservation; and
2. develop as a team to solve practical malting, brewing, distilling and analytical problems or problems associated with food and beverage processing.

Course Contents
Basic methods of food processing and preservation, Processing – materials handling, sorting, cleaning, grading, size reduction, dehydration, freezing, separation, mixing, concentration and fermentation. Preservation – chemical, dehydration, drying, salt, curing/pickling, blanching, smoking, freezing and irradiation.

BST 314: Food Analysis (2 Units C: LH 15; PH 45)

Learning Outcomes
At the completion of this course, students should be able to:
1. describe and use principal analytical methods used for quantifying the composition and reactions of food components;
2. interpret and report data derived from chemical experiments/analysis in a meaningful way;
3. apply basic statistical methods to sampling/testing and the analysis of experimental data;
4. learn basic methods of instrumental and sensory evaluation, including when certain methods might be used, the type of data derived, and how that data might be used in decision-making; and
5. choose appropriate analytical techniques for foods and when/how to use them in a food processing environment/situation such as QA&/QC.

Course Contents
Principles and application of analytical methods such as photometry, colorimetry, gravimetry and refractometry. Physical and chemical analysis of water and other major food components – carbohydrates, fats, proteins, minerals; analyses for food colours, additives, trace metals and contaminants.

BST 321: Brew-House Theory and Technology (3 Units C: LH 45)

Learning Outcomes
At the end of this course, students will be able to
1. perform practical exercises in brewing at small and intermediate scales;
2. explain all aspects of beer production and be able to design, brew and evaluate beers.
3. plan and implement the production of beer according to a selected style.

Course Contents
Purpose of brew-house operation, storage, handling and preparation of materials. Schematic layout of brew-house equipment. Milling system: different types and operations. Principles of size reduction. Crushing – capacity and measurement.
Mashing: objectives of mashing. Biochemistry of the process. Types of equipment, mashing system and time – temperature schedules. Wort separation, Wort boiling and hoping. Wort cooling. High gravity brewing. Brew-house economy.

BST 322/418: Fermentation Technology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. provide an in-depth knowledge of areas of current topical interest and research in the fermentation of wort, maturation and storage of beer;
2. explain in detail the technical and biochemical principles of wort fermentation, and beer maturation and storage;
3. assess and interpret data from current research on yeast metabolism and factors affecting beer stability and storage;
4. access and evaluate complex scientific and technical information;
5. develop and present clear arguments based on scientific evidence; and
6. evaluate the range yeasts and technology available to produce stable and flavoursome beer commercially.

Course Contents
Objectives in fermentation. Yeast: nature of yeast, histology of the yeast cell. Yeast cultures, pitching yeast. Yeast infections. Biochemistry of fermentation: changes from wort to beer, glycolysis, fermentation by-products. Yeast physiology and growth in batch culture and continuous culture. Brewery fermentation, main fermentation rooms and vessels. Control and regulation of fermentation. Secondary fermentation. maturation/conditioning. Problem fermentation – beer types.

BST 325: Microbiology of Beer (3 Units C: LH 30; PH 45)

Learning Outcomes
On the successful completion of this course, students will be able to:
1. determine the occurrence, frequency, biology and be able to detect micro-organisms that are associated with the spoilage of the brewing process from raw materials to final product;
2. assess the impact of contamination on process and final product quality; and

3. explain the principles and practice of hazard analysis and critical control coints (*HACCP*), cleaning-in-place (CIP) and good manufacturing practice (GMP).

Course Contents
Brewing yeasts: chemical composition, especially of cell wall and relationship to flocculation, fining and head formation mechanism of flocculation and laboratory measurement. Mechanism of fining, yeast genetics and handling techniques, improvement of brewing strains, hybridization, ethanol contaminants of pitching yeast methods. Assessment of various selective media. Determination of yeast viability. Microbiological analysis of beer.

BST 399/499: Student Industrial Work Experience Scheme (SIWES)
(3/6 Units C: (12/24 Weeks))

Learning Outcomes
At the end of the experience, students should be able to:
1. provide hands-on experience of operating malting, brewery and distillery equipment;
2. provide the opportunity to perform laboratory tests on samples from the pilot work;
3. provide the opportunity to develop sensory methods and a detailed understanding of the quality control techniques used in industry;
4. develop a critical understanding and hands-on experience of current industry practices;
5. provide understanding and develop the skills required to be an effective employee;
6. provide problem-solving technique in a systematic way;
7. demonstrate a core understanding of practices in the food and/or beverage industry and how they relate to the overall business;
8. develop and deliver standard operating procedures for industry practices;
9. develop organisational, interpretative, investigative and reporting skills;
10. enable students to work as a team to solve practical malting, brewing, distilling and analytical problems or problems associated with food and beverage processing;
11. teach students to prepare succinct reports – written and verbal;and
12. enable students to learn the art of presenting seminar on industrial training experience.

Course Contents
Students should be attached to relevant industrial establishments for 24 weeks, during the second semester of the fourth year to gain hands-on experience on brewing science and technology. Performance of students should be assessed based on written reports, seminar presentation and supervisors' reports. SIWES Report Writing, Industrial-Based SIWES Assessment, SIWES Site Visit Assessment, Assessment of Completed SIWES Logbook and SIWES Defence/Examination.

MCB 305: Fungi of Medical, Food and Industrial Importance
(2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students will be able to:
1. explain structure, physiology and classification of fungi;
2. elucidate pathogenicity, immunity, epidemiology, treatment and incidence of fungi of medical importance; and
3. illustrate physiology and metabolites of fungi used in food and industrial microbiology.

Course Contents
Structure, life cycles, physiology and classification of fungi. Fungi of medical, food and industrial importance, fungal pathogenicity, immunity epidemiology, incidence treatment-superficial mycoses (ringworm, superficial candidosis, pityriasis), subcutaneous mycoses(mycetoma, histoplasmosis, phaeohyphomycosis) systemic mycoses coccidomycoses, blastomycose, paracocidio-domycosis, aspergillosis, cryptococcosis) Fungi of food and industrial importance (aspergillus niger, Saccharomyces cerevisiae importance). Metabolites of fungi, industrial uses of fungi. Fungi in medicine.

400 Level

BST 411: Quality Control I (3 Units C: LH 45)

Learning Outcomes
By the completion of this course, students should be able to:
1. participate in sensory classes; and
2. identify the tastes, flavours and aromas associated with the key international beer styles in modern production.

Course Contents
Sampling Test: physical, chemical, biochemical and microbiological evaluation of brew-house raw materials. Germination tests for barley. Methods of prediction of the quality of barley for malting. Wort composition and quality control. Physical and chemical analyses of beer. Shelf-life evaluation. Significance and control of oxygen in cellar operations. Quality control of containers, crowns and labels. Organoleptic methods of beer analysis. Taste testing panel. Gushing in beer..

BST 412: Beer Treatment and Packaging (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain, in details, the principles of packaging;
2. assess and interpret data from current developments in packaging; and
3. evaluate the range of technologies available to package alcoholic beverages.

Course Contents
Beer stabilization methods, clarification and filtration techniques. Exclusion of air. Chilling and carbonating. Container filling and sealing equipment and their operating principles. Pasteurization and other methods of beer sterilization. Maintenance of equipment and corrective measures for variances in packaged product quality.

BST 413: Process Engineering II (3 Units C: LH 45)

Learning Outcomes
On the successful completion of this course, students will be able to:

1. perform calculations with different systems of units and apply concepts of dimensional consistency;
2. explain the various basic concepts used in chemical engineering and process calculations;
3. formulate and solve problems involving mass and energy balances;
4. demonstrate how to use computers for solving process design problems;
5. outline the various stages involved in undertaking engineering projects in the chemical process industry;
6. use key concepts of process simulation to solve an open-ended mass & energy balance for a relatively complex process flowsheet;
7. work efficiently and productively in small teams; and
8. compose a properly formatted design report.

Course Contents

Fluid Flow pumps and Pumping. System heads. Centrifugal pumps. Positive displacement pumps. Factors influencing pump selection, pump installation and maintenance. Pump seals and packing. Valves. Mixing of liquids in tanks. Mixers and mixing. Small blade-high speed agitators. Large blade-low speed agitators. Dimensionless groups for mixing. Power curves. Scale-up of liquid mixing systems. The purging of stirred tanks. Fluid motion in the presence of solid particles. Relative motion between a fluid and a single particle. Relative motion between a fluid and a concentration of particles. Fluidization. Slurry transport. Material handling and size reduction. Material of construction.

Steam Generation**:** Types of boilers. Operation of boiler plant and its component parts. Feed water analysis and treatment. Types and calorific values of boiler fuel. Simple problem on air-fuel ratio. Smoke test of boilers. Burners – types of burners and their characteristics. Maintenance of boiler plant.

Refrigeration**:** Composition of refrigeration plant – compressors, condenser, expansion valve, evaporator. Types of condensers: air-cooled and water-cooled. Cooling tower and how they function. Types of evaporators and their evaporating systems. Ammonia controls – automatic values, and many more. Types of defrosting methods. Maintenance of the fridge plant.

Compressors**:** Types of compressors and their characteristics. Double stage compressors. Compressor driers. Intercoolers, after coolers. Maintenance of compressors. Working of pressure release values.

BST 415 Entrepreneurship Studies in Brewing Science (3 Units C: LH 45)

Learning Outcomes

At the completion of this course, students will be able to:

1. provide background understanding, the nature and value of entrepreneurship in economies, and to encourage thinking about ideas development and refinement, considerations of the commercial world, creativity and innovation;
2. transfer knowledge to practice by simulating business venturing process or actually creating a business;
3. develop core skills applicable to entrepreneurship such as team working, communication, initiative, creativity, analysis, problem identification and solving;
4. develop business skills applicable to entrepreneurship such as researching markets, understanding the commercial environment, product/service development, financial planning and presenting;

5. equip themselves for potential future ventures or current ones by providing hands-on experience of entrepreneurship;
6. exhibit skills in establishing private entrepreneurial ventures;
7. demonstrate knowledge in business practices and demands in brewing and distilling; and
8. exhibit skills to assess and address both the technical and entrepreneurial challenges as they arise in the industry.

Course Contents

Entrepreneurship and Creativity in brewing- Nature and value of entrepreneurship in economies, ideas development and refinement, considerations of the commercial world, creativity and innovation. **Entrepreneurial Venturing**- Simulating business venturing process or actually creating a business; team working, communication, initiative, creativity, analysis, problem identification and solving; Business skills applicable to entrepreneurship such as researching markets, understanding the commercial environment, product/service development, financial planning and presenting. Potential future ventures or current ones by providing hands-on experience of entrepreneurship.

BST 419/513: Wine – Making Technology (3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of the course, students should be able to:
1. apply various methods used in the production of wine;
2. describe history, viticulture, chemistry, and technology of wine making;
3. produce grape wines according to vinification protocols; and
4. apply grape handling and vinification practices.

Course Contents

History of wine making. Raw materials: grapes, fruits, honey and sugar. Alcoholic fermentation, natural (spontaneous) fermentation and yeast culture fermentation, biochemistry of process. Role of oxygen. Cooling systems. Flavour compounds of wine; aromas associated with grape varieties. Post fermentation operations; ageing and mellowing. Microbial stabilization, malo-lactic fermentation, microbial spoilage, hot-bottling, addition of sorbic acid, sterile filtration and sterile bottling. Sulphur dioxide addition, dangers and safeguards. Wine types, table wines, fruit wines, honey wines, fortified wines and flavoured fortified wines. Indigenous wine-making technologies e.g. palm-wine, cocoa-wine, *burukutu*.

BST 420/520: Research Project in Brewing Science & Technology
(6 Units C: PH 270)

Learning Outcomes

At the end of the course, students should be able to:
1. apply their knowledge and skills gained throughout the programme
2. carry out a detailed laboratory research investigation under supervision of staff;
3. write it up as a project report; and
4. exhibit knowledge of the work before a panel of external and/or internal examiners in an oral examination.

Course Contents
Research findings into selected topics in Brewing Science. Students are expected to carry out literature survey on chosen topics, perform experiments and produce reports. Students are to be subjected to both seminar and oral examinations on their projects.

BST 421/521: Seminar (2 Units C: LH 30)

Learning Outcomes
By the completion of this seminar, students should be able to:
1. develop independent skills in information retrieval, handling and presentation in the area of malting, brewing, distilling or related fields;
2. describe and critically review how research has been designed and methods currently used in research;
3. solve problems in a systematic way;
4. put together a review on a specific field of malting, brewing or distilling in a scientifically acceptable way;
5. assess and screen scientific literature applicable to their field of study;
6. critically review published research and presentation of the key elements to an informed audience;
7. write in a succinct and scientific style;
8. critically appraise cutting edge research in the fields of malting, brewing, distilling and related subject field areas;
9. undertake self-directed study and personal project management in order to meet the desired objectives;
10. respond to feedback in a professional manner;
11. write in a succinct and scientific style using appropriate reference management software and word processing skills;
12. perform a literature search using electronic library resources;
13. communicate scientific ideas; and
14. work in a group to prepare and critique written and oral presentations.

Seminar Contents
Each student is expected to present a report and make oral presentation on an assigned or chosen current topic in brewing science. Review of literature on the assigned topic should be included.

BST 422: Technical Report Writing and Presentation (1 Unit C: LH 15)

Learning Outcomes
At the end of the course, students should be able to:
1. clearly convey specialized information from a technical field to a non-specialized audience;
2. identify and use appropriate formats and conventions derived from individual disciplines;
3. assess effectiveness and validity of information sources, such as web sites, business documents, and professional journals;
4. develop strategies for information design, to include producing visually enhanced documents;
5. summarize larger texts in clear, direct style for practical applications; and
6. design and produce a research project appropriate to the student's major and/or career interests. Edit documents according to professional guidelines.

Course Contents
Principles of effective communication. Professional use of English language, principles of technical writing. Oral presentation of technical ideas.

BST 425: Brewhouse Contamination, Hygiene & Safety Measures
(2 Units C: LH 15; PH 45)

Learning Outcomes
Upon successful completion of this course, the students should be able to:
1. discuss how contamination can occur in brewery;
2. display sound practices to prevent the possibility of food poisoning;
3. identify measures/procedures that will reduce or eliminate accidents in preparation and service areas;
4. prevent or avoid contamination rather than responding to it;
5. optimize the cleaning *procedures* of the bright tanks by developing a benchmarking and microbiological checks so that *contamination* of beer can be avoided; and
6. ensure product quality and minimise contamination risks, learn the rapid and reliable methods must be used for hygiene control.

Course Contents
Specific hazards: explosive atmosphere, activated carbon, toxic atmosphere, carbon dioxide and ammonia zone. Mechanical hazards: lockout procedures, tank or vessels entry procedures. Slip and fall, protective clothing and equipment, eye protection. Microbial contaminants including bacteria, yeasts and moulds. Their sources and incidence during the brewing process. Their influences on the brewery raw materials, wort fermentation, conditioning and dispensing and non-microbial contamination.

500 Level

BST 511: Quality Control II (3 Units C: LH 30; PH 45)

Learning Outcomes
By the completion of this course, students should be able to:
1. have an in-depth knowledge on microbial contamination in breweries for good quality brews;
2. gain practical knowledge of detection and enumeration of microorganisms;
3. identify the major faults in beers, and describe the practices for minimisation of microbial and oxidative spoilage; and
4. control sanitation and infestation in the brewery.

Course Contents
Microbial contamination in breweries, including bacteria, yeasts, molds. Their sources and incidence during the brewing process, and their influence on brewery raw materials, wort fermentation, conditioning and dispensing. Non-microbial contamination. Yeast flocculation, yeast speciation and determination of yeast cell concentration. Detection of wild yeasts and respiratory deficient mutants. Gram stain and KOH techniques. Detection and identification of bacteria. Control of sanitation and infestation in the brewery. Statistical quality control with

emphasis on useful simple statistics for both laboratory and production personnel. Purification of water. Effluent treatment.

BST 512: Brewing Calculations and Plant Design (2 Units C: LH 30)

Learning Outcomes
By the completion of this course, students should be able to;
1. use a range of industry standard process design simulation tools;
2. appreciate the differences between ideal design and practicalities;
3. visualise the practical aspects of design;
4. make a decision based on the knowledge gained;
5. know the Consumer Price Index (CPI) market awareness; and
6. participate in group activities for technical, economic and ethical problem solving.

Course Contents
Brew-house calculations – grist weight, wort volume, extract yield, hoping rate, time and energy utilization. Brewery plant lay-out. Construction and economics of process design and optimization techniques. Optimum design of modern brewing plants.

Minimum Academic Standards

Equipment
1. Malt Mill
2. Mash Tun
3. Filters (Plate or Candle)
4. Heat Exchanger
5. Hydrometer
6. Refractometer
7. Industrial Thermometer
8. Whirlpool Tan.
9. Brite/Storage Tanks
10. One-barrel (31 gallon) system
11. Three-barrel (93 gallon) system
12. Oxygen Tanks
13. Boilers
14. Pasteurization Tanks
15. Water Distillers
16. Laminar flow hoods
17. Ductless Fume hoods
18. Three 40-gallon Fermenters.
19. Stirrer
20. Temperature Adjustable Cold Rooms,
21. Plate and Frame hiller
22. Two Temperature Adjustable Cold Rooms,
23. Pumps and Components
24. Hach UV Vis Spectrophotometer DR6000
25. Pilot Plant Brewery and Distillery
26. Homogenizer

27. Autoclave
28. Bottle Washer
29. Liquid/Bottle Filling Machine
30. Corking Machine
31. Mini Water Plant
32. Carbonation Machines
33. Seed Germinator
34. Vinegar Generator

Staffing

Academic Staff

The guidelines on academic staff/student ratio of 1:20 for Science Programmes shall apply.
To start any programme in Brewing science and technology, there should be a minimum of six academic staff with at least three Senior Lecturers and above. There is need to have a reasonable number of staff with PhD degrees accounting for at least 70% of the total number and having adequate teaching experience for every programme in the Discipline.

Administrative Support Staff

The services of the administrative support staff are indispensable in the proper administration of departments and faculty offices. It is important to recruit very competent, computer literate senior staff.

Technical Support Personnel

The services of technical support staff, which are indispensable in the proper running of laboratories and workshops, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

Library

There should be a Departmental Library that can contain a minimum of 50 students and equipped with relevant books, journal articles and other relevant news articles particularly on Brewing Science & Technology.

Classrooms, Laboratories, Workshops and Office Space

The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

B. Sc. Chemistry

Overview

B.Sc. chemistry is an all-encompassing study on the nature of chemistry and all it's forms, this includes areas of core analytical, forensic, inorganic and physical chemistry, with courses on material chemistry, spectroscopic methods, computational chemistry and a broad spectrum of organic related chemistry. The chemistry programme is designed to enable graduates acquire broad based knowledge on chemical processes in living and non-living organism which spread through the areas of organic, inorganic, physical and material elements. The first year of the programme is designed to prepare the students to acquire sound background knowledge of relevant science subjects, which would be a foundation to prepare them for specialised knowledge in chemistry. During the second and third year, the programme will expose the students to fundamental constituents in chemistry that constitute the broad and dynamic spectrum of chemical composition and build up. This will prepare them to appreciate the consequences of various deviations from normal chemistry to more robust areas of chemistry during the final year. Chemistry spreads into various multidisciplinary areas forming the basis for the development of areas such as petroleum chemistry, pharmaceutical chemistry, Industrial chemistry, geochemistry, environmental Chemistry etc. The programme provides students with the opportunity to learn the skills necessary to gain access into different areas of chemistry. The course also takes into cognisance natural science which includes courses in Physics, mathematics and computer science.

The course is designed to give students a broad knowledge of both the science and the application of chemistry, to develop problem solving skills and to prepare students for professional life.

Philosophy

The philosophy of Chemistry programme is to foster undergraduate appreciation of the centrality of chemical science to human well-being, as well as its inevitable linkage to, and interactions with, other branches of science.

Objectives

Chemistry programme is specifically designed to:

1. stimulate in the students sustained interest and enthusiasm in chemistry and its applications;
2. build in students a culture of continuing enquiry;
3. provide students with a broad and balanced base of chemical knowledge and practical skills;
4. develop in students a range of skills applied in chemical and non-chemical areas, that can provide confidence for employment;
5. provide students with a solid base of chemical knowledge and skills that are required for postgraduate studies and research, and
6. inculcate in students an appreciation of chemistry in all human endeavours;
7. access and utilize chemical information technology;
8. work as part of a problem- solving team;
9. apply fundamental principles of Chemistry to life sciences, environments, materials, emerging technological fields of chemistry as well as everyday situations; and
10. apply ethical responsibilities to professional conduct.

Employability Skills

The B.Sc. Chemistry programme develop students with excellent laboratory techniques. Its multidisciplinary in nature provide the student skills that are useful in the areas of biology and medicine, physics and engineering, and geology and earth science. Chemistry is also studied in an environmental and social context, student also can gain awareness of its ethical implications and issues relating to environmental impact and sustainability. As well as developing strong mathematical/numerical ability, a chemistry degree empowers the student with transferable skills such as:

1. Analysis and problem solving
2. Time management and organisation
3. Written and oral communication
4. Monitoring/maintaining records and data
5. Teamwork
6. Research and presentation
7. IT and technology.

Unique Features

The unique features of the programme include:

1. Forensic analysis of biological samples, pharmaceutical samples, organic analytes, and macromolecular samples.
2. Theory of Hydraulics, as applied to fuels in pump-pipeline systems.
3. Fundamentals of electricity with emphases on electrical safety in petroleum
4. Lubrication and wear, with importance attached to the physical and chemical properties of lubricants.

21st Century Skills

1. Collaboration
2. Communication
3. Creativity and Innovation
4. Critical Thinking
5. Technology Literacy
6. Information Literacy
7. Teamwork
8. Flexibility

Admission and Graduation Requirements

Admission Requirements

4-year degree programme

The entry requirements shall be at least credit level passes in five subjects including English Language, Mathematics, Chemistry, Physics and any other relevant science subject at the Senior Secondary School Certificate or its equivalent. In addition, an acceptable pass in the UTME examination with the appropriate combination of subjects is required.

Direct entry mode
Candidates with five SSCE (or equivalent) credit passes with at least two passes in relevant subjects at the GCE Advanced Level or IJMB or JUPEB may be considered for admission into 200 Level.

Graduation Requirements
For a student to be deemed fit to graduate, he/she must have passed a minimum of 120 Units for UTME entrants and 90 Units for Direct Entry students, including all Compulsory courses as well as a CGPA of not less than 1.00.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
BIO 101	General Biology I	2	C	30	-
BIO 102	General Biology II	2	C	30	-
BIO 107	General Biology Practical I	1	C	-	45
BIO 108	General Biology Practical II	1	C	-	45
CHM 101	General Chemistry I	2	C	30	-
CHM 102	General Chemistry II	2	C	30	-
CHM 107	General Chemistry Practical I	1	C	-	45
CHM 108	General Chemistry Practical II	1	C	-	45
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 107	General Physics Practical I	1	C	-	45
PHY 108	General Physics Practical II	1	C	-	45
	Total	**29**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	30	
CHM 210	Physical Chemistry I	2	C	30	
CHM 211	Organic Chemistry I	2	C	30	
CHM 212	Inorganic Chemistry I	2	C	30	
CHM 213	Analytical Chemistry I	2	C	30	
CHM 214	Structure and Bonding	2	C	30	-

Course Code	Course Title	Unit(s)	Status	LH	PH
CHM 207	General Chemistry Practical III	1	C	-	45
CHM 208	General Chemistry Practical IV	1	C	-	45
STA 202	Statistics for Physical Sciences & Engineering	2	C	30	-
	Total	**18**			

300 Level

Course Code	Course Title	Units	Status	LH	PH
ENT 312	Venture Creation	2	C	15	45
GST 312	Peace and Conflict Resolution	2	C	30	-
CHM 301	Physical Chemistry II	2	C	30	
CHM 302	Inorganic Chemistry II	2	C	30	
CHM 303	Organic Chemistry II	2	C	30	
CHM 304	Atomic & Molecular Structure & Symmetry	2	C	30	-
CHM 312	Analytical Atomic spectroscopy	2	C	30	
CHM 314	Entrepreneurship skill in Chemistry	2	C	30	
CHM 316	Applied Spectroscopy	2	C	30	-
CHM 319	Environmental Chemistry	2	C	30	-
CHM 399	Industrial Attachment II (12 Weeks)	3	C	135	
	Total	**23**			

400 Level

Course Code	Course Title	Units	Status	LH	PH
CHM 400	Seminar	1	C	-	45
CHM 401	Research Project	6	C	-	270
CHM 406	Reaction Kinetics	2	C	30	-
CHM 410	Analytical Chemistry II	2	C	30	
CHM 423	Organometallic Chemistry	2	C	30	-
CHM 424	Co-ordination Chemistry	2	C	30	-
	Total	**15**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:

1. identify possible sound patterns in English Language;
2. list notable Language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents

Sound patterns in English Language (vowels and consonants, phonetics, and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple, and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and Deductive Argument and Reasoning Methods, Analogy, Generalisation and Explanations). Ethical considerations, Copyright Rules, and Infringements. Writing Activities: (Pre-writing, Writing, Post writing, Editing and Proofreading; Brainstorming, outlining, Paragraphing, Types of writing, Summary, Essays, Letter, Curriculum Vitae, Report writing, Note making etc. Mechanics of writing). Comprehension Strategies: (Reading and types of Reading, Comprehension Skills, 3RsQ). Information and Communication Technology in modern Language Learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112- Nigerian Peoples and Culture (2 units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of Trade, Economic and Self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building
6. analyse the role of the Judiciary in upholding people's fundamental rights
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification. Judiciary and

fundamental rights. Individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation; Re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption(WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes
At the end of this course students should be able to:
1. explain basic definition of Set, Subset, Union, Intersection, Complements and use of Venn diagrams;
2. solve quadratic equations;
3. Solve trigonometric functions;
4. identify various types of numbers; and
5. solve some problems using Binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, venn diagrams. Real numbers, integers, rational and irrational numbers. Mathematical induction, real sequences and series. Theory of quadratic equations. Binomial theorem. Complex numbers. Algebra of complex numbers. The Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of this course students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of Function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative, as limit of rate of change. Techniques of differentiation. Extreme curve sketching; Integration as an inverse of differentiation. Methods of integration, Definite integrals. Application to areas, volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;

3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

BIO 101: General Biology I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. explain cell structure and organizations;
2. summarize functions of cellular organelles;
3. characterize living organisms and state their general reproduction;
4. describe the interrelationship that exists between organisms;
5. discuss the concept of heredity and evolution; and
6. enumerate habitat types and their characteristics.

Course Contents
Cell structure and organization. functions of cellular organelles. characteristics and classification of living things. chromosomes, genes their relationships and importance. General reproduction. Interrelationships of organisms (competitions, parasitism, predation, symbiosis, commensalisms, mutualism, saprophytism). Heredity and evolution (introduction to Darwinism and Lamarckism, Mendelian laws, explanation of key genetic terms). Elements of ecology and types of habitat.

BIO 102: General Biology II (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures, students should be able to:
1. List the characteristics, methods of identification and classification of Viruses, bacteria and fungi;
2. state the unique characteristics of plant and animal kingdoms;
3. describe ecological adaptations in the plant and animal kingdoms;
4. explain nutrition, respiration, excretion and reproduction in plants and animals; and
5. describe growth and development in plants and animals.

Course Contents
Basic characteristics, identification and classification of viruses, bacteria and fungi.
A generalized survey of the plant and animal kingdoms based mainly on the study of similarities and differences in the external features. Ecological adaptations. Briefs on physiology to include nutrition, respiration, circulatory systems, excretion, reproduction, growth and development.

BIO 107: General Biology Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. outline common laboratory hazards;
2. provide precautions on laboratory hazards;
3. state the functions of the different parts of microscope;
4. use the microscope and describe its maintenance;
5. draw biological diagrams and illustrations; and
6. apply scaling and proportion to biological diagrams.

Course Contents
Common laboratory hazards: prevention and first aid; measurements in biology. Uses and care of microscope: compound and dissecting microscope. Biological drawings and illustration, scaling, accuracy and proportion. Use of common laboratory apparatus and laboratory experiments designed to illustrate the topics covered in **BIO 101.**

BIO 108: General Biology Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the anatomy of flowering plants;
2. differentiate types of fruit and seeds;
3. state ways of handling and caring for biological wares;
4. describe the basic histology of animal tissues; and
5. identify various groups in the animal kingdom.

Course Contents
Anatomy of flowering plants, primary vegetative body: stem, leaf and root to show the mature tissues namely parenchyma, collenchyma, sclerenchyma, xylem and phloem. Types of fruits and seeds. Care and use of dissecting kits and other biological wares. Dissection and general histology of animal tissues based on vertebrate forms. Morphology and functions of epithelial, muscular, nervous and connective tissues. Examination of various groups of lower invertebrates under microscopes, identification of various groups of organisms in Animal Kingdom. And any experiment designed to emphasize the practical aspects of topics in BIO 102.

CHM 101: General Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. define atom, molecules and chemical reactions;
2. discuss the Modern electronic theory of atoms;

3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. illustrate shapes of simple molecules and hybridized orbitals;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents

Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence Forces. Structure of solids. Chemical equations and stoichiometry; Chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry. Rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reactions;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. describe basic properties of Transition metals.

Course Contents

Historical survey of the development and importance of Organic Chemistry. Fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures, nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The Chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify the differences between primary and secondary standards;
5. perform redox titration;
6. recording observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents
Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify and carry out preliminary tests which includes ignition, boiling point, melting point, test on known and unknown organic compounds;
5. perform solubility tests on known and unknown organic compounds;
6. conduct elemental tests on known and unknown compounds; and
7. conduct functional group/confirmatory test on known and unknown compounds which could be acidic / basic / neutral organic compounds.

Course Contents
Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the student should be able to:
1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics.
4. apply Newton's laws to describe and solve simple problems of motion.
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects.
6. explain and apply the principles of conservation of energy, linear and angular momentum.

7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Courses Contents

Space and time. Units and dimension, Vectors and Scalars. Differentiation of vectors: displacement, velocity and acceleration. Kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). Relative motion. Application of Newtonian mechanics. Equations of motion.Conservation principles in physics. Conservative forces. Conservation of linear momentum. Kinetic energy and work. Potential energy. System of particles. Centre of mass. Rotational motion:Torque, vector product, moment, rotation of coordinate axes and angular momentum. Polar coordinates. Conservation of angular momentum. Circular motion. Moments of inertia. gyroscopes and precession. Gravitation: Newton's Law of Gravitation. Kepler's Laws of Planetary Motion. Gravitational Potential Energy. Escape velocity. Satellites motion and orbits.

PHY 102: General Physics II (Electricity & Magnetism) (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the student should be able to:

1. describe the electric field and potential, and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;
5. describe electromagnetic induction and related concepts, and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters; and
8. determine the characteristics of ac voltages and currents in resistors, capacitors, and Inductors.

Course Contents

Forces in nature. Electrostatics; electric charge and its properties, methods of charging. Coulomb's law and superposition. electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators, current, voltage and resistance. Ohm's law and analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step-down transformers: Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, resistance, and combinations.

PHY 107: General Practical Physics I (1 Unit C: PH 45)

Learning Outcomes

At the end of this course, the student should be able to:

1. conduct measurements of some physical quantities;

2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasizes quantitative measurements, the treatment of measurement errors and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity etc., covered in PHY 101 and PHY 102. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

PHY 108: General Practical Physics II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the student should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data; and
6. prepare and present practical reports.

Course Contents
This practical course is a continuation of PHY 107 and is intended to be taught during the second semester of the 100 level to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements. The treatment of measurement errors, and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. State the basic principles of e-commerce.

Course Contents
Concept of Entrepreneurship (Entrepreneurship, Intrapreneurship/Corporate Entrepreneurship,). Theories, Rationale and relevance of Entrepreneurship (Schumpeterian and other perspectives, Risk-Taking, Necessity and opportunity-based entrepreneurship and Creative destruction). Characteristics of Entrepreneurs (Opportunity seeker, Risk taker, Natural and Nurtured, Problem solver and change agent, Innovator and creative thinker). Entrepreneurial thinking (Critical thinking, Reflective thinking, and Creative thinking). Innovation (Concept of innovation, Dimensions of innovation, Change and innovation, Knowledge and innovation). Enterprise formation, partnership and networking (Basics of Business Plan, Forms of business ownership, Business registration and Forming alliances and join ventures). Contemporary Entrepreneurship Issues (Knowledge, Skills and Technology, Intellectual property, Virtual office, Networking). Entrepreneurship in Nigeria (Biography of inspirational Entrepreneurs, Youth and women entrepreneurship, Entrepreneurship support institutions, Youth enterprise networks and Environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

CHM 210: Physical Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. state the kinetic theory of gases and solve problems related to ideal and real gases;
2. derive the formula for molecular velocity of gases and use the derived formula to solve problems;

3. describe and explain the fundamental concepts of physical chemistry including those of statistical mechanics, chemical Kinetics, quantum mechanics and spectroscopy;
4. apply simple models to predict properties of chemical systems;
5. define and state type of solutions; define different concentration terms which include molarity, normality etc. explain vapour pressure lowering of the solvent, boiling point elevation of solutions, freezing point depression of solution and measurement of osmotic pressure;
6. apply numerical or computational methods to calculate physical properties of Chemical systems and assess the appropriateness of different computational techniques and numerical approximations for solving chemistry problems;
7. design and plan an investigation by selecting and applying appropriate practical, theoretical, and/or computational techniques or tools; and
8. states Ohms law and describe the electrolytic conduction, states the Faraday's Law and Conductance Law of solution and calculation on electrical conductance on different electrolyte solution.

Course Contents
Kinetic theory of gases; science of real gases; the laws of thermodynamics; entropy and free energy; reactions and phase equilibria; reaction rates; rate laws; mechanism and theories of elementary processes; photochemical reactions; basic electrochemistry.

CHM 211: Organic Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe and solve problems in chemistry of aromatic compounds;
2. describe the structures of simple sugars, starch and cellulose, peptides and proteins and show the difference in their conformation structure;
3. describe and solve problems in chemistry of bifunctional compounds;
4. explain he mechanisms of substitution, elimination, addition and rearrangement reactions;
5. describe stereochemistry and its application;
6. describe condition and pathways of the following organic reactions - Grignard reaction, Aldol and related reactions; and
7. describe simple alicyclic carbon compounds and their synthesis.

Course Contents
Chemistry of aromatic compounds. Structures of simple sugars, starch and cellulose, peptides, and proteins. Chemistry of bifunctional compounds. Energetics, kinetics, and the investigation of reaction mechanisms. Mechanisms of substitution, elimination, addition, and rearrangement reactions. Stereochemistry. Examples of various named organic reactions e.g., Grignard reaction, Aldol and related reactions. Simple alicyclic carbon compounds and their synthesis.

CHM 212: Inorganic Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. list the first-row transition elements and explain their characteristics and properties;
2. explain crystal field theory (CFT) and draw the diagram to illustrate with examples of coordination compounds;

3. state the advantages of CFT over other bonding theories;
4. discuss the comparative Chemistry of the following elements. (I) Ga, In, Tl (II). Ge, Sn, Pb (III). As, Sb, Bi (IV). Se, Te, Po;
5. define organometallic chemistry;
6. give relevant examples with illustrations;
7. classify organometallic compounds with examples;
8. list the roles of metals in biochemical systems;
9. discuss the concepts of hard and soft acids and bases.
10. list examples of item 9 above;
11. explain oxidation and reduction reaction; and
12. illustrate the above (11) with appropriate reactions.

Course Contents

Chemistry of first row transition metals. Introduction to coordination chemistry including elementary treatment of crystal field theory. Comparative Chemistry of the following elements: (a) Ga, In, TI, (b) Ge, Sn, Pb, (c) As, Sb, Bi (d) Se, Te, Po.

Elementary introduction to organometallic chemistry. Role of metals in biochemical systems. Concepts of hard and soft acids and bases. Oxidation and reduction reactions.

CHM 213: Analytical Chemistry I (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

1. explain analytical processes which include description of chemist as a problem solver;
2. describe and differentiate forms of error;
3. explain its implication on laboratory analysis;
4. state different statistical tool use in treatment of data;
5. solve practical problems using the statistical tools;
6. define sampling and give reasons for sampling in field work;
7. state and describe different sampling techniques;
8. state different forms of sample collection and processing;
9. describe volumetric method of analysis and solve some practical problems; and
10. describe gravimetric method of analysis and solve some practical problems.

Course Contents

Theory of errors; and statistical treatment of data: Theory of sampling. Chemical methods of analysis including volumetric, gravimetric, data analysis and presentation. and. Physicochemical methods, Optical methods of analysis; separation methods.

CHM 214: Structure and Bonding (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students will be able to:

1. explain the idea of quantum states, orbital, shape and energy;
2. explain simple valency theory, electron repulsion theory and atomic spectra;
3. explain Symmetry, molecular geometry and structure, and molecular orbital theory of bonding;
4. sketch to illustrate with specific examples for item (3) above;

5. express how molecular orbital theory of bounding explains the magnetic properties in main group compounds;
6. explain the methods used in the determination of molecular shapes. Bond lengths and angles; and
7. explain with the use model the structure and chemistry of some of the representatives of main group elements.

Course Contents

Idea of quantum states, orbitals, shape; and energy. Simple valence theory, electron repulsion theory, atomic spectra. Symmetry, molecular geometry and structure, molecular orbital theory of bonding. Methods of determining molecular shape, bond lengths and angles. The structure and chemistry of some representative main group element compounds.

CHM 207: General Chemistry Practical III (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students will be able to:
1. describe the measurement of pH;
2. determine the relative molar mass from the colligative properties;
3. demonstrate the partition coefficient of two immiscible solvents;
4. demonstrate temperature measurements and heat of dissolution, heat of neutralization and many others
5. determine the critical solution temperature of water-Phenol system; and
6. measure the molar volume of a gas and universal gas constant.

Course Contents
pH Measurement Determination of Relative Molar Mass from Colligative Properties, Demonstration of Partition Coefficient in two Immiscible Solvents, Temperature Measurement and Heat of Dissolution Heat of Neutralisation, Determination of Critical Solution Temperature of Water-Phenol System Ideal Gas Law: Measuring the Molar Volume of a Gas and the Universal Gas Constant

CHM 208: General Chemistry Practical IV (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students will be able to:
1. identify general laboratory rules;
2. explain the preparation of simple organic compounds (esters, aldehydes and ketones);
3. describe the analysis of vinegar;
4. demonstrate A simple experiment on thin layer chromatography;
5. perform an experiment on the dehydration of alcohol; and
6. conduct experiments on qualitative analysis of common functional groups.

Course Contents
The Preparation of Esters, The preparation of Aldehydes and Ketones. Vinegar Analysis, Chromatography, Thin Layer Chromatography, Dehydration of Alcohol Qualitative Analysis of Common Functional Groups

STA 202: Statistics for Physical Sciences and Engineering (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe the scope for statistical methods in physical sciences and engineering;
2. define the Measures of location, partition, and dispersion;
3. explain the elements of probability. Probability distribution: binomial Poisson, geometric, hypergeometric, negative-binomial, normal Poisson, geometric, hypergeometric, negative-binomial, normal, Student's t and chi-square distributions;
4. differentiate point from internal estimation and could be able to tests for hypotheses concerning population means proportions and variances;
5. be able to compute for Regression and correlation as well as conduct some Non–parametric tests with reference to Contingency table analysis; and
6. be able to explain the elements of design of experiments and Analysis of variance.

Course Contents
Scope for statistical methods in physical sciences and engineering. Measures of location, partition and dispersion. Elements of probability. Probability distribution: binomial Poisson, geometric, hypergeometric, negative-binomial, normal Poisson, geometric, hypergeometric, negative-binomial, normal, Student's t and chi-square distributions. Estimation (point and internal) and tests of hypotheses concerning population means proportions and variances. Regression and correlation. Non-parametric tests. Contingency table analysis. Introduction to design of experiments. Analysis of variance.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents
Concepts of Peace, Conflict and Security in a multi-ethnic nation. Types and Theories of Conflicts: Ethnic, Religious, Economic, Geo-political Conflicts; Structural Conflict Theory, Realist Theory of Conflict, Frustration-Aggression Conflict Theory. Root causes of Conflict and Violence in Africa: Indigene and settlers Phenomenon; Boundaries/boarder disputes; Political disputes; Ethnic disputes and rivalries; Economic Inequalities; Social disputes; Nationalist Movements and Agitations; Selected Conflict Case Studies – Tiv-Junkun; Zango Kartaf, Chieftaincy and Land disputes etc. Peace Building, Management of Conflicts and Security: Peace & Human Development. Approaches to Peace & Conflict Management --- (Religious, Government, Community Leaders etc.). Elements of Peace Studies and Conflict Resolution: Conflict dynamics

assessment Scales: Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice; The Nigeria Legal System. Insurgency and Terrorism. Peace Mediation and Peace Keeping. Peace & Security Council (International, National and Local levels) Agents of Conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of International Organizations in Conflict Resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping. Media and Traditional Institutions in Peace Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students through case study and practical approaches, should be able to:

1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/Market Research, Unutilised resources, Social and climate conditions and Technology adoption gap). New business development (business planning, market research). Entrepreneurial Finance (Venture capital, Equity finance, Micro finance, Personal savings, small business investment organizations and Business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, Customer Acquisition & Retention, B2B, C2C and B2C models of e-commerce, First Mover Advantage, E-commerce business models and Successful E-Commerce Companies,). Small Business Management/Family Business: Leadership & Management, Basic bookkeeping, Nature of family business and Family Business Growth Model. Negotiation and Business communication (Strategy and tactics of negotiation/bargaining, Traditional and modern business communication methods). Opportunity Discovery Demonstrations (Business idea generation presentations, Business idea Contest, Brainstorming sessions, Idea pitching). Technological Solutions (The Concept of Market/Customer Solution, Customer Solution and Emerging Technologies, Business Applications of New Technologies - *Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy etc.* Digital Business and E-Commerce Strategies).

CHM 301: Physical Chemistry II **(2 Units C: LH 30)**

Learning Outcomes
At the end of this course, the students will be able to:
1. describe the general knowledge of Gibbs function;
2. explain the concept of thermodynamics compare to kinetics; and
3. explain the concept of statistical thermodynamics and use statistical equation to solve problems in ideal and non-ideal solution.

Course Contents
A review of Gibbs Function. Chemical thermodynamics. Introduction to statistical thermodynamics. Ideal solutions and non-Ideal solutions. Properties of electrolytes. Colligative Properties. Studies on biochemical systems

CHM 302: Inorganic Chemistry II **(2 Units C: LH 30)**

Learning Outcomes
At the end of this course, students will be able to:
1. analyse inorganic chemistry information;
2. demonstrate and apply knowledge of inorganic Chemistry;
3. explain the electronic structure and general properties of group 1A and Group IIA elements;
4. compare Group IA and Group IIA in terms of the parameters mentioned in 3 above;
5. explain the chemistry of Boron; carbon and Silicon; Nitrogen and phosphorus; Oxygen and sulphur;
6. explain the halogen chemistry;
7. explain the periodic properties of the transition metals and to use these to predict and/or rationalise the chemistry of these metal ions and their complexes;
8. use Crystal Field Theory to explain and understand some of the key features of complexes of the first-row transition metals including their shapes, colours, and magnetic properties;
9. synthesis and characterise a metal coordination compound using practical inorganic chemistry techniques;
10. describe ligand and crystal field theories;
11. draw the diagram showing crystal and ligand field theories with specific examples;
12. list advantages and limitations of these bonding theories;
13. define radioactive decay processes and nuclear radiation;
14. explain the principles of utilizing radioactivity applied to chemistry, chemical processes and adjacent fields where chemistry is an integral part;
15. discuss the principles of radiation hygiene and the interaction of radiation and matter;
16. explain current methods in radiochemistry;
17. define radioactivity;
18. define and describe all three types of radioactivity (alpha, beta, and gamma radiation); and
19. explain the roles of metals in living systems.

Course Contents

The Noble gases. Hydrogen. Electronic structure and general properties and comparative study of Group IA and Group IIA elements. Chemistry of Boron. Carbon and Silicon. Nitrogen and Phosphorus. Oxygen and Sulphur. The halogens. Transition elements. Separation of metals. Introduction to co-ordination chemistry. Introductory organo-metallic chemistry. Ligand and Crystal field theories. Introduction to radiochemistry. Radioactivity and the periodic table. Role of metals in living systems.

CHM 303 Organic Chemistry II (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

1. recognize and distinguish between aromatic and Alicyclic compounds by their structures;
2. identify the properties of aromatic and Alicyclic compounds, and the chemical consequences of aromaticity;
3. recognize and be able to write the mechanism of electrophilic aromatic and Alicyclic substitution;
4. outline the completed electrophilic aromatic substitution reactions of the following types: halogenation, nitration, sulfonation, and Friedel-Crafts acylation & alkylation;
5. explain the chemistry of heterocyclic Chemistry (3,4,5 and 6-membered ring of O, N, S heterocyclic compounds);
6. describe the Reactive intermediates – carbocations, carbanions, carbenes, nitrenes;
7. express the rearrangement reactions e.g., Beckmann, Baeyer-Villiger etc.
8. illustrate with various reaction mechanisms and types; and
9. organize Forensic analysis of biological samples, pharmaceutical samples, organic analytes and macromolecular samples.

Course Contents

Pre –requisite –CHM 211

Aromatic and Alicyclic chemistry. Survey of representative polycyclic compounds. Heterocyclic Chemistry (3,4,5 and 6-membered ring of O, N, S heterocyclic compounds). Reactive intermediates – carbocations, carbanions, carbenes, nitrenes etc. Selected rearrangement reactions such as, Beckmann, Baeyer-Villiger, and many others to illustrate various reaction mechanisms and types. Forensic analysis of biological samples, pharmaceutical samples, organic analytes and macromolecular samples.

CHM 304: Atomic and Molecular Structure and Symmetry (2 Units C: LH 30)

Learning Outcomes

At the end of this course, students should be able to:

1. illustrate the Schrodinger wave equation for the hydrogen molecule and ion;
2. define the terms in the time-independent Schrodinger wave equation;
3. express equation for the 3D Schrodinger wave equation;
4. define Pauli Exclusion Principle and the Hund's rule;

5. illustrate electron configurations for atoms in either the subshell or orbital box notations;
6. illustrate electron configurations of ions;
7. explain how molecular orbital are formed;
8. draw molecular orbital diagrams for diatomic molecules;
9. define modern valence theory;
10. explain the concept of resonance and configuration interaction;
11. explain Huckel theory;
12. outline Walsh rules;
13. illustrate Walsh rules with specific examples;
14. explain the theory of electronic spectroscopy; and
15. explain Franck-Condon Principle;
16. use Franck-Condon Principle to account for the vibrational structure of electronic transitions'
17. explain Russel- Saunders coupling, orbital and spin angular momentum; and
18. use of symmetry in chemistry.

Course Contents
Prerequisite –CHM 214
Schrödinger equation. Helium atom, ground and excited states, Spin and Pauli Exclusion Principle. Hydrogen molecule; Comparison of molecular orbital and valence bond theory, concept of resonance and configuration interaction. Coulson Fischer function. Molecular orbitals for diatomic molecules. Simple pi electron theory, Huckel theory. Walsh rules. Rotational, vibrational and electronic spectra. Applications for determining bond lengths and angles. Atomic spectra, Russell Saunders coupling, orbital and spin angular momentum. Use of symmetry in Chemistry.

CHM 312: Analytical Atomic Spectroscopy (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the concept of interaction of atoms with electromagnetic radiation;
2. explain the principles of atomic absorption spectrometry; atomic fluorescence spectrometry; X-ray fluorescence;
3. explain the procedure and use of these instruments in analytical chemistry and industries; and
4. discuss the preparations of standard solution for these instruments.

Course Contents
Introduction of concept of interaction of atoms with electromagnetic radiation, atomic absorption spectrometry; atomic emission spectrometry; atomic fluorescence spectrometry and X-ray fluorescence spectrometry.

CHM 314: Entrepreneurship skill in Chemistry (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. demonstrate the entrepreneurial skills;
2. Identify international entrepreneurship opportunities;
3. develop competency in identification of new business ventures;
4. identify legal issues and business environments;

5. discuss marketing strategies; and
6. identify Cost accounting.

Course Contents
Entrepreneur perspectives and strategies. International entrepreneurship opportunities, identification, pursuit of new ventures (Water treatment, production of bio -renewable plastics such as polylactic acids PLA, textile and clothing: medical textiles, military and industrial textiles, electronics: semiconductors, food and drinks, packaging, drug designs, soap and hand sanitizers etc), marketing strategies in business ventures, creativities and the business ideas, legal issues and business environment, and cost accounting. Field trips.

CHM 316: Applied Spectroscopy (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. characterize spectroscopical molecules and materials with the infrared; UV; NMR and mass spectrometry;
2. discuss the general principles of the analytical instruments listed above;
3. describe the applications of spectroscopy, such as the study of the atmosphere; cultural heritage, astrophysics, and materials;
4. describe the theoretical principle of GC-MS; LC-MS; LC-NMR;
5. study and characterise molecules and materials with the listed instruments in (4) above; and
6. list the application of these instruments in Industry and medicine.

Course Contents
Principles and applications of UV, IR, NMR and Mass spectroscopy in the determination and elucidation of structures of organic compounds. Brief mention of hyphenated systems: GC-MS, LC-MS and LC-NMR, and diagnostic use of NMR in medicine.

CHM 319: Environmental Chemistry (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the elementary circle of the following element oxygen, nitrogen, sulphur and many others;
2. describe the stratification of the earth atmosphere and state characteristics of each strata;
3. state and describe different sources of environmental pollution;
4. state and describe different types of environmental pollution and their effect on the environment;
5. describe water and state qualities that define the uses of water;
6. describe and explain different sources of water contamination and its impact on agricultural land crops and many others;
7. state and describe different methods use in treatment of waste water – chemical, biological and physical methods;
8. state and justify chemical and physical instrumentation in environmental chemistry;
9. describe environmental impact assessment; and
10. state and describe twelve principles of green chemistry and its practical applications.

Course Contents
Concepts of elementary cycles. Characteristics of the atmosphere. Sources, types and effects of environmental pollution. Wastewater treatment. Composition of domestic/industrial wastes and waste management. Water chemistry and analysis. Chemical and physical instrumentation in environmental sciences. Introduction to Environmental Impact Assessment. Twelve principles of green chemistry.

CHM 399: Industrial Attachment (3 Units C: PH 135)

Learning Outcomes
At the end of this course, students will be able to:
1. use various analytical equipment for quality control;
2. apply basic knowledge acquire in the classroom to solve practical problems in the laboratory;
3. give a seminar presentation of new knowledge gain during the industrial training; and
4. demonstrate the use of multimedia for seminar presentation.

Course Contents
Students should be attached to some industrial organizations for additional 12 Weeks at the 300 Level preferably during the long vacation for more industrial experience. Students to be assessed based on seminar presentation, their reports and assessment by supervisors.

CHM 400: Seminar (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. demonstrate basic knowledge of report writings;
2. identify basic elements of research which includes: Introduction, literature reviews, methodology/experimentation/materials and methods, results and discussion, conclusion, recommendations and referencing;
3. identify various types of referencing such as, APA, Chicago, Harvard and many others.
4. identify Spacing and paragraph used in presentation writings;
5. identify the use of multimedia in seminar presentations; and
6. demonstrate assessment and grading of the written and oral presentation.

Course Contents
Student reports on an assigned or chosen current topic in chemistry. Review of literature on the assigned topic should be included. Assessment to be on written report and oral presentation.

CHM 401: Research Project (6 Unit C: PH 270)

Learning Outcomes
At the end of this course, the students should be able to:
1. demonstrate basic knowledge of report writings;
2. identify a chemistry related Topic for the final year project;

3. identify basic elements of research which includes Introduction, literature reviews, methodology/experimentation/materials and methods, results and discussion, conclusion, recommendations and referencing;
4. identify various types of referencing e.g., APA, Chicago, Harvard and many others.
5. identify Spacing and paragraph used in presentation writings;
6. express the use of multimedia in project seminar presentations; and
7. demonstrate assessment and grading of the written and oral presentation.

Course Contents
Research projects into selected topics in chemistry. Students will be expected to carry out literature survey on chosen topics, perform experiments and produce reports. Students will be subjected to both seminar and oral examinations on their projects.

CHM 406: Reaction Kinetics (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. identify the first, second and third order rate equations.;
2. use the coefficients of a balanced chemical equation to express the rate of reaction in terms of the change in concentration of a reactant or product over time;
3. distinguish between instantaneous rates and average rates from a graph; and
4. determine the rate law from initial rate data and be able to determine:
   - the order of reaction with respect to each reactant;
   - the overall order of reaction; and
   - the rate constant with units.
5. recognise the integrated rate laws and be able to:
   - use integrated first-order and second-order rate laws to find the value of one variable, given;
   - values of the other variables;
   - explain the concept of reaction half-life and describe the relationship between half-life and rate;
   - constant for first order and second-order reactions;
   - determine the order of the reaction from plots of concentration versus time, ln (concentration);
   - versus time, and 1/(concentration) versus time.
6. use Collision Theory to explain how reactions occur at the molecular level, and

   - explain the concept of activation energy and how it relates to the variation of reaction rate with temperature;
   - be able to interpret potential energy profiles and use them to determine the activation energy;
   - potential energy changes for a reaction;
   - be able to use the Arrhenius equation to calculate a rate constant, activation energy, and
   - frequency factor.
7. define a catalyst and
   - give a reaction mechanism, identify the reaction intermediate(s) and catalyst(s), write the overall;

- and determine the molecularity of each step;
- describe the effect of a catalyst on the energy requirements for a reaction;
- sketch a potential energy profile showing the activation energies for the forward and reverse;
- reactions and show how they are affected by the addition of a catalyst;

8. explain how enzymes act as biological catalysts and how they interact with specific substrate molecules.
9. explain why enzymatic reactions respond differently to temperature changes compared to nonenzymatic processes.
10. chemical warfare:
    - recognize selected classes of toxic agents of military importance: blister agents, (mustard,
    - lewisite), nerve agents (sarin, VX), choking agents (chlorine, phosgene), blood agents (HCN), riot.
    - control agents
11. explain the mechanism by which sarin inhibits acetylcholinesterase ; and
12. identify photochemical reaction mechanism.

Course Contents
Review of first, second and third order rate equations. Rate constants and equilibrium constants. Collision theory. Transition state theory. Reaction co-ordinates. Unimolecular reaction mechanisms. Bimolecular reaction mechanisms. Chain reaction mechanisms. Chemical warfare, Catalysis and heterogeneous reactions. Photochemical reaction mechanisms.

CHM 410: Analytical Chemistry II (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. describe different thermal methods of analyses: TG, DTG, DTA, DSC;
2. describe the potentiometric method of analysis using pH;
3. describe the conductometric method analysis;
4. describe the colorimetric method analysis;
5. describe the polarography methods analysis;
6. explain and perform calculation using chromatography principles;
7. explain principles of different chromatographic technique; and
8. explain the principle of radiochemical method in environmental analysis.

Course Contents
Potentiometric and pH methods. Conductometric, electroanalytical, amperometric, colorimetric methods of analysis. Coupled methods of analysis e.g. GC-MS, LC-MS. Radio-chemical methods, Chromatography.

CHM 423: Organometallic Chemistry (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. identify the classifications of organometallic compounds by bonding and ligands;

2. explain Preparation, structure and reactions including abnormal science of organometallic compounds;
3. identify electron rule, bonding, chemistry of ferrocene and related compounds; and
4. explain the roles of organometallic compounds in some catalytic reaction;

Course Contents

Classification of organometallic compounds. Preparation, structure and reactions including abnormal science of organometallic compounds. Synthetic utility of organometallics. Introduction to organometallic compounds of the transition elements. Classification of ligands, electron rule, bonding, preparation of organic transition metal compounds. Reaction and structures of organometallic compounds of transition elements. The organic chemistry of ferrocene and related compounds. The role of organometallic compounds in some catalytic reaction.

CHM 424: Coordination Chemistry (2 Units C: LH 30)

Learning Outcomes

At the end of this course, students should be able to:

1. define coordination compounds;
2. recognise coordination compounds and their application;
3. identify the nomenclature, coordination formula and isomerism in complexes;
4. explain the stereochemistry of complex molecules;
5. identify theories of bonding: Werner, valence bond, crystal field/ligand field and molecular bond theories;
6. discuss their advantages, disadvantages, and their limitations;
7. discuss the physiochemical methods for structural elucidation of coordination compounds;
8. identify spectrochemicalseries, nephelauxetic series and Jahn- Teller distortions;
9. identify stabilization of unusual oxidation states by complex formation, thermodynamic stability of complex compounds, the stability constant, the chelate effect;
10. discuss Preparation and reactions of complexes. Kinetics and mechanisms;
11. discuss Domain structures, magnetostrictions, magnetic relaxation, magnetohydrodynamics and many others; and
12. identify Technological applications of magnetohydrodynamics.

Course Contents

Prerequisite –CHM 302

Definition, recognition and applications of co-ordination compounds. Nomenclature, co-ordination formula and isomerism in complexes. Stereochemistry of complex molecules. Theories of structure and bonding. Physical methods of structural investigation. Magnetic properties. Absorption and vibrational spectra. The spectrochemical series. The Nephelauxetic series and the Jahn-Teller distortions. Stabilisation of unusual oxidation states by complex formation. Thermodynamic stability of complex compounds, the stability constant, the chelate effect. Preparation and reactions of complexes. Kinetics and mechanisms.

Minimum Academic Standards

Equipment

Every university teaching laboratory should be equipped with a wide range of specialist facilities including:

State-of-the-art synthetic labs for project work.

Dedicated NMR spectrometer for exclusive use by undergraduates.

A suite of dedicated analytical instrumentations.

The undergraduate teaching labs should also have HPLC and HPLC-MS instruments to help in learning the fundamentals and applications of measurement and of separation science.

UV Spectrophotometers and a suite of infra-red spectrometers for measuring solids, liquids and gases.

Students should also have access to:

Open access research laboratories for Separations, EPR, NMR and Mass Spectrometry.

Cutting-edge X-ray diffractometers, Susceptibility Machines, Elemental Analysis machines, Analytical weighing balances, Electrochemical Impedence spectroscopy,

Overhead tanks, Fume cupboards and glasswares.

Research Computing Facility to support teaching & learning in computational and theoretical science.

List of Equipment

Item	Quantity
Calorimeter Model: C 200	1
Differential Scanning Calorimeter (DSC) Model: DSC 1| -150 … 700 °C	1
Digital Laboratory Hot Plate Magnetic Stirrer Model: RET basic IKAMAG®	10
Digital Refractometer Model: ATR-B TOUCH	1
Distillation Unit Apparatus Model: UDK 149 - Automatic steam distillation system	1
Drying Oven Model: Turbo-Fan Drying Oven 230V	10
Electronic Balance Model Number: JA103H	10
f2271 Ice-making machine	2
Fourier Transform Infrared (FTIR) Spectrometer	1
Freeze Dryer Model: Christ Beta 2-8 LD Freeze Dryer	3
Fume Chamber, Laboratory Fume Hood	1
Laboratory pH Meter -2 ... 20 pH, ± 2 000 mV | PP series	10
Melting Point Apparatus Model: VMP–PM	10
Multiskan™ GO Microplate Spectrophotometer with cuvette	1
Polarimeter Model: AUTOPOL VI	1
Rotary Evaporator Model: R-210/R-215	3
Soxhlet Extraction Apparatus with Energy Regulator	3
TLC adjustable spreader	20

TLC Chromatographic Tanks	20

Laboratories
Preparation room, store and technologists' office are to be provided in all conventional laboratories.
Instrumentation Laboratory - conventional laboratory with full complement of utilities and adequate workstations to accommodate 30-50 persons
General Chemistry Laboratory - conventional bench laboratory with full complement of utilities and adequate workstations to accommodate 100 persons
Physical Chemistry Laboratory - conventional bench laboratory with full complement of utilities and adequate workstations to accommodate 50-100 persons.
Research Laboratory - conventional bench laboratory with full complement of utilities and adequate workstations to accommodate 25-50 persons.
Inorganic Chemistry Laboratory - conventional bench laboratory with full complement of utilities and adequate workstations to accommodate 50-100 persons.
Organic Chemistry Laboratory - conventional bench laboratory with full complement of utilities and adequate workstations to accommodate 50-100 persons.
Integrated Laboratory - conventional bench laboratory with full complement of utilities and adequate workstations to accommodate 200- 300 peoples.

Staffing

Academic Staff
The guidelines on academic staff/student ratio of 1:20 for Science Programmes shall apply. To start any programme in science, there should be a minimum of six academic staff. There is need to have a reasonable number of staff with PhD degrees accounting for at least 70% of the total number and having adequate teaching experience for every programme in the Discipline.

Administrative Support Staff
The services of the administrative support staff are indispensable in the proper administration of departments and faculty offices. It is important to recruit very competent, computer literate senior staff.

Technical Support Personnel
The services of technical support staff, which are indispensable in the proper running of laboratories and workshops, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

Classrooms, Laboratories, Workshops and Office Space
The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00

Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

Library

Universities should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition, well stock and current hardcopies of reference and other textual materials should be provided centrally at the level of the faculty. A well network digital library should serve the entire university community. Availability of wireless facilities (Wifi) with adequate bandwidth should enhance access to these electronic resources.

In any case, there should be internet ready workstations available in the library for least 25% of the total student enrolled in each academic programme. The funding of the library should be in line with NUC guidelines.

B.Sc. Environmental Management and Toxicology

Overview

Environmental Management and Toxicology is a profession of educating people on environment and to build upon this foundation by exploring in some depths, specific aspects such as natural resource conservation, ecosystem functioning, ecotoxicology, waste management, environmental administration and policy, eco-innovation, climate change and other global environmental issues. The training will equip the trained and skilled manpower into solving present and emerging global environmental problems through monitoring, surveillance, and management.

Philosophy

The philosophy of the Environmental Management and Toxicology programme is to engender or assure an improved environment essential for both human and livestock through the training of personnel with adequate and relevant knowledge and expertise on issues of quality and safe environment required for a sustainable and overall human existence and development.

Objectives

The objectives of the programme are to:

1. produce highly skilled manpower in Environmental Management using model curriculum with courses designed for thorough grounding in the latest techniques at resolving environmental and public health issues;
2. equip the students with sufficient knowledge and skills to maintain the environment and prevent infections and infestations for the overall improvement of human and livestock health;
3. train students to gain knowledge of the interrelationship and interdependency (dynamics) of the components of the environment to ensure a stable and safe environment for man;
4. take cognizance of the overall academic objectives of the university built on result and mission-oriented education to produce highly skilled, cultured, and self-reliant graduates which would be able to improve and sustain the quality of our environment and human health for sustainable development; and
5. prepare skilled manpower that would be relevant in research-oriented institutions, impact assessment consultancy firms, oil and gas exploration companies, agricultural and desertification programmes, health institutions, government and public institutions and related organisations.

Unique Features of the Programme

The programme is unique in combining various subjects for a better understanding of the environment and safety of everyone.

1. the curriculum emphasizes the effects of chemicals on humans, animals, and natural environments;
2. the curriculum seeks to utilise scientific literature and databases to identify information needed to understand and effectively communicate aspects of toxicology;
3. the programme demonstrates an understanding of legal, regulatory, and ethical considerations relating to toxicology within the broader societal context;

4. the syllabus applies scientific methods in gaining technical expertise and laboratory skills through experimentation and research; and
5. develop a broad set of knowledge on the fundamentals in the basic areas of toxicology.

Employability Skills

Graduates from the programme will be;

1. proficient at demonstrating practical skills relating to the solution of environmental problems;
2. empowered with leadership skills and will be capable of overseeing the environmental performance of public, private organisations and ensure compliance with environmental legislations/regulations in air quality, wastes and pollution;
3. equipped with numerical and IT skills, developed through the application of statistics and measurement techniques;
4. capable to synthesise concepts; ability to employ scientific methods in gaining technical expertise and laboratory skills through research to solve environmental problems;
5. able to practice as environmental consultant, environmental education officer, nature conservation officer, recycling officer ,waste management officer, water quality scientist etc;
6. competent to be self-employed or even employer of labour as a result of exposure to and acquisition of 21st century skills; and
7. skilled to forecast and analyse toxicology impact using Geographic Information System (GIS) mapping, statistical and modelling technology.

21st Century Skills

1. Creativity and innovations
2. Cognitive abilities
3. Self-management
4. Computer literacy
5. Communication and I.T Skills
6. Goal setting
7. Decision making
8. Resiliency/Mental toughness
9. Problem solving
10. Team cohesion

Admission and Graduation Requirements

Admission Requirements

Candidates can be admitted into Environmental Management and Toxicology through two different pathways: the indirect entry and direct entry.

Indirect entry mode

Candidates who have successfully completed the Senior Secondary Certificate (SSC) or its equivalent and obtained five credits in Mathematics, English Language, Chemistry and Biology or Agricultural Science, in not more than two sittings and candidates must also have a pass in physics. Candidate must have acceptable score in the UTME with relevant subjects' combination.

Direct-Entry mode
For consideration of admission into the programme at 200 Level, candidates shall possess a minimum of Ordinary National Diploma (OND) or National Certificate of Education (NCE) in a relevant discipline with a minimum grade of Upper Credit, or HND in a relevant discipline with a minimum grade of Lower Credit, or A-Level certificate with at least two passes (graded A-E) including Biology and any relevant subject (Botany, Chemistry, Geography, Mathematics, and Physics).

Graduation Requirements
To be eligible for the award of a bachelor's degree in Environmental Management and Toxicology, a student must pass a minimum of 150 credits/ units to enable him or her graduate. Students must equally and unfailingly partake in SIWES and all other compulsory courses without which that student cannot graduate.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	30	-
GST 112	Nigerian Peoples and Culture	2	C	30	-
COS 101	Introduction to Computing Sciences	3	C	30	45
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 105	Practical Physics I	1	C	-	45
PHY 106	Practical Physics II	1	C	-	45
CHM 101	General Chemistry I	2	C	30	-
CHM 102	General Chemistry II	2	C	30	-
CHM 107	General Chemistry Practical I	1	C	-	45
CHM 108	General Chemistry Practical II	1	C	-	45
BIO 101	General Biology I	2	C	30	-
BIO 102	General Biology II	2	C	30	
BIO 103	General Practical Biology I	1	C	-	45
BIO 104	General Practical Biology II	1	C	-	45
	Total	**29**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
CSC 201	Computer Programming I	1	C	-	45

Course Code	Course Title	Unit(s)	Status	LH	PH
EMT 201	Introduction to Environmental Science	2	C	30	-
EMT 202	Methods of Environmental Analysis	2	C	15	45
EMT 206	Introductory GIS	2	C	15	45
BCH 201	General Biochemistry I	2	C	30	-
BIO 202	Introductory Ecology	2	C	15	45
CHM 211	Organic Chemistry I	2	C	15	45
CHM 212	Inorganic Chemistry I	2	C	15	45
	Total	**19**			

300 Level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	-
ENT 312	Venture Creation	2	C	15	-
EMT 301	Principles of Natural Resources Management	2	C	30	-
EMT 300	Environment Ecosystem and Man	2	C	30	-
EMT 302	Hazardous Substance Management	2	C	30	
EMT 303	Metal and Environment	2	C	30	-
EMT 305	Environmental Pollution Studies	2	C	15	45
EMT 306	Environmental Aspects of Agro Chem icals and Other Toxicants	2	C	15	45
EMT 307	Remote Sensing Techniques	2	C	15	45
MCB 221	General Microbiology	2	C	30	-
STA 210	Elementary Statistics for Agriculture and Biological Sciences	3	C	45	-
	Total	**23**			

400 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
EMT 401	Environmental Monitoring Systems a nd Techniques	2	C	15	45
EMT 403	Water Analysis	1	C	-	45
EMT 405	Rural and Urban Regional Planning	2	C	30	-
EMT 407	Environmental Education and Awareness	2	C	30	-
ENT 415	Entrepreneurial Studies II	2	C	30	-
EMT 499	Industrial Attachment	6	C	-	-
	Total	**15**			

500 Level

Course Code	Course Title	Units	Status	LH	PH
EMT 501	Environmental Law	2	C	30	-
EMT 502	Waste Management and Control	3	C	30	45
EMT 503	Ecological Disasters and Control	2	C	15	45
EMT 504	Human Settlement and Development	2	C	15	45
EMT 506	Natural Resources Conservation and Environmental Management	2	C	30	-
EMT 507	Seminar	2	C	-	-
EMT 599	Research Project	6	C	-	-
	Total	**19**			

Course Structure for Environmental Toxicology

100 Level

Course Code	Course Title	Units	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
COS 101	Introduction to Computing Sciences	3	C	30	45
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 105	Practical Physics I	1	C	-	45
PHY 106	Practical Physics II	1	C	-	45
CHM 101	General Chemistry I	2	C	30	-
CHM 102	General Chemistry II	2	C	30	-
CHM 107	General Chemistry Practical I	1	C	-	45
CHM 108	General Chemistry Practical II	1	C	-	45
BIO 101	General Biology I	2	C	30	-
BIO 102	General Biology II	2	C	30	
BIO 103	General Practical Biology I	1	C	-	45
BIO 104	General Practical Biology II	1	C	-	45
	Total	**29**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
CSC 201	Computer Programming I	1	C	-	45
EMT 201	Introduction to Environmental Science	2	C	30	-

Course Code	Course Title	Unit(s)	Status	LH	PH
EMT 202	Methods of Environmental Analysis	2	C	15	45
EMT 206	Introductory GIS	2	C	15	45
BCH 201	General Biochemistry I	2	C	30	-
BIO 202	Introductory Ecology	2	C	15	45
CHM 211	Organic Chemistry I	2	C	15	45
CHM 212	Inorganic Chemistry I	2	C	15	45
	Total	**19**			

300 Level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	-
ENT 312	Venture Creation	2	C	15	-
EMT 301	Principles of Natural Resources Management	2	C	30	-
EMT 300	Environment Ecosystem and Man	2	C	30	-
EMT 302	Hazardous Substance Management	2	C	30	
EMT 303	Metal and Environment	2	C	30	-
EMT 305	Environmental Pollution Studies	2	C	15	45
EMT 306	Environmental Aspects of Agro Chemicals and Other Toxicants	2	C	30	45
EMT 307	Remote Sensing Techniques	2	C	15	45
MCB 221	General Microbiology	2	C	30	-
STA 210	Elementary Statistics for Agriculture and Biological Sciences	3	C	45	-
	Total	**23**			

400 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
EMT 401	Environmental Monitoring Systems and Techniques	2	C	15	45
EMT 403	Water Analysis	1	C	-	45
EMT 405	Rural and Urban Regional Planning	2	C	30	
EMT 407	Environmental Education and Awareness	2	C	30	-
ENT 415	Entrepreneurial Studies II	2	C	15	45
EMT 499	Industrial Attachment	6	C	-	270
	Total	**15**			

500 Level

Course Code	Course Title	Units	Status	LH	PH
EMT 501	Environmental Law	2	C	30	-
EMT 506	Structural Elucidation of Organic Pollutants	3	C	30	45
EMT 507	Seminar	2	C		
EMT 511	Principles of Analysis of Toxicants	2	C	15	45
EMT 516	Principle of Toxicology	2	C	15	45
EMT 522	Environmental and Community Health	2	C	30	-
EMT 599	Research Project	6	C	-	
	Total	**19**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 3O)

Learning Outcomes

At the end of this semester, students will be able to:

1. identify possible sound patterns in English Language;
2. list notable Language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents

Sound patterns in English Language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and critical thinking and reasoning methods (logic and syllogism, inductive and deductive argument and reasoning methods, analogy, generalisation and explanations). Ethical considerations, copyright rules and infringements. Writing activities: (pre-writing , writing, post writing, editing and proofreading; brainstorming, outlining, paragraphing. Types of writing: summary, essays, letter, curriculum vitae, report writing, note making etc. Mechanics of writing). Comprehension strategies: (reading and types of reading, comprehension skills, 3RsQ). Information and Communication Technology in modern language learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of Trade, economic and self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian state towards nation building
6. analyse the role of the judiciary in upholding people's fundamental rights
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture, peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria. Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914, formation of political parties in Nigeria, Nationalist movements and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics, Nigerian civil war). Concept of trade and economics of self-reliance (indigenous trade and market system. Indigenous apprenticeship system among Nigeria people, trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification. Judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition. Citizenship and civic responsibilities, indigenous languages, usage and development. Negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation. Re-orientation strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption(WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents

Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing

computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the basic concept of sets, subsets, union, intersection, complements, venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. explain the various types of numbers; and
5. solve some problems using Binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, venn diagrams. Real numbers. Integers, rational and irrational numbers, mathematical induction, real sequences, and series. Theory of quadratic equations, binomial theorem. Complex numbers. Algebra of complex numbers. The Argand Diagram. De Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition, and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the different types of rules in differentiation and integration;
2. describe function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integral in areas and volumes.

Course Contents
Calculus. Function of a real variable, graphs, limits and idea of continuity. The derivative, as limit of rate of change. Techniques of differentiation. Extreme curve sketching. Integration as an inverse of differentiation. Methods of integration. Definite integrals. Application to areas, volumes.

PHY 101: General Physics I (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify and deduce the physical quantities and their units;

2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents

Space and time. Units and dimension. Vectors and Scalars. Differentiation of vectors: displacement, velocity and acceleration, kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). Relative motion. Application of Newtonian mechanics. Equations of motion. Conservation principles in physics. Conservative forces, conservation of linear momentum. Kinetic energy and work, Potential energy. System of particles. Centre of mass. Rotational motion. Torque, vector product, moment, rotation of coordinate axes and angular momentum. Polar coordinates. Conservation of angular momentum. Circular motion. Moments of inertia, gyroscopes and precession. Gravitation: Newton's Law of Gravitation. Kepler's Laws of Planetary Motion. Gravitational Potential Energy. Scape velocity, Satellites motion and orbits.

PHY 102: General Physics II (2 Units C: LH 30)

Learning Outcomes

On Completion, the Student should be able to;

1. describe the electric field and potential, and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;
5. describe electromagnetic induction and related concepts, and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters; and
8. determine the characteristics of ac voltages and currents in resistors, capacitors, and Inductors.

Course Contents

Forces in nature. Electrostatics, electric charge and its properties, methods of charging. Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators, current, voltage and resistance. Ohm's law and analysis of DC circuits. Magnetic fields, Lorentz force, Biot-Savart and Ampère's laws. Magnetic dipoles, Dielectrics, Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, resistance, and combinations.

PHY 105: General Practical Physics I **(1 Unit C: PH 45)**

Learning Outcomes
On Completion, the student should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasizes quantitative measurements. The treatment of measurement errors, and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc., covered in PHY 101 and PHY 102. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

PHY 106: General Practical Physics I **(1 Unit C: PH 45)**

Learning Outcomes
On Completion, the student should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This practical course is a continuation of PHY 105 and is intended to be taught during the second semester of the 100 level to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements, the treatment of measurement errors and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

CHM 101: General Chemistry I **(2 Units C: LH 30)**

Learning Outcomes
At the end of this course, the students should be able to:
After studying all materials and resources presented in the course, the student will be able to:
1. define atom, molecules and chemical reactions;
2. discuss the Modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. illustrate shapes of simple molecules and hybridized orbitals;

7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents

Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence Forces. Structure of solids. Chemical equations and stoichiometry. Chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry. rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:
1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reaction;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. describe basic properties of Transition metals.

Course Contents

Historical survey of the development and importance of Organic Chemistry. Fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures, nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The Chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify the differences between primary and secondary standards;
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents
Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify and carry out preliminary tests which includes ignition, boiling point, melting point, test on known and unknown organic compounds;
5. execute solubility tests on known and unknown organic compounds;
6. execute elemental tests on known and unknown compounds; and
7. conduct functional group/confirmatory test on known and unknown compounds which could be acidic / basic / neutral organic compounds;

Course Contents
Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

BIO 101: General Biology I: (2 Units C: LH 30)

Learning Outcomes
At the end of lectures, students should be able to:
1. explain cell structure and organizations;
2. summarize functions of cellular organelles;
3. characterize living organisms and state their general reproduction;
4. describe the interrelationship that exists between organisms;
5. discuss the concept of heredity and evolution; and
6. enumerate habitat types and their characteristics.

Course Contents
Cell structure and organization, functions of cellular organelles, characteristics and classification of living things, chromosomes, genes their relationships and importance, general reproduction, interrelationships of organisms (competitions, parasitism, predation, symbiosis, commensalisms, mutualism, saprophytism); heredity and evolution (introduction to Darwinism and Lamarkism, Mendelian laws, explanation of key genetic terms), elements of ecology and types of habitat.

BIO 102: General Biology II (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures, students should be able to:
1. List the characteristics, methods of identification and classification of Viruses, bacteria and fungi;
2. state the unique characteristics of plant and animal kingdoms;
3. describe ecological adaptations in the plant and animal kingdoms;
4. explain nutrition, respiration, excretion and reproduction in plants and animals; and
5. describe growth and development in plants and animals.

Course Contents
Basic characteristics, identification and classification of viruses, bacteria and fungi.
A generalized survey of the plant and animal kingdoms based mainly on the study of similarities and differences in the external features. Ecological adaptations. Briefs on physiology to include nutrition, respiration, circulatory systems, excretion, reproduction, growth and development.

BIO 103: General Biology Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of the lectures, students should be able to:
1. outline common laboratory hazards;
2. provide precautions on laboratory hazards;
3. state the functions of the different parts of microscope;
4. use the microscope and describe its maintenance;
5. draw biological diagrams and illustrations; and
6. apply scaling and proportion to biological diagrams.

Course Contents
Common laboratory hazards. prevention and first aid. measurements in biology. uses and care of microscope. compound and dissecting microscope. Biological drawings and illustration. scaling, accuracy and proportion. use of common laboratory apparatus and laboratory experiments designed to illustrate the topics covered in **BIO 101**

BIO 104: General Biology Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. describe the anatomy of flowering plants;
2. differentiate types of fruit and seeds;

3. state ways of handling and caring for biological wares;
4. describe the basic histology of animal tissues; and
5. identify various groups in the animal kingdom.

Course Contents
Anatomy of flowering plants, primary vegetative body. stem, leaf and root to show the mature tissues namely parenchyma, collenchyma, sclerenchyma, xylem and phloem. Types of fruits and seeds. Care and use of dissecting kits and other biological wares. Dissection and general histology of animal tissues based on vertebrate forms. Morphology and functions of epithelial, muscular, nervous and connective tissues. Examination of various groups of lower invertebrates under microscopes, identification of various groups of organisms in Animal Kingdom. Andany experiment designed to emphasize the practical aspects of topics in BIO 102.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk-taking
2. state the characteristics of an entrepreneur;

3. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents

Concept of entrepreneurship (entrepreneurship, intrapreneurship/corporate entrepreneurship,). Theories, rationale and relevance of entrepreneurship (Schumpeterian and other perspectives, risk-taking, necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of entrepreneurs (opportunity seeker, risk taker, natural and nurtured, problem solver and change agent, innovator and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking, and creative thinking). innovation (concept of innovation, dimensions of innovation, change and innovation, knowledge and innovation). enterprise formation, partnership and networking (basics of business plan, forms of business ownership, business registration and forming alliances and joint ventures). Contemporary entrepreneurship issues (knowledge, skills and technology, intellectual property, virtual office, networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, youth and women entrepreneurship, entrepreneurship support institutions, youth enterprise networks and environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

COS 201: Computer Programming I (3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of this course, students should be able to:

1. explain the principles of good programming and structured programming concepts;
2. explain the programming constructs, syntax and semantics of a higher-level language;
3. describe the chosen programming language variables, types, expressions, statements and assignment; simple input and output;
4. describe the programme control structures, functions and parameter passing, and structured decomposition; and
5. develop simple programmes in the taught programming language as well as debug and test them.

Course Contents

Introduction to computer programming. Functional programming; Declarative programming; Logic programming; Scripting languages. Introduction to object-orientation as a technique for modelling computation. structured, and even some level of functional programming principles; Introduction of a typical object-oriented language, such as Java; Basic data types, variables, expressions, assignment statements and operators; Basic object-oriented concepts: abstraction; objects; classes; methods; parameter passing; encapsulation. Class hierarchies and programme organisation using packages/namespaces; Use of API – use of iterators/enumerators, List, Stack, Queue from API; Searching; sorting; Recursive algorithms; Event-driven programming: event-handling methods; event propagation; exception handling. Introduction to Strings and string

processing; Simple I/O; control structures; Arrays; Simple recursive algorithms; inheritance; polymorphism.

Lab work: Programming assignments; design and implementation of simple algorithms, e.g., average, standard deviation, searching and sorting; Developing and tracing simple recursive algorithms. Inheritance and polymorphism.

MCB 221: General Microbiology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the basic concepts and scope of microbiology;
2. describe the layout of a microbiology laboratory, equipment and reagents in a microbiology laboratory; and
3. discuss the theory behind basic protocols in a microbiology laboratory

Course Contents
History of the Science of Microbiology. Classification of organisms into prokaryotes and eukaryotes, classification of prokaryotes into Archaea and eubacteria anatomy and cytochemistry of bacteria and fungi. Shapes, groupings and colonial morphology of bacteria and fungi. Structure of viruses. Sterilization and disinfection, structure, ecology and reproduction of representative microbial genera. Culture of micro-organisms. Isolation of micro-organisms, isolation of bacteria, viruses fungi (yeasts and moulds). Nutrition and biochemical activities of micro-organisms. Antigens and antibodies. Identification and economic importance of selected microbial groups. Microbial variation and heredity. Study of laboratory equipment. Introduction to microbiology of air food, milk, dairy products, water and soil. Staining techniques, antibiotic sensitivity tests, serological testsand antimicrobial agents.

STA 210: Statistics for Agricultural and Biological Sciences
(3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the scope for statistical methods in Biology and Agriculture;
2. define the measures of location, partition and dispersion;
3. explain the elements of probability, probability distributions: binomial, poison, geometric, hypergeometric, negative binomial and normal, student's t and chi-square distributions;
4. differentiate point from interval estimation and could be able to tests for hypotheses concerning population means, proportions and variances;
5. be able to compute for regression and correlation as well as conduct some non–parametric tests with reference to contingency table analysis; and
6. be able to explain the elements of design of experiments and Analysis of variance.

Course Contents
Scope for statistical method in Biology and Agriculture. Measures of location, partition and dispersion. Elements of probability. Probability distributions: binomial, Poisson, geometric, hypergeometric, negative binomial and normal, Student's t and chi-square distributions. Estimation (point and interval) and tests of hypotheses concerning population means, proportions

and variances. Regression and correlation. Non–parametric tests. Contingency table analysis. Introduction to design of experiments. Analysis of variance.

EMT 201: Introduction to Environmental Science (2 Units C: LH 30)

Learning Outcomes

At the end of this semester, students will be able to:

1. explain the principles of science and recognize their role in evaluating and a viable human society within earth's systems;
2. describe the basic ecological concepts and knowledge of the natural world;
3. recognise, describe and quantitatively describe earth systems, including the land, water, sea, atmosphere and how these functions collectively support life on earth;
4. describe the variation in ecosystems, their structure and function both internally and as part of the larger biosphere; and
5. explain human population characteristics and growth and recognize the impacts of human society on earth's systems and resources.

Course Contents

Application of physical and chemical principles, ecological concepts, and systems approach to policy analysis of atmospheric environments, freshwater and marine environments, land use, energy supplies and technology and other resources.

EMT 202: Methods in Environmental Analysis I (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students will be able to:

1. explain the fundamental concepts of environmental analysis, and be able to classify and prepare standard solution;
2. demonstrate an in-depth understanding of statistical analyses of data- Errors, Mean, Standard Deviation, Reliability of an average value (t – test), F – test, rejection of outliers (Q test and 4Q test). Analysis of variance (ANOVA);
3. explain some chemical analyses applicable to environmental studies such as Gravimetric analysis, Acid Base titrimetry, Non-Aqueous Titration etc; and
4. describe oxidation and reduction, balancing of redox reactions etc.

Course Contents

Review of fundamental concepts: What is environmental analysis. Importance of environmental analysis. Classification of units of concentration. Preparation of standard solutions. Statistical treatment of analytical data, accuracy, precision, errors, mean, standard deviation, reliability of an average value (t – test), F – test, rejection of outliers (Q test and 4Q test). Analysis of Variance (ANOVA). Sampling, Techniques, Graph plotting (Centroid method/Least square). Gravimetric analysis. Types – Evolution, Loss in Ignition, Gas absorption, Thermogravimetry, Electrogravimetry, Precipitation from Solution (Conditions for Analytical Precipitation, Digestion, Filtration, Handling of Precipitates, Co-precipitation), Calculations. Acid Base Titrimetry. Primary Standards, Indicators, Titration Curves, Application. Fundamental Principle of Calculation in titrimetry. Non-Aqueous Titration. Definition of (Arrhenius, Bronsted lowry, lewis, General Solvent), standards. Precipitation Titrimetry. Titration Curves, Indicators in precipitation titration (Mohrs, Volhard): Complexometric Titration. Types of Complexing agents, Important feature of

EDTA, Masking and Demasking, Complexometric Indicators, Titration methods with EDTA. Oxidation reduction: Titrimetry. Concept of oxidation & Reduction, Oxidation States, Balancing of Redox reactions. Standard electrode potentials. Relationship between Concentration and Potential End Point Detection (Self, Specific and True Oxidation. Red Indicators Application.

EMT 206: Introductory Geographic Information System (GIS)
(2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students will be able to:
1. explain the concept and components of GIS;
2. exhibit skills on data collection (both spatial and aspatial);
3. use GIS tools and software in analysis, storage and manipulation of GIS data; and
4. demonstrate knowledge on interpretation of remote sensing data – aerial photographs, satellite imageries etc

Course Contents
Survey of the development of geographical data collection procedures; exploration, land use survey, regional planning surveys, computer cartography, geographic coding, remote sensing.

BCH 201: General Biochemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures, students should be able to:
1. explain the structure of different macromolecules in biological system;
2. identify types of chemical reactions involving these macromolecules;
3. explain the various methods of isolation of these macromolecules;
4. estimate the effects of acids and alkalis on the macromolecules;
5. describe purification of macromolecules; and
6. discuss quantification of the various macromolecules.

Course Contents
Introductory chemistry of amino acids, their properties, reactions and biological functions. Classification of amino acids: neutral, basic and acidic, polar and non-polar, essential and non-essential amino acids. Peptides. Introductory chemistry and classification of proteins. Biological functions of proteins. Methods of their isolation, purification and identification. Primary, secondary, tertiary and quaternary structures of proteins. Basic principles of tests for proteins and amino acids. Introductory chemistry of carbohydrates, lipids and nucleic acids. Nomenclature of nucleosides and nucleotides, effects of acid and alkali on hydrolysis of nucleic acids.

BIO 202: Introductory Ecology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the lectures in this course, students should be able to:
1. explain various concepts and terminologies associated with the ecosystem;
2. list and explain features of various habitat types;
3. 3.explain natural destruction/disaster, community and natural cycles; and

4. explain and describe factors responsible for changes in population.

Course Contents
Concept and definition of ecosystem. ecology at community level. ecological classification of habitat types. terrestrial and aquatic biomass. specific features of each, biotic components of habitat. Natural destruction. factors of communities, success of community interaction. natural cycle and dynamics of population.

CHM 211: Organic Chemistry I (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe and solve problems in chemistry of aromatic compounds;
2. describe the structures of simple sugars, starch and cellulose, peptides and proteins and show the difference in their conformation structure;
3. describe and solve problems in chemistry of bifunctional compounds;
4. explain he mechanisms of substitution, elimination, addition and rearrangement reactions;
5. describe stereochemistry and its application;
6. describe condition and pathways of the following organic reactions - Grignard reaction, Aldol and related reactions; and
7. describe simple alicyclic carbon compounds and their synthesis.

Course Contents
Chemistry of aromatic compounds. Structures of simple sugars, starch and cellulose, peptides and proteins. Chemistry of bifunctional compounds. Energetics, kinetics and the investigation of reaction mechanisms. Mechanisms of substitution, elimination, addition and rearrangement reactions. Stereochemistry. Examples of various named organic reactions e.g. Grignard reaction, Aldol and related reactions. Simple alicyclic carbon compounds and their synthesis.

CHM 212: Inorganic Chemistry I (2 Units C: LH 15; PH 45)

Learning Outcomes
After completing the course, the students will be able to:
1. list the first-row transition elements and explain their characteristics and properties;
2. explain crystal field theory (CFT) and draw the diagram to illustrate with examples of coordination compounds;
3. state the advantages of CFT over other bonding theories;
4. discuss the comparative Chemistry of the following elements. (I) Ga, In, Tl (II). Ge, Sn, Pb (III). As, Sb, Bi (IV). Se, Te, Po;
5. define organometallic Chemistry;
6. give relevant examples with illustrations;
7. classify organometallic compounds with examples;
8. list the roles of metals in biochemical systems;
9. discuss the concepts of hard and soft acids and bases.
10. list examples of item 9 above;
11. explain oxidation and reduction reaction; and
12. illustrate the above (11) with appropriate reactions.

Course Contents
Chemistry of first row transition metals. Introduction to coordination chemistry including elementary treatment of crystal field theory. Comparative chemistry of the following elements: (a) Ga, In, TI, (b) Ge, Sn, Pb, (c) As, Sb, Bi (d) Se, Te, Po. Elementary introduction to organometallic chemistry. Role of metals in biochemical systems. Concepts of hard and soft acids and bases. Oxidation and reduction reactions.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents
Concepts of Peace, Conflict and Security in a multi-ethnic nation. Types and Theories of Conflicts: Ethnic, Religious, Economic, Geo-political Conflicts. Structural Conflict Theory, Realist Theory of Conflict, Frustration-Aggression Conflict Theory. Root causes of Conflict and Violence in Africa: Indigene and settlers Phenomenon. Boundaries/boarder disputes. Political disputes. Ethnic disputes and rivalries. Economic Inequalities. Social disputes. Nationalist Movements and Agitations, Selected Conflict Case Studies – Tiv-Junkun; Zango Kataf, Chieftaincy and Land disputes etc. Peace Building, Management of Conflicts and Security: Peace & Human Development. Approaches to Peace & Conflict Management --- (Religious, Government, Community Leaders etc.). Elements of Peace Studies and Conflict Resolution: Conflict dynamics assessment Scales: Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice. The Nigeria Legal System. Insurgency and Terrorism. Peace Mediation and Peace Keeping. Peace & Security Council (International, National and Local levels) Agents of Conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of International Organizations in Conflict Resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping. Media and Traditional Institutions in Peace Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis.

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning outcomes
At the end of this course, students, through case study and practical approaches, should be able to:
1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical

location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/Market research, Unutilised resources, Social and climate conditions and Technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (Venture capital, Equity finance, Micro finance, Personal savings, Small business investment organisations and Business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, Customer Acquisition & Retention, B2B, C2C and B2C models of e-commerce, First Mover Advantage, E-commerce business models and Successful E-Commerce Companies,). Small Business Management/Family Business: Leadership & Management, Basic book keeping, Nature of family business and Family Business Growth Model. Negotiation and Business communication (Strategy and tactics of negotiation/bargaining, Traditional and modern business communication methods). Opportunity Discovery Demonstrations (Business idea generation presentations, Business idea Contest, Brainstorming sessions, Idea pitching). Technological Solutions (The Concept of Market/Customer Solution, Customer Solution and Emerging Technologies, Business Applications of New Technologies - *Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy etc.* Digital Business and E-Commerce Strategies).

EMT 301: Principles of Natural Resources Management (2 Units C: LH 30)

Learning Outcomes

At the end of this semester, students will be able to :
1. explain natural resources and its concepts, resource management, its principles, types and importance;
2. illustrate the scope of environmental conservation, how to protect and converse the natural species; and
3. explain the principles of biodiversity, extinction and other natural resource management practices.

Course Contents

Natural resources types and origin, Environment resource and development, Rational use of resources and Concept of sustainable development. Management of forests, grazing, lands, soils, foods, minerals, etc. Community resource development, population and pressure on resource utilization. Administration and management of natural resource in Nigeria. Resource economics and management. Environmental conservation – Protection of nature and conservation of species. Conservation of agricultural landscape. Case studies concerned with concepts of balanced approach to natural resources management. Development of planning and management

principles of natural resources and ecosystem subject to increasing development processes. Convention on Biodiversity.

EMT 300: Environment, Ecosystems and Man (2 Units C: LH 30)

Learning Outcomes

At the end of this semester, students will be able to:

1. define and understand the terms "Population, community, ecosystem, environment and environmental factors", their characteristics, how it relates to each other;
2. explain population ecology, community ecology, and the interaction of species both inter & intra dependency;
3. have in-depth knowledge on the effect of man on the ecosystem and learn the required skills to manage anthropogenic impacts to yield a sustainable future for man-kind and planet at large; and
4. explain eco-development, integrated development and environmental planning principles.

Course Contents

Population, community, ecosystem, environment and environmental factors. Study of communities and ecosystem, abundance, density, yield, cover, frequency. The ecology of niche, overlap competition, coexistency, resource shift. Habitats: the primary terrestrial and aquatic habitats which affect man. Alteration imposed on the habitats by man. Integration of ecology and environment into development planning. Ecological management. Eco-development and integrated development. Environmental planning principles – inter-disciplinary not multidisciplinary, holistic, comprehensive, participative coordinated, integrated and continuous planning.

EMT 302: Hazardous Substances Management (2 Units C: LH 30)

Learning Outcomes

At the end of this semester, students will be able to:

1. explain the nature, origin and classification of waste and hazardous toxic substances, its characteristics;
2. enumerate skill sets in identifying, sourcing, sorting and disposal of hazardous and toxic substances;
3. describe the route of exposure, entry and accumulation in man and the environment; and
4. explain the principles and laws regulating the handling and practices of toxic substances locally and internationally.

Course Contents

The nature, origin, and classification of hazardous toxic substances. Characteristics of wastes and hazardous substances. Identification of hazardous substances. Sources and pathways of hazardous substances. Disposal methods and technology of hazardous substances. Geological environmental factors affecting choice of disposal site. Contamination of water bearing strata, soil, plants, food webs and bio-concentration. Analysis of hazardous and toxic substances. Regulations and law governing the sale, importation, transportation, storage and disposal of hazardous and toxic substances.

EMT 303 Metal and the Environment (2 Units C: LH 30)

Learning Outcomes
At the end of this semester, students will be able to:
1. describe environmental pollution as a result of discharge of metal pollutants in our environment;
2. explain the effects of metal pollutants in the environment; and
3. illustrate the techniques of analysing metals in environmental.

Course Contents
Origin of metals. Classification of metals. Utilisation of metals in industries. Sources of metal pollution. Geological weathering, industrial discharge. Metals - fabricating and furnishing, leaching of metals from garbage, agricultural waste products. Effect of metals on the environment - sediment, waste, air and food. Adverse effect of heavy metals – poisoning effects of Pb, Cd, Zn and Hg. Other effects e.g., neurological and renal effects. Analysis of metals in environmental samples.

EMT 305: Environmental Pollution Studies (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the semester, students will be able to:
1. define Agrochemicals and other toxicants – what they are and what are the risks they may pose;
2. identify the scenarios – where and when are man exposed;
3. recognise signs, symptoms and diseases that may be related to agrochemical and other toxicants exposure; and
4. identify how to prevent and treat pesticides exposure.

Course Contents
The environment and its interaction concept of elementary cycles. Characteristics of the atmosphere, types and effects of environmental pollution. Land pollution and methods of waste disposal. Air pollution and its effects on man, plants and materials. Water pollution and treatment of waste waters, nuclear pollution, noise pollution and global environmental problems, greenhouse effect, global warming, ozone layer depletion, nuclear winter, acid rain.

EMT 306: Environmental Aspects of Agro Chemicals and other Toxicants (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the semester, students will be able to:
1. define Agrochemicals and other toxicants – what they are and the risks they may pose;
2. identify the scenarios – where and when are man exposed;
3. recognise signs, symptoms and diseases that may be related to agrochemical and other toxicants exposure; and
4. recognise how to prevent and treat pesticides exposure.

Course Contents
Movement and absorption of pesticides in soil. Factors affecting mobility of pesticides and other toxicants in the soil. Soil-herbicide interaction and herbicide efficacy. Fumigant action and systematic activity. Pesticide conversion mechanisms in the environment. Enzymic and non-enzymic conversion, degradation of pesticides and other toxicants in soil, water, plants and in animals. Pesticides in food chains. Detection/determination and management of toxic wastes in the environment, sanitary fundamentals of pesticide application, safety measures in storage, dispensing, transportation and use of pesticides, disposal of pesticide containers and wastes, ecological and environmental health effects. Environmental criteria standards, regulations on pesticidal use. Case studies of global disasters of misuse and abuse of pesticides.

EMT 307: Remote Sensing Techniques (2 Units C: LH 15; PH 45)

Learning Outcomes
Students will acquire knowledge on various applications of remote sensing in surveying of natural resources and monitoring of land use.

Course Contents
Concept of remote sensing. The electromagnetic spectrum, imaging systems and their capabilities, remote sensing platforms, applications in natural resource surveys and monitoring land use.

400 Level

EMT 401: Environmental Monitoring Systems & Techniques
(2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the semester, students will be able to:
1. explain and practice many methods to be able to collect samples in their research and in their professions;
2. describe quality control, including documentation, calibration, and sample management; and
3. defend their data and base good decisions on measurements taken.

Course Contents
Definition, general principles of environmental monitoring. Organisation of monitoring programmes for site and resource specific strategies. Classification of monitoring techniques and use (physical, chemical, biological, radioactive). Global sources, sinks and transport (mass balance) of both man-made and natural atmospheric trace components, Ocean-atmosphere interactions, reversible effect of human activities on the global environment e.g., greenhouse effect, climate change, depletion of stratosphere ozone layer, acid rain. Air pollution meteorology, chemistry and biology. Atmosphere dispersion models. Elements of air pollution control. Sampling and air monitoring techniques. Mechanism of pollutant interaction with soil and vegetation. General principles of biotesting, aquatic toxicity, types, bioassays, data analysis and interpretation.

EMT 403: Water Analysis (1 Unit C: PH 5)

Learning Outcomes
After the semester, students should be able to:
1. explain water sampling techniques;
2. elucidate specific chemistry tests for water quality;
3. describe several factors that could affect water quality;
4. describe water as an environmental, economic and social resource;
5. explain how environmentalists help maintain water quality for health and recreation through monitoring and treatment; and
6. analyse, interpret, and report on laboratory and field findings using appropriate statistical techniques and computer applications.

Course Contents
Sampling and analysis of water for various biological and physicochemical water quality parameters: pH, hardness, alkalinity, chloride, phosphate, nature, ammonia, sulphate, sulphide, sulphite, faecal bacteria, etc. Determination of dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD) dissolved and suspended solids, conductivity, turbidity, temperature, saturation index, sodium adsorption ratio, etc.

EMT 405: Rural and Urban Regional Planning (2 Units C: LH 30)

Learning Outcomes
At the end of this semester, students will be able to:
1. explain the objectives, scope and content of regional planning;
2. exhibit indepth knowledge on the underlying concepts, models and theories of regional development;
3. effectively apply the policies and simple techniques of regional analysis in impacting the surrounding environment (Case study); and
4. explain the cost-benefit approach to project evaluation, growth pole strategies, social and economic overhead capitals, rural development programmes.

Course Contents
The objective, scope and content of regional planning. The underlying concepts, models and theories of regional development. Policies, simple techniques of regional analysis. Cost-benefit approach to project evaluation, growth pole strategies, social and economic overhead capitals, rural development programmes.

EMT 407: Environmental Education and Awareness (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students will be able to:
1. Effectively carry out citizen-research and community surveys;
2. Disseminate information accordingly to different population size, and target groups; and
3. Gather the skills in community entry and mobilization.

Course Contents
Population and environment (responsible use). Role of educational intervention in environmental action. Methods of dissemination of environmental information. Case studies of information to

various target groups. Methods of public opinion assessment. Social theory for environmental psychology, ecological, psychology theory of participation. Social response to environmental-pollution, environmental damage and compensation.

EMT 499: Industrial Attachment (6 Units C: 24weeks)

Learning Outcomes
At the end of this semester, students will be exposed to practical, field, and industrial experiences.

Course Contents
Students should be attached to relevant organisations for 24 weeks for appropriate hands-on practical experience. Students should be assessed based on seminar presentations, written reports, and supervisors' assessments.

500 Level

EMT 501: Environmental Law (2 Units C: LH 30)

Learning Outcomes
At the end of this semester, students will be:
1. introduced to the concepts of environmental laws, standards and regulations;
2. abreast with both federal and state laws including regulations and edicts, knowing the procedures involved in promulgating a law, act, etc.;
3. exposed to regulation enactments, enforcement, violations and sanctions; and
4. knowledgeable about the local and international laws, conventions guiding the planet and adopting practicable ones.

Course Contents
Basic concepts of environmental standard criteria and regulation. Federal environmental laws on environment protection. State edicts and regulations on the environment, plant and animal quarantine. Regulations and enforcement mechanisms. Violations and sanctions. Comparative study of environmental laws in some advanced countries. e.g., USA, Canada, etc. International laws and conventions.

EMT 502: Waste Management and Control (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of this semester, students will be able to:
1. explain the types, sources and forms of waste;
2. practice and set up methods of solid, liquid and gaseous waste management technology such wastes recycling and utilisation; and
3. profitably make wealth out of waste.

Course Contents
Types and forms of wastes. Sources of waste. Methods of solid, liquid and gaseous waste management technology including wastes recycling and utilisation. Institutional arrangements for waste management. Environmental health effects of waste management. Economics of waste management. Waste management strategies. Case studies.

EMT 503: Ecological Disasters and Control (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this semester, students will be able to:
1. explain natural hazards and their management;
2. describe emergency responses and role of key players;
3. discuss ecological consequences of natural resource mismanagement; and
4. explain erosion, hurricane, land slide, earthquakes, mud Slide, tsunamis and tornadoes.

Course Contents
Ecological consequences of mismanagement of natural resources. Origin and causes of erosion. Erosion forecasting. Surface water management. Soil hydrology. Soil water movement. Drainage, leaching and water disposal. Economics and benefits of erosion control. Mechanics of erosion. Types and forms of erosion. Evapo-transportation. Erosion/flood control measures, engineering and administrative measures.

EMT 504: Human Settlement and Development (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this semester, students will be able to:
1. describe factors influencing location, landscape designs, parks and reserves;
2. explain the principles of environmental injustice, Rural, urban land use and environmental quality; and
3. highlight the impacts of human settlement and development on the environment.

Course Contents
Human settlements, size and density, factors influencing location, landscape designs, parks and reserves. Rural, urban land use and environmental quality. Culture and environment: patterns, health and safety. Environmental ethics, impact of human settlement and development on the environment. Case studies: examples of significant human settlements and developments, projects and their environmental impacts.

EMT 506: Natural Ressources Conservation & Environnemental Management (2 Units C: LH 30)

Learning Outcomes
At the end of this semester, students will be able to:
1. utilize the knowledge gained from this course on conservation and its application to the society, identify local and international issues on natural resources over-exploitation;
2. guide the society on the ecological implication of threatened and endangered species; and
3. train others on the most appropriate ecologically sustainable plans for conservation of the natural resources around us.

Course Contents
Natural resources, concepts and definitions. Natural resources exploitation. Environmental and or ecological implications of threatened/endangered natural resources. Sustainable use and conservation of natural resources.

EMT 507: Seminar **(2 Units C: PH 90)**

Course Contents
The purpose of this course is to familiarize the students with effective use of the library, preparation of project reports, papers for journal publication and journal reviews. Students should be given essays on topics of general interest from different areas of environmental management.

EMT 511: Principles of Analysis of Toxicants **(2 Units C; LH 15; PH 45)**

Learning Outcomes
At the end of the course, students will:
1. have an advance knowledge on toxicology, where emphasis would be laid on fate and effects of different types and classes of toxicants such as pesticides, metals, radiation and radioactive materials, plant and animal toxins, polyhalogenated compounds, hazardous wastes, dusts, asbestos, plastics, etc.;
2. gather skills applicable in Hazard analyses and Critical Control Points such as impacts of food additives studies, cosmetics/drugs toxicity and their residual effects; and
3. know about regulation and setting of standards of the aforementioned toxicants.

Course Contents
Types, nature and characteristics of toxicants, sampling of air, soil, water and other ecological materials particularly using a sampler at different flow rates and other modern methods. Sample preservation and preparation techniques. Samples collection techniques of air, soil, water, food, blood etc. Analytical methods for toxicants. Activation analysis. Atomic absorption spectrophotometer UV/Visible spectrophotometer. Gas chromatograph hybrid methods e.g., GC/Mass spectrometer. Auto-analyzer chemical separation methods. Gas analyzers. Quality assurance of analytical data. Statistical treatment of data. Interpretation of data.

EMT 516: Principles of Toxicology **(2 Units C: LH 15; PH 45)**

L**earning Outcomes**
At the end of this course, students will be able to:
1. demonstrate knowledge on toxicology, where emphasis would be laid on fate and effects of different types and classes of toxicants such as pesticides, metals, radiation and radioactive materials, plant and animal toxins, polyhalogenated compounds, hazardous wastes, dusts, asbestos, plastics, etc.;
2. exhibit skills applicable in Hazard analyses and Critical Control Points such as impacts of food additives studies, cosmetics/drugs toxicity and their residual effects; and
3. describe regulation and setting of standards of the aforementioned toxicants.

Course Contents
Sources, fate and effects of different toxicants in the environment. Pesticides, metals, radiation and radioactive materials, plant and animal toxins, polyhalogenated compounds, hazardous wastes, dusts, asbestos, plastics. Factors that influence toxicity, route of administration, chemical and biological factors. Environmental toxicology, food additives and contaminants, atmospheric, aquatic and soil pollutants. Clinical toxicology, cosmetics and drugs, occupational toxicology and health. Autoradiography. Toxicity testing. Future of toxicology in the developing countries i.e., regulatory and legal requirements.

EMT 522: Environmental and Community Health (2 Units C: LH 30)

Learning Outcomes
At the end of this semester, students will be able to:
1. impart relevant knowledge needed for promotion and sustenance of the health and safety of man in his environment;
2. demonstrate the knowledge of prevailing communicable diseases, their mode of transmission and methods of controlling the biological and physical environment so as to prevent them; and
3. explain the basic knowledge of physical, sociological and biological theories, concepts, principles and their applications in the practice of environmental health.

Course Contents
This course will expose students to what health really means. The effect of man's domestic, industrial, and other productive activities on human health and family. It also elaborates on acceptable ameliorative measures to maintain environmental health, applying recent health models and theories.

EMT 599: Research Project (6 Units C: PH 270)
Investigation of environmental problems.

Minimum Academic Standards

Equipment

1. Rotary microtome specimen size:55x55mm, Universal cassette clamp for standard cassette.
2. Freezing microtome portable and affordable, the H/I freezing microtome is designed for use with any model cryo-Histomat. Knife angle adjustable through 10 degrees.
3. Incubator, carbolite peak range 80°c—120
4. Monocular microscope
5. Thermostatic water bath grant JB aqua range.
6. WildM691 multipurpose or binocular microscope, manual XY movement, halogen,power zoom and focus
7. Orbital shaker
8. pH meter / DO meter
9. UV/Visible Spectrophotometer
10. Water bath
11. Weighing balance (analogue)
12. Weighing balance (digital)
13. Ranging pole
14. Magnetic stirrer with hot plate
15. Hot air oven
16. Herbarium cabinet
17. Plant press
18. GPS

19. Fume cupboard
20. Colorimeter
21. Colony counter
22. Compass
23. Clinometer
24. Centrifuge
25. Autoclave
26. Increment borer
27. Girth tape

Staffing

Academic Staff

The Staff-student ratio of the department should be 1:20 as approved by NUC. There should be a minimum of six (6) academic staff comprising of Biologist, Chemist, Geologist, Zoologist, and Botanist with Ph.D degrees accounting for at least 70% of the total number and having adequate experience. The staff should cover the various cadres in the ratio 3:2:1 or 45:35:20 (Professors: Senior Lecturers: Lecturer 1 and below respectively)

Administrative support staff

The services of the administrative support staff are indispensable in the proper administration of the department. It is important to recruit very competent, computer literate senior staff.
The department should have at least

1. A secretary to each Head of Department,
2. A secretary to every two professors
3. A senior typist/Data management officer,
4. One typist to 4 lecturers,
5. One clerical officer,
6. One driver,
7. Office assistant/cleaners.

Technical support personnel

The services of technical support staff, which are indispensable in the proper running of laboratories and workshops, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.
There should be adequate number of qualified technical staff in the various cadres listed below, with a minimum of school certificate and National Diploma in Science Laboratory Technology or its equivalent:

1. Chief Technologist
2. Assistant Chief Technologist
3. Senior Technologist
4. Technologist I
5. Technologist II
6. There should also be adequate number of Laboratory Assistants with a minimum of school certificate.

Library
Universities should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition well stock and current hardcopies of reference and other textual materials should be provided centrally at the level of the faculty. A well network digital library should serve the entire university community. Availability of wireless facilities (Wifi) with adequate bandwidth should enhance access to these electronic resources.
In any case, there should be internet-ready workstations available in the library for at least 25% of the total students enrolled in each academic programme. The funding of the library should be in line with NUC guidelines.

Classrooms, Laboratories, Workshops and Office Space
The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

B. Sc. Forensic Science

Overview
Forensic science is defined as the application of scientific methods and processes in solving crime, both civil and criminal. During the course of an investigation, forensic scientists collect, preserve, and analyze scientific evidence. Physical evidence is collected from an object, person or crime scene, analyzed in a forensic laboratory and then the results presented in court. Each crime scene is unique and each case presents its own challenges.

The study of forensic science is grounded in fundamental concepts and techniques gathered from the natural sciences. The study involves a multi-disciplinary approach, largely covering biological methods and analytical chemistry techniques. Forensic science is, indeed, a multi-disciplinary and broad field, covering an array of sub-disciplines.

Philosophy
The Philosophy of Forensic Science Programme is to programme is to prepare graduates with necessary skills and knowledge to examine and analyse evidence from crime scenes, and/or suspects to develop findings that can assist crime investigation and prosecution.

Objectives
The principal objectives of the programme are:
1. students will develop a thorough understanding of modern scientific principles of crime scene investigation, particularly evidence collection and preservation;
2. students will receive intensive training in forensic laboratory methodology so as to examine and analyse evidences.
3. students will develop effective written and oral communication skills for presentation of their findings in the court of law;
4. students will develop and appreciate the importance of interaction between law and enforcement agents, scientists and legal professionals;
5. students will develop and appreciate the importance of a high sense of professionalism and ethical behaviour; and
6. students will acquire advanced knowledge through research studies.

Unique Features of the Programme
Forensic Science is unique in the following respects:
1. applies the methods and techniques of all the established sciences to legal matters;
2. uses unique investigative techniques in the evaluation of samples taken at crime scenes; and
3. addresses issues associated with the law.

Employability Skills
1. Analytical Chemist
2. Arson & Fire Investigator
3. Ballistics Expert
4. Blood Spatter Analyst
5. Biomedical Scientist
6. Crime Scene Investigator
7. Crime Lab Analyst

8. Crime Scene Photographer
9. Computer Forensic Investigator
10. Detective
11. Digital Forensic Analyst/Officer
12. Fingerprint Analyst
13. Forensic Accountant
14. Forensic Anthropologist
15. Forensic Artist
16. Forensic Ballistics Analyst
17. Forensic Hypnotist
18. Forensic Investigator
19. Forensic Odontologist
20. Forensic Pathologist
21. Forensic Serologist
22. Forensic Scientist
23. Forensic Psychologist
24. Forensic Toxicologist
25. Latent Print Examiner
26. Mobile Forensic Analyst

21st Century Skills

1. Critical thinking (quantitative reasoning and problem solving)
2. Computer proficiency
3. Observation and attention to details
4. Interpersonal skills
5. Public speaking
6. Oral and written presentation

Admission and Graduation Requirements

Admission Requirements

Candidates can be admitted into the B. Sc. Forensic Science degree programme by one of the following two ways:

1. Indirect Entry
2. Direct Entry (DE)

Indirect Entry Mode

The minimum academic requirement is credit level passes at Senior Secondary Certificate (SSC) in English Language, Mathematics, Biology, Chemistry and Physics at not more than two sittings. In addition, an acceptable pass in the following Unified Tertiary Matriculation Examination (UTME) subjects is also required for admission into 100 Level: English, Biology, Chemistry and Physics.

Direct Entry Mode

Candidates seeking admission into B. Sc. Forensic Science programme through Direct Entry must have two passes at GCE 'A' Level/IJMB or its equivalent in Biology, Chemistry or Physics to be considered for admission into 200 Level.

Graduation Requirements

To qualify for the award of B.Sc. Forensic Science degree, a student must satisfy the following requirements:

- pass a minimum of 120 Units (for UTME candidates) and 90 Units (for DE candidates) including all compulsory courses.

Global Course Structure

100 Level

Course Code	Course Title	Units	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	
COS 101	Introduction to Computing Science	3	C	30	45
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
FRS 102	Introductory Forensic Science	2	C	30	-
	Total	**13**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
CYB 201	Fundamentals of Cyber Security I	1	C	15	-
FRS 201	Footwear and Tire Track Examination	2	C	30	-
FRS 203	Forensic Audio and Video Analysis	2	C	30	-
FRS 205	Forensic Entomology	2	C	30	-
LAW 211	Criminal Law for Forensic Scientists	2	C	30	-
PSY 215	Forensic Psychology	2	C	30	-
CYB 202	Fundamentals of Cyber Security II	2	C	30	-
FRS 202	Crime Scene Investigation	2	C	30	-
FRS 204	Trace Evidence	2	C	30	-
FRS 206	Forensic Microbiology	2	C	30	-
LAW 212	Introduction to Criminal Justice Administration	2	C	30	-
	Total	**25**			

300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
FRS 301	Introduction to Forensic Serology	2	C	30	-
FRS 303	Forensic Practical I	1	C	-	45

Course Code	Course Title	Unit(s)	Status	LH	PH
FRS 307	Research Methodology	3	C	45	-
FRS 308	Forensic Practical II	1	C	-	45
FRS 302	Fingerprint	2	C	30	-
FRS 305	Forensic Odontology	2	C	30	-
FRS 306	Forensic Toxicology	2	C	30	-
FRS 399	SIWES	3	C	-	12 weeks
	Total	**20**			

400 Level

Course Code	Course Title	Units	Status	LH	PH
FRS 401	Introduction to Questioned Documents	2	C	30	-
FRS 402	Forensic Pathology	2	C	30	-
FRS403	Forensic Ballistics	3	C	45	-
FRS 404	DNA Fingerprinting	2	C	30	-
FRS 405	Forensic Practical III	2	C	-	90
FRS 406	Forensic Practical IV	2	C	-	90
FRS 404	Forensic Anthropology	2	C	30	-
FRS409	Applied Forensic Physics	2	C	30	-
FRS 410	Entrepreneurship for Forensic Scientists	2	C	30	-
FRS 499	Final Year Research Project	6	C	-	270
	Total	**25**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. identify possible sound patterns in English Language;
2. list notable Language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English Language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and usage

(tense, mood, modality and concord, aspects of language use in everyday life). Logical and critical thinking and reasoning methods (logic and syllogism, inductive and deductive argument and reasoning methods, analogy, generalisation and explanations). Ethical considerations, copyright rules and infringements. Writing activities: (pre-writing , writing, post writing, editing and proofreading; brainstorming, outlining, paragraphing. Types of writing: summary, essays, letter, curriculum vitae, report writing, note making etc. Mechanics of writing). Comprehension strategies: (reading and types of reading, comprehension skills, 3RsQ). Information and Communication Technology in modern language learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112- Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of trade, economic and self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian state towards nation building
6. analyse the role of the Judiciary in upholding people's fundamental rights
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification. Judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation; Re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption (WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the basic concept of sets, subsets, union, intersection, complements, venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. explain the various types of numbers; and
5. solve some problems using Binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers; integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers; algebra of complex numbers; the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration.
2. describe the meaning of function of a real variable, graphs, limits and continuity.
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Functions of a real variable, graphs, limits and idea of continuity. The derivative, as limit of rate of change. Techniques of differentiation, maxima and minima. Extreme curve sketching, integration, definite integrals, reduction formulae, application to areas, volumes (including approximate integration: Trapezium and Simpson's rule).

FRS 102: Introductory Forensic Science (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. demonstrate knowledge and understanding of the historical developments that gave birth to forensic science, emphasizing facts and time lines of events;
2. describe the scope and branches of forensic science;
3. explain legal and medical aspects of forensic science, including documentation and court presentations;
4. describe basic analytical techniques used in forensic science; and
5. describe the procedures used for detection, preservation, classification and analysis of fingerprints.

Course Contents
Historical development of Forensic Science. Scopes/ areas in Forensic Science. Medical and legal aspects of forensic science. Analytical techniques in forensic science. Documentation and court presentation. Fingerprint: detecting and preservation of developed finger prints from crime scene, patterns/classification of finger prints and analysis of finger prints.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;

7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents
Concept of entrepreneurship (entrepreneurship, intrapreneurship/corporate entrepreneurship,). Theories, rationale and relevance of entrepreneurship (Schumpeterian and other perspectives, risk-taking, necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of entrepreneurs (opportunity seeker, risk taker, natural and nurtured, problem solver and change agent, innovator and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking, and creative thinking). Innovation (concept of innovation, dimensions of innovation, change and innovation, knowledge and innovation). Enterprise formation, partnership and networking (basics of business Plan, forms of business ownership, business registration and forming alliances and joint ventures). Contemporary entrepreneurship issues (knowledge, skills and technology, intellectual property, virtual office, networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, youth and women entrepreneurship, entrepreneurship support institutions, youth enterprise networks and environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

CYB 201: Fundamentals of Cyber Security I (1 Unit C: LH 15)

Learning outcomes
At the end of the course, students are expected to be able to:
1. demonstrate knowledge and understanding of basic concepts of cyber security, including confidentiality, integrity and availability;
2. describe the methodologies for implementing security policies, global best practices risk management, disaster recovery and access control; and
3. explain basic cryptography and software application vulnerabilities.

Course Contents
Topics include basic concepts on CIA (Confidentiality, Integrity, and Availability). methodologies for implementing security policies. best current practices, testing security, and incident response. risk management. disaster recovery. access control. basic cryptography and software application vulnerabilities.

FRS 201: Footwear and Tire Track Examination (2 Units C: LH 30)

Learning Outcomes
On successful completion of the course, students should be able to:
1. demonstrate knowledge and understanding of different types of footwear and tire track evidence examined in forensic investigation;
2. explain the procedures used in collection of footwear and tire track evidence;
3. compare footwear and tire track evidence to known impressions, impressions connected to other crimes and evidence stored in databases; and
4. recognize and interpret different types of imprint and impression characteristics, including but not limited to, class, individual and wear characteristics.

Course Contents
Types of footwear and tire track evidence examined in forensics. Procedure of sample collection (adhesive lifter, gelatin lifter, electrostatic dust printing, etc.). Evidence detection, recovery, and handling procedure. Laboratory and photography procedure. Courtroom testimony and legal issues, casework. Comparison of collected evidence to known impressions, impressions connected to other crimes and evidence stored in databases' Imprints and impression characteristics (class, individual and wear characteristics). Uses of footwear and tire track examination

FRS 203: Forensic Audio and Video Analysis (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students are expected to:
1. explain the meaning of forensic audio and video analysis;
2. describe the different types of audio and video evidence relevant to forensic investigation;
3. collect, repair and recover audio and video evidence for forensic investigation;
4. enhance audio and video evidence to assist investigators, jurors and attorneys;
5. analyse, interpret and identify audio and video recordings;
6. identify people and objects on recordings; and,
7. use audio and video recordings in legal matters.

Course Contents
Meaning of forensic audio analysis and forensic video analysis. Types of audio and video evidence. Collection of audio and video evidence for forensic analysis. Repair and recovery of audio and video evidence for forensic investigations. Audio and video evidence enhancement techniques used to assist investigators, jurors and attorneys. Analysis, interpretation and identification of audio and video recordings (authentication of recordings, Identifying people and objects on recordings). Uses of audio and video recordings in legal matters

FRS 205: Forensic Entomology (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the meaning and historical development of forensic entomology;
2. demonstrate knowledge and understanding of the various stages of decomposition of a human corpse;
3. recognize and identify major arthropods involved with post-mortem changes in a carrion;
4. estimate post-mortem index (PMI) of a corpse; and
5. demonstrate an understanding of the techniques of forensic entomology, including DNA analysis, scanning electron microscopy and potassium permanganate staining.

Course Contents
Meaning and historical development of forensic entomology. Stages in the decomposition of a carrion. Arthropods involved with post-mortem changes of the human body. Collecting, preserving and packaging specimens. Estimating post-mortem index (PMI). DNA analysis for species identification. Scanning electron microscopy and potassium permanganate staining. Applications of forensic entomology. Limitations of forensic entomology.

LAW 211: Criminal Law for Forensic Scientists (2 Units C: LH 30)

Learning Outcomes
On completion of the course, it is expected that students should be able to:
1. demonstrate knowledge and understanding of essential elements of evidence law, witness testimony and requirements for establishing offences;
2. state and describe homicide and non-fatal offenses;
3. explain history and structure of police force and nature of police administration; and,
4. demonstrate knowledge and understanding of juvenile delinquency, drug abuse, provisions of Motor Vehicle Act 1 and Provisions of Nigerian Penal Code.

Course Contents
Elements of evidence law. Expert Witness Testimony. Ingredients of establishing offences. Specific offenses relating to homicide and non-fatal offenses. Police: history and structure. Police administration. Juvenile delinquency. Drug abuse. Relevant provisions of Motor Vehicle Act, 1 (offenses and penalties). Relevant provisions of Nigerian Penal Code.

PSY 215: Forensic Psychology (2 Units C: LH 30)

Learning Outcomes
At the end of the course, it is expected that students should be able to:
1. demonstrate knowledge and understanding of meaning and scope of forensic psychology;
2. describe the techniques and processes of forensic investigations, the art of identification of incidence as well as psychological approaches to interrogations and confessions using psychological skills;
3. explain the impact of crime, delinquency and psychopathic behaviours on society;
4. construct the personality profile of criminals; and,
5. describe the role of psychologists in the criminal justice system, mental health of the offender and mental health legislations.

Course Contents
The concept and scope of forensic psychology, techniques and processes of forensic investigations, art of identification of incidence, psychological approaches to interrogations and confessions using psychological skills; crime and delinquency, psychopathic behaviours and society, juvenile offender, social and psychological implications of legal judgements; crime culture and prevention, the reliability of eye witness testimony, construction of the personality profile of criminals; role of psychologists in the criminal justice system (court room), the mental health of the offender and mental health legislation.

CYB 202: Fundamental of Cyber Security II (2 Units C: LH 30)

Learning Outcomes
After completion of the course, a student should be able to:
1. describe basic operating system protection mechanisms, intrusion detection systems and formal models of security;
2. explain the meaning of steganography, network and distributed system security, denial of service attack strategies, viruses and worms; and,
3. demonstrate knowledge and understanding of transfer of funds, electronic voting, homeland cyber security policy, secure applications and government regulations of information technology.

Course Contents
Operating system protection mechanisms. Intrusion detection systems. Formal models of security. Cryptography. Steganography. Network and distributed system security. Denial of service (and other) attack strategies, worms, viruses. Transfer of funds/value across networks. Electronic voting. Secure applications. Homeland cyber security policy, and government regulation of information technology.

FRS 202: Crime Scene Investigation (3 Units C: LH 45)

Learning outcomes
Students who took the course should be able to:
1. define and explain different types of crime scenes;

2. describe crime scene management procedures and roles of forensic scientists and other stake holders in maintaining chain of custody as well as securing, protecting and recording crime scene;
3. demonstrate knowledge and understanding of the procedures for collection, packaging and preservation of physical evidence from crime scenes;
4. sketch indoor and outdoor crime scenes using baseline and triangulation methods;
5. analyse different types of fibre, paint and soil samples; and,
6. collect and handle toxicological, fire crime scene and hit-and-run crime scene samples.

Course Contents

Crime Scene: definition and types of crime scene (primary and secondary crime scenes); general crime scene procedures: crime scene management; role of forensic scientists, forensic doctors, fire brigade and judiciary, maintaining the chain of custody; securing, protecting and recording the crime scene: forensic photography, sketching and field notes; definition, importance and types of physical evidences; collection and preservation of physical evidences, and forwarding to the forensic laboratory in crimes like murder, theft, extortion, explosion etc.; investigation and sketching of indoor and outdoor scenes of crime using triangulation method and baseline method; collection and packaging of different types of evidences; collection and handling of toxicological, hit and run crime scene and fire crime scene samples; analysis of different types fibres; examination of soil and paints samples

FRS 204: Trace Evidence (3 Units C: LH 45)

Learning Outcomes

At completion of the course, students are expected to be able to:

1. collect and measure physical properties (such as weight, density, temperature and refractive index) of physical evidences like glass, soil, fibres, hair and liquids;
2. collect, preserve and forensically analyse soil samples by determining their colour, particle size, colour and chemical composition;
3. use different analytical techniques to determine chemical composition, pigmentation distribution, and other properties of different types of paints;
4. collect, preserve, classify, compare and identify natural and synthetic fibres; and,
5. separate different types of dyes by Thin Layer Chromatography (TLC) and Column Chromatographic (CC) techniques.

Course Contents

Physical properties of evidence (temperature, weight, density and refractive index). Physical evidence like soil, glass, fiber, hair and liquids. Forensic examination of glass: composition of glass, measuring and comparing physical properties of glass. Classification of glass samples. Comparison of glass fragments and fractures. Collection and preservation of glass evidence. Forensic analysis and examination of soil– colour, density, size distribution of particles, mineral and chemical analysis of soil. Variations in soil, collection and preservation of soil evidence. Types of paints and their composition, macroscopic and microscopic studies, pigment distribution, micro-chemical analysis- solubility test and other necessary analytical techniques helping in the interpretation of paint evidence. Fibers: classification of fibers and preliminary examination. Identification and comparison of manufactured fibres, significance of match. Collection and

preservation of fiber evidence. Antigen-antibody reaction (blood groupings). Studying the morphology of different plant parts. Study of conducting tissue- Xylem and phloem elements in angiosperms and gymnosperms as seen in L.S. and R.L.S.. Study of fungal colonies by using PDA culture. Separation of dyes by TLC and paper chromatographic techniques.

FRS 206: Forensic Microbiology (2 Units C: LH 30)

Learning Outcomes
At the completion of the course, students should be able to:
1. define and explain the scope of forensic microbiology, bioterrorism, agro-terrorism and biological warfare;
2. demonstrate knowledge and understanding of types of samples, sample collection techniques and sample matrix analysis for forensic microbiology purposes;
3. demonstrate knowledge of techniques used in identifying causative biological agents of bioterrorism, agro-terrorism and biological warfare; and,
4. explain the applications of forensic microbiology.

Course Contents
Definition and scope of forensic microbiology. Bboterrorism, agro-terrorism and biological warfare. Types of samples collected. Sample collection. Sample matrix analysis. Water sample analysis. DNA profiling. Techniques used in elucidating causative biological agents. Investigating a suspected bioterrorist attack. Postmortem microbiology (PMM) analysis. Applications of forensic microbiology.

LAW 212: Introduction to Criminal Justice Administration (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. define and explain criminal justice;
2. describe aspects of the procedure and practice of the criminal process;
3. demonstrate knowledge and understanding of concepts and principles underlying criminal law; and,
4. demonstrate knowledge and understanding of the crime picture, criminal law, causes of crime, the legal environment, etc.

Course Contents
Definition of criminal justice. Aspects of the procedure and practice of the criminal process. Concepts and principles underlying criminal law; The crime picture; causes of crime; Criminal law; the legal environment; the court: the courtroom workgroup; Sentencing; Probation and parole; Prisons; The future of criminal justice

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict and security;

2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and,
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents

Concepts of Peace, Conflict and Security in a multi-ethnic nation. Types and Theories of Conflicts: Ethnic, Religious, Economic, Geo-political Conflicts; Structural Conflict Theory, Realist Theory of Conflict, Frustration-Aggression Conflict Theory. Root causes of Conflict and Violence in Africa: Indigene and settlers Phenomenon; Boundaries/boarder disputes; Political disputes; Ethnic disputes and rivalries; Economic Inequalities; Social disputes; Nationalist Movements and Agitations; Selected Conflict Case Studies – Tiv-Junkun; Zango Kataf, Chieftaincy and Land disputes etc. Peace Building, Management of Conflicts and Security: Peace & Human Development. Approaches to Peace & Conflict Management --- (Religious, Government, Community Leaders etc.). Elements of Peace Studies and Conflict Resolution: Conflict dynamics assessment Scales: Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice; The Nigeria Legal System. Insurgency and Terrorism. Peace Mediation and Peace Keeping. Peace & Security Council (International, National and Local levels) Agents of Conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of International Organizations in Conflict Resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping. Media and Traditional Institutions in Peace Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students, through case study and practical approaches, should be able to:

1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity Identification (sources of business opportunities in Nigeria, environmental scanning, demand and supply gap/unmet needs/market gaps/market research, unutilised resources, social and climate conditions and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (Venture capital, equity finance, micro

finance, personal savings, small business investment organizations and business plan competition). Entrepreneurial marketing and e-commerce (principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first mover advantage, E-commerce business models and successful E-Commerce companies,). Small business management/family business: leadership & management, basic book keeping, nature of family business and family business growth model. Negotiation and business communication (strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological solutions (the concept of market/customer solution, customer solution and emerging technologies, business applications of new technologies - Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy etc. Digital Business and E-Commerce Strategies).

FRS 301: Introduction to Forensic Serology (2 Units C: LH 30)

Learning Outcomes

Students who took the course are expected to be able to:

1. describe blood, blood components and their uses;
2. explain how to identify bloodstains by microscopic methods;
3. analyze blood by catalytic, crystal, spectrophotometric, chromatographic and immunological methods;
4. demonstrate knowledge and understanding of composition and forensic uses of body fluid such as semen, saliva, urine, sweat and vaginal secretion;
5. examine and interpret bloodstains on objects such as clothing, furniture and footwear;
6. document, photograph and interpret bloodstain patterns.

Course Contents

Blood: The nature of blood, blood components and their functions, identification of bloodstains by microscopic methods. Tests used in blood analysis: catalytic and crystal tests. ABO, Rh and MN systems. Use of spectrophotometric, chromatographic and immunological methods in blood analysis. Determination of species of origin, Ring test, single diffusion, double diffusion, crossed-over electrophoresis. Grouping of blood stains: techniques for the determination of blood groups from bloodstains. Composition and examination of biological fluids such as saliva, semen, vaginal fluid, urine and sweat. Protection, packaging & transportation of biological evidences. Bloodstain pattern interpretation: Properties of human blood, target surface considerations, size, shape and directionality of bloodstains, spattered blood, other bloodstain patterns, interpretation of bloodstain on clothing and footwear. Documentation and photography for bloodstain pattern analysis. Preservation of blood evidence; procedures and precautions

FRS 303: Forensic Practical I (1 Unit C: PH 45)

Learning Outcomes

At the end of the course, students would be able to:

1. determine blood group from fresh and old blood stains;
2. perform catalytic and crystal tests for blood;
3. determine species of origin of blood samples;
4. perform bloodstain pattern analysis;

5. analyse various biological fluids, including urine, saliva, sweat and semen;
6. examine and identify diatoms, pollen grains and spores of forensic significance;
7. study life cycle of blowflies;
8. examine and identify different types of hair samples.

Course Contents

Blood Group analysis from fresh and old blood stains. Catalytic and crystal tests for blood. Determination of species of origin; Blood stain pattern analysis. Analysis of biological fluids (semen, saliva, sweat, urine). Photography of bite marks and skid marks. Preparation of permanent slides by using maceration technique of various forensic materials of plant origin. Study of pollen grains and spores of forensic significance. Identification of pollen grains and diatoms. Study of life cycle of blowflies. Study of structure of hair; Finding results of different logic gates and their combinations; Working with Windows – File (creation, modification, deletion, attributes), Folder (creation, nesting, attributes). Working with Linux – File (creation, modification, deletion, attributes), Various commands on Linux (basic utility commands e.g. Date Viva-Voce, Cal etc.). Obtaining the system and process information (Windows)

FRS 304 - Forensic Anthropology (2 Units C: LH 30)

Learning Outcomes

Upon successful completion of the course, students should be able to:
1. describe meaning and historical development of forensic anthropology;
2. describe different types of evidence examined in forensic anthropology;
3. explain the uses of forensic anthropology in determination of sex, stature, age, ancestry and time of death; and,
4. explain molecular analysis of skeletal evidence, biomechanics of bone trauma, bone microscopy, isotope analysis as well as facial imaging and forensic facial reconstruction.

Course Contents

Meaning and historical overview of forensic anthropology; Types of evidence examined (single bone or bone fragment and complete or nearly complete skeleton); Modern uses of Forensic Anthropology; Determination of sex; Determination of stature; Determination of age; Determination of ancestry; Determination of time of death; Recent advances in forensic anthropology: molecular analysis of skeletal evidence, biomechanics of bone trauma; Bone microscopy; isotope analysis; facial imaging and forensic facial reconstruction

FRS 308: Forensic Practical II (1 Units C: PH 45)

Learning Outcomes

Upon completion of the course, students are expected to be able to:
1. make fingerprints on fingerprint cards and identify the pattern;
2. develop fingerprints by powder and chemical methods;
3. lift and identify latent fingerprints and shoe prints;
4. analyse metallic, vegetable, volatile and non-volatile poisons;
5. separate components of insecticides, barbiturates and other drugs by thin layer chromatography (TLC);
6. determine age from skull sutures and teeth;

7. estimate height and weight using long bones; and,
8. determine sex of deceased persons from skull and pelvis.

Course Contents
Making of fingerprints on fingerprint cards and identifying the pattern. Development of fingerprints using powder and chemical methods. Classification of fingerprints. Lifting and identification of latent fingerprints. Lifting and identification of footprints and shoe prints. Analysis of metallic poisons; Analysis of volatile and non-volatile poisons. TLC of insecticides, Barbiturates and other drugs. Analysis of vegetable poisons. Estimation of height and weight using long bones. Determination of age from skull sutures and teeth. Determination of sex from skull and pelvis.

FRS 302: Fingerprint (2 Units C: LH 30)

Learning Outcomes
Upon successful completion of the course, students should be able to:
1. describe historical development, classification and principles of fingerprint analysis;
2. demonstrate knowledge and understanding of collection, preservation of fingerprints, counting and tracing ridges, general and individual characteristics of fingerprints;
3. describe various methods of development of fingerprints and other impressions, including conventional, physical, chemical, fluorescent, fuming, magnetic powder and laser methods;
4. describe methods of restoration of erased marks;
5. explain how to take latent fingerprints by lifting technique;
6. explain how to take fingerprints from living and dead persons;
7. present fingerprints and other impressions as evidences in court.

Course Contents
Fingerprinting: History and Development of fingerprints. Classification of fingerprints by the Henry System. Extension of Henry system, Single digit classification, Fingerprint Bureau. Principles of fingerprints, importance, nature and location. Fingerprints as evidence: its recognition, collection and preservation. Biological significance of skin pattern, ridge formation, counting and tracing. Important figures in the field of fingerprints, fingerprint patterns, general and individual characteristics of fingerprints. Fingerprints and other impressions: taking fingerprints from living and dead persons. Other Impressions: Tyre marks, tool marks (compression marks, striated marks, combination of compression and striated marks, repeated marks), lip prints and foot print examinations. Latent fingerprint and chance fingerprints in criminal investigation, investigating latent fingerprints, Various methods of development of fingerprints and other impression marks: conventional, physical and chemical, fluorescent, magnetic powder, fuming, laser methods. Lifting of latent fingerprints. Restoration of erased/obliterated marks*:* Method of making cast, punch, engrave, obliteration, restoration, etching (etchings for different metals), magnetic, electrolytic etc. Recording of restored marks – restoration of marks on wood, leather and polymer. Presentation of fingerprints and other impressions as evidences in court.

FRS 305 - Forensic Odontology (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students are expected to be able to:
1. describe meaning, historical development and uses of forensic odontology;

2. explain species determination by DNA analysis, collection of teeth specimens, age estimation by examination of developmental and degenerative changes, sex determination by craniofacial morphology and dimensions, sex differences in tooth dimension;
3. classify bite marks; and,
4. describe cheiloscopy and its forensic value.

Course Contents

Definition and history of forensic odontology. Uses of forensic odontology. Methods and applications of forensic odontology. Identification of unknown remains: positive identification, possible identification, insufficient evidence, and exclusion. Determination of species by DNA analysis: collection of specimens, reference samples, saliva, teeth and storage. Age estimation by examination of developmental and degenerative changes. Sex determination by cranofacial morphology and dimensions, sex differences in tooth dimension, tooth morphology and DNA analysis. Bite mark analysis: classification of bite marks – haemorrhage, abrasion, contusion, laceration, incision, avulsion and artefact. Drawbacks of bite mark analysis; lip print analysis (cheiloscopy).

FRS 306: Forensic Toxicology (2 Units C: LH 30)

Learning Outcomes

At the end of the course, the students should be able to:

1. describe different types of poisons, including metallic poisons, volatile poisons, insecticides, animal poisons and vegetative poisons as well as poison factors influencing their action;
2. describe the samples required for toxicological analyses and the methods of collection and preservation;
3. explain the different analytical methods and procedures used for detection, isolation and estimation of poisons and toxins;
4. describe proper procedure for documentation of laboratory test results and report preparation; and,
5. describe the role of forensic toxicologist as an expert witness.

Course Contents

Metallic Poisons:- arsenic, mercury, bismuth, lead (nature, administration, symptoms, post-mortem findings, detection and medico-legal aspects). Insecticides:- organophosphorus compounds, organochlorine compounds and carbamates (nature, administration, symptoms, post-mortem findings, isolation, detection, estimation and medico-legal aspects). Volatile poisons:- methyl alcohol, ethyl alcohol, chloroform, and acetone (nature, administration, symptoms, post-mortem findings, isolation, detection, and estimation, medico-legal aspects). Toxicology of alcohol:- introduction, definition of alcohol and illicit liquor. Proof spirit, absorption, detoxication and excretions of alcohol. Problems in alcohol cases and difficulties in diagnosis. Breath test instruments, field sobriety testing, analysis of blood for alcohol. Cases of drunken driving. Analytical techniques in the analysis of alcohol. Miscellaneous Poisons:- *animal poisons*: snake, scorpions and other insects. Vegetable Poisons: opium, datura, oleander, madar, abrus precarious, castor, cannabis, nux vomica, cyanide, etc. (nature, administration, symptoms, post-mortem findings, isolation, detection and medico-legal aspects).

FRS 399: Industrial Training (12 weeks) (3 Units C: PH 135)
Student's industrial work experience of 6 months' duration. Students' reports will be presented in a seminar.

Learning Outcomes
After completing the industrial training, students are expected to:
1. acquire and practice practical skills at a work place;
2. operate advanced equipment that are not ordinarily available in university-based laboratories; and,
3. develop positive work attitudes and ethics.

400 Level

FRS 401: Introduction to Questioned Documents (2 Units C: LH 30)

Learning Outcomes
On completion of the course, students are expected to be able to:
1. demonstrate knowledge and understanding of meaning, types, nature, problems and importance of questioned documents;
2. describe location, collection procedure, handling and presentation of questioned documents;
3. examine and determine alterations, erasures, overwriting, additions and obliterations on questioned documents;
4. demonstrate knowledge and understanding of detection methods such as detection and deciphering of indented writing, charred documents and invisible/secret writing;
5. describe composition of major types of ink, ink analysis and ink dating;
6. identify and compare typescripts;
7. determine physical characteristics of paper, water mark, fiber composition and perform trace elemental analysis;
8. demonstrate knowledge and understanding of principle of handwriting, individual and class characteristics, and physical factors affecting handwriting; and,
9. identify authentic, forged, disguised and traced signatures and describe factors affecting the signature of individuals.

Course Contents
Questioned Documents: definition, types, importance, nature and problems. Location, collection, handling and presentation of documents. Adequacy of examples and standards. Examination of alterations, erasures, overwriting, additions and obliterations. Methods of Detection: detection and deciphering of indented writing, charred documents, invisible/secret writing. Ink examination: composition of major types (carbon ink, fountain pen ink, ballpoint pen ink, rolling ball marker inks, fibre or porous tips pen ink). Analysis of writing inks and ink dating; Analysis of documents: pencil lead examination and age of the documents. Identification and comparison of typescripts. Paper analysis: physical characteristic, water mark examination, fibre analysis, chemical and trace elemental analysis. Equipment required: camera, microscope, reference standards, TLC and HPLC. Handwriting and signature: identification, principle of handwriting, individual and class handwriting characteristics. External, internal and physical characteristics affecting the

handwriting; Signatures: authentic, forged, disguised and traced signatures and their characteristics. Factors affecting the signature of individuals.

FRS 402: Forensic Pathology (2 Units C: LH 30)

Learning Outcomes

At the completion of this course, students should be able to:

1. demonstrate knowledge and understanding of global medical jurisprudence and Nigerian laws related to death investigations;
2. recognize and interpret documentary evidence, such as medical certificates, medical reports and death declaration;
3. describe basic forensic pathology terms for estimation of post-mortem interval;
4. recognize and interpret early and intermediate changes following death;
5. describe the ways in which disease and trauma affect the body; and,
6. identify and document proof, including scars, dentures, professional marks, fingerprints, skeletal remains, etc.

Course Contents

Introduction: global medical jurisprudence, legal procedure in Nigeria: -police, magistrate's and coroner's inquests. Oath and affirmation. Documentary evidence: -medical certificates, medical reports, death declaration. Understanding laws and ethics of medical practice. Death: - medico-legal aspects of death. Diagnosis of death-somatic and molecular. Early and intermediate changes following death. Late changes after death-putrefaction, autolysis, bacterial action, factors affecting these changes. Determination of time since death, including histopathological methods. Post-mortem examination: - ante- and post – mortem examinations; external and internal examination; collection, preservation and packaging of viscera. Role of a Forensic pathologist. Wounds: definition, types and identification. Medico–legal aspects of wounds. Determining the age of the injury, ante–mortem, post–mortem injuries; abrasions, grazes, lacerations, Bruises and contusion. Punctured wounds and incised wounds – causes, dimensions, ante – mortem, post – mortem analysis and its medico-legal aspects. Difference between suicidal, homicidal and accidental wounds. Wound/Terminal Ballistics: - introduction, injuries and the quantity of energy of projectiles. Shock wave and cavitation effect. Wounding mechanism, Elements of wound Ballistics. Nature of target, velocity of projectile, constructional features of projectile. Contact, point blank, near, chips and distant ranges. Penetration of shots in different regions of the body. Personal Identification: importance and need for personal identification, cases that will require personal identification. Documents proof: scars, professional marks, personal articles, finger printings, dentures, sketches and photographs, skeletal remains. Identification in mass disasters, mutilated remains and decomposed bodies.

FRS 403: Forensic Ballistics (3 Units C: LH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. demonstrate knowledge and understanding of history, nature, parts and classification of firearms, weapon types and their operations;

2. demonstrate knowledge and understanding of history and components of ammunitions, propellants, non-toxic shots, primary compounds and primers; and head stamp markings on ammunitions;
3. describe different types ballistics and their forensic significance;
4. describe velocity and theory of recoil, ballistic coefficient, barrel pressure measurements, and angle elevation of the barrel;
5. reconstruct sequence of events in a shooting case; and,
6. present evidence on use of ballistics in court.

Course Contents

Firearms: introduction, brief history of fire arms, weapon types and their operations, proof marks. Ammunition: a brief history, components, non-toxic shots, propellants, priming compounds and primers, head stamp marking on ammunition. Bullet comparisons, cartridge case examination, class and individual characteristics of identification. Firearms: nature, parts and classification. Uses of standard firearms data bases and automated search systems (DRUGFIRE and IBIS). Ballistics: definition and forensic importance. Types of ballistics: internal, external and terminal ballistics. velocity and theory of recoil, barrel pressure measurement, ballistic coefficient, angle of elevation of the barrel. Range of fire. Muzzle pattern, scorching, blackening, tattooing, wad distribution, pellet patterns, GSR analysis, and primer residues. Reconstruction of the sequence of events in a shooting case. Presentation of evidence in the court. Ricochet: critical angle for ricochet for the bullet and the surface, relationship between the angle of incidence and ricochet, stability in flight after ricochet, and Lethal effects of ricochet bullet.

FRS 404: DNA Fingerprinting (2 Units C: LH 30)

Learning Outcomes

On successful completion of the course, students should be able to:
1. describe the concept and practical applications of DNA fingerprinting;
2. demonstrate knowledge and understanding of the principles behind DNA fingerprinting methodologies currently in use, including but not limited to VNTR, STR, PCR, SNPs, RFLP, Y-STR and mitochondrial DNA (mDNA) analysis;
3. describe the genetic techniques currently used for forensic human identification purposes;
4. describe and source data from DNA databases; and,
5. demonstrate an understanding of how DNA fingerprinting results can be used in the Nigerian legal system.

Course Contents

DNA fingerprinting: definition, importance in Forensic Science. Collection and types of evidences for DNA fingerprinting. Genetic basis of DNA Fingerprinting. Chromosomes, DNA, Nuclear DNA and Mitochondrial DNA. Techniques of DNA fingerprinting; Isolation, performing southern blots, making radioactive probe, Hybridization reaction, visualization, VNTR, HLA-DQα, STRs, RFLP. Types of DNA fingerprinting: Single locus DNA and multi–locus DNA fingerprinting. Mini satellite, micro-satellite, FTA cards for isolation of DNA. Polymerase chain reaction: instrumentation, principle, significance in forensic case samples. Denaturation, annealing and extension. Detection of PCR products. Practical application of DNA fingerprinting: Paternity and maternity testing,

personal identification, criminal identification etc.. DNA databank; limitations of DNA fingerprinting; legality of DNA fingerprinting in Nigeria.

FRS 405: Forensic Practical III (2 Units C: PH 90)

Learning outcomes
Upon successful completion of the course, students should be able to:
1. examine and identify fraudulent documents;
2. write scientific reports;
3. identify invisible writing, indented writing individual characteristics in handwriting;
4. perform TLC on different ink samples;
5. perform quantitative analyses using spectrophotometer, calorimeter; and,
6. separate proteins and nucleic acids by electrophoresis.

Course Contents
Examination and detection of fraudulent documents; Scientific report writing. Identification of indented writing, invisible writing, class and individual characteristics in handwriting. TLC of different ink samples. Photography of documents. Quantitative analysis using Colorimeter and Spectrophotometer. Immuno-diffusion technique. Electrophoretic separation of proteins

FRS 406: Forensic Practical IV (2 Units C: PH 90)

Learning Outcomes
On successful completion of the course, students should be able to:
1. perform spot test for explosives;
2. compare and differentiate bullets;
3. study various parts of firearms including barrel, stock, calibre and choke;
4. perform electrophoresis on blood, blood proteins and enzymes;
5. identify bite marks; and,
6. pay visit for autopsy.

Course Contents
Spot test for explosives. Comparison of bullets. Chemical analysis of explosive materials (e.g., gun powder)-Colour test and microscopic examination. Study of various parts of the firearms: - barrel, stock, calibre, choke etc. Electrophoresis of blood, blood proteins and enzymes. Isolation of DNA. Examination of personal identification marks. Visit for autopsy. Identification of bite marks.

FRS 407: Research Methodology (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the concept of research in science in general, and in forensic science in particular;
2. describe scientific social science and behaviour science methods;

3. demonstrate knowledge and understanding of experimental and non-experimental research design, tools of data collection, observation, questionnaires, interview schedules and case study methods; and,
4. demonstrate knowledge and understanding of simple correlation methods, graphical representation of data, and elements of descriptive statistics such as measures of central tendency and dispersion.

Course Contents

Introduction to Research Methodology: definition, concept and research in science and forensic science; Scientific, social science and behaviour science methods. Experimental research and non– experimental research design. Tools of data collection; observation, questionnaires, interview schedules and case study methods. Introduction to statistics: parametric and non-parametric statistics. Descriptive Statistics: measures of central tendency and dispersion. Graphical representation of the data and simple correlation methods.

FRS 409: Applied Forensic Physics (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students will be able to:

1. demonstrate knowledge and understanding of aspects of Physics of speech, including production of sound, amplitude vibration, sine waves, simple harmonic motion and physical properties of vibrating systems;
2. describe modes of vibration and its significance in voice identification;
3. learn the causes and investigation of vehicular accidents;
4. demonstrate knowledge and understanding of aspects of automobile accidents, including sources of information, eye witnesses' accounts, tire and other marks, speed and damage, time and distance, reaction time, pedestrian impacts and vehicle condition;
5. demonstrate knowledge and understanding of elements of forensic photography such as types of cameras and films, digital photo imaging, Exposure Index, ISO number, photo imaging evidence, surveillance photography, aerial photography and methods for developing photographs; and,
6. describe legal aspects of visual evidence, photography of fingerprints, impressions and tool marks.

Course Contents

Physics of Speech: generation of sound, amplitude vibration, simple harmonic motion, sine waves, physical properties of vibrating systems. Propagation of sound and standing waves, modes of vibration and its significance in voice identification. Causes and investigation of vehicular accidents: automobile accidents-introduction, sources of information, eyewitnesses, tire and other marks, pedestrian impacts and vehicle condition, speed and damage. Curved scuffmarks, time and distance, reaction time. Photography and plans. Forensic photography: introduction, types of cameras and films, digital photo imaging, ISO number, exposure index, photo imaging evidence. Angle, scale, depth of field, light, ambient light, colour, temperature, flash/ strobe. Surveillance photography and aerial photography and accessories. Methods for developing photographs: high-speed photography, legal aspects of visual evidence; image magnification, photography of fingerprints, impressions, tool marks and restored latent prints and impressions.

FRS 410: Entrepreneurship for Forensic Scientists (2 Units C: LH 30)

Learning Outcomes

On successful completion of the course, students are expected to:

1. explain the meaning, scope and purpose of management;
2. describe who is a manager and the concept of management in profit and non-profit organisations;
3. demonstrate a knowledge and understanding of the foundation of entrepreneurship and how a forensic scientist can become an entrepreneur; and,
4. describe the corporate innovation of entrepreneurship and how a forensic scientist can discover business opportunities within the realm of entrepreneurship.

Course Contents

Definitions, nature and concepts of management (meaning of management; Scope of management; Purpose of management; who is a manager? Concepts of management in profit and non-profit organisations). Foundation of entrepreneurship; who is an entrepreneur? How can a forensic scientist become an entrepreneur The corporate innovation on entrepreneurs; discovering business opportunity.

FRS 499: Final Year Student's Research Project (6 Units C: PH 270)

Each final year B. Sc. Forensic Science student must carry out an independent research project on selected areas of interest under the supervision of an academic staff and present findings before internal and external examiners.

Minimum Academic Standards

Equipment

S/No.	Description	Quantity
1.	Magnetic stirrer hotplate, 160 x 160mm	6
2.	Polarimeter	3
3.	Incubator	2
4.	Centrifuge	2
5.	Fume hood	1
6	-20^{0}C Freezer	1
7.	-86^{0}C Freezer	1
8.	Vortex mixer	3
9.	Microfuge	2
10.	Electrophoresis machine	2
11.	Real Time PCR (RT-PCR) machine	1
12.	Gel documentation system	1
13.	LC-MS machine	1
14.	CCD camera	1
16.	Rotary evaporator	1
17.	LED light source	1
18.	X-ray spectrometer	1
19.	DART^{TM} Mass spectrometry machine	1
20.	Polarized light microscope	2
21.	Fluorescence microscope	1
22.	Scanning Electron Microscope (SEM)	1
23.	Transmission Electron Microscope (TEM)	1
24.	Stereomicroscope	2
25.	Compound microscope	2
26.	Binocular microscope	2
27.	Simple light microscope	4
28.	Sonicator	1
29.	Fridges	2
30.	Digital balance	2
31.	Automated microtone	2
32.	Autoclave	2
33.	Minigel apparatus	2
34.	Nano drop UV visible spectrophotometer	1
35.	Class II biosafety cabinet	1
36.	Magnetic stirrer	2
37.	UV transilluminator	1
38.	Thermal cyler	1
39.	Water bath	2
40.	Hor air oven	2
41.	Lyophilizer	1
42.	Orbital shaker	1
43.	Spectrophotometer, double beam	3
44.	Set of FUME cupboard, bench mounted	3

45.	Balance, electronic, top loading	3
46.	Balance, analytical	5
47.	Conductivity meter	5
48.	soxhlet extractor apparatus	15
50.	Thermometer, -30 to 360 °C	200
51.	Deioniser, analyst 40	3
52.	pH meter, bench	20
53.	Hanna portable pH/ORP meter	50
54.	Digital melting point apparatus	5
55.	Calorimeter	6
56.	GC/Spectrometer	1
57.	HPLC	2
58.	FT-IR spectrometer	2
59.	AA spectrophotometer	2
60.	High temperature muffle furnace	5
61.	Lab Companion vacuum oven	1
62.	Gravity convection oven	1
63.	Digital laboratory thermostatic water bath	4
64.	UV lamp	3
65.	NMR spectrometer	1
66.	Ultra pure water machine	1
67.	Switches	1
68.	Routers	1
69.	Computer systems	100
70.	Printers	2
71.	Scanners	2
72.	Solar inverters power back up	2
73.	VSAT	
74.	Trouble shooting tools (scraping tools)	
75.	Network cables (fiber optics, Cat 6, Coaxial)	
76.	Software tools (JAVA programme language, Visual studio)	
77.	Network simulator (packet tracer)	
78.	Smart and fingerprint machines	
79.	Card reader	
80.	Forensic software tools for computer systems Autopsy (digital forensic platform); Os Forensics (for forensic imagery); EPRG; Forensic Recovery of Evidence Device (FRED), Encase	
81.	Portable/Mobile forensic Kits (Ducumentation Form, evidence bag, tag and label)	
82.	Digital video camera	2
83.	3D – scanner	2
84.	Loupe	5
85.	Callipers	5
86.	Sound filters	2

87.	CCTV camera	5
88.	Digital video recorder (embedded and stand-alone)	2
89.	Digital video recorder (PC –based)	1
90.	Analogue video recorder	2
91.	Spectrum analyzer	2
92.	QEMSCAN	2
93.	Vacutainer	50
94.	Tweezers	50
95.	Harris micro-punch	2
96.	Electrostatic Detection Apparatus (ESDA)	2
97.	Video Spectral Comparator (VSC)	2

Staffing

Academic staff
The guidelines on academic staff/student ratio of 1:20 for science programmes shall apply.
To start any programme in science, there should be a minimum of six academic staff. There is need to have a reasonable number of staff with PhD degrees accounting for at least 70% of the total number and having adequate teaching experience for every programme in the discipline.

Administrative support staff
The services of the administrative support staff are indispensable in the proper administration of departments and faculty offices. It is important to recruit very competent, computer literate senior staff.

Technical support personnel
The services of technical support staff, which are indispensable in the proper running of laboratories and workshops, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular trainings to keep them abreast of developments in equipment operation and maintenance.

Library
Universities should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition, well stock and current hardcopies of reference and other textual materials should be provided centrally at the level of the faculty. A well network digital library should serve the entire university community. Availability of wireless facilities (Wifi) with adequate bandwidth should enhance access to these electronic resources.
In any case, there should be internet-ready workstations available in the library for at least 25% of the total students enrolled in each academic programme. The funding of the library should be in line with NUC guidelines.

Classrooms, Laboratories, Workshops and Office Space
The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

B. Sc. Geology

Overview
Geology programme is designed to enable students acquire broad based knowledge of the Earth in respect of its internal driving forces and external processes and the consequences of the processes. Specifically, students are expected to learn about the rocks, minerals, fossils and how they are formed.

The first 2 years of the programme is packed with learning of the basic geological principles, geological history and characteristics of the rocks and minerals. These aspects of learning are made possible through fundamental scientific principles of Physics, Chemistry, Biology, Mathematics, Computer Science which are embedded within the first two years of course structure.

Students are given intensive field geological mapping training which is the most practical aspect of the programme in the last phase of the degree programme and the most engaging independent research project in an applied Geosciences during the last two years of the programme. The field work and geological excursion through major Precambrian rocks and Cretaceous sequences in Nigeria provide opportunities for students hands-on experience on managing geological data, geological map preparation and report writing. Also in the last phase, particularly the final year, students are exposed to learn specialised skills in the area of petroleum geology, groundwater geology, mineral prospecting and mining and engineering geology. Another key component of the programme is industrial attachment and geosciences-based entrepreneurship skill acquisition which prepare students for job marketability and self-employment as the case may be.

Philosophy
The philosophy of the Geology programme is to provide broad based education in resource exploration, as well as expertise in solving various environmental, groundwater, energy (oil and gas) and engineering geological-related problems.

Objectives
The objectives of the degree programme in Geology are to:
1. instil in students a sense of enthusiasm for Geology, an appreciation of its principle, application, and relevance in providing solution for different societal developmental problems, and to involve them in an intellectually stimulating and satisfying experience of learning and studying;
2. provide students with a broad and balanced foundation of geological knowledge and practical skills;
3. develop in students the ability to apply their geological knowledge and skills to the solution of theoretical and practical problems in geology;
4. develop in students, a range of transferable skills and attitudes that are of value in geological and non-geological employment;
5. provide students with the knowledge and skills base from which they can proceed to further studies in specialized areas of geology or cognate multi-disciplinary areas; and
6. inculcate in students an appreciation and application of Geology in an industrial, economic, environmental, technological and social development.

Unique Features of the Programme

The unique features of the programme include:

1. more practical hours are conducted using field, laboratory, and relevant digital technologies;
2. emphasize on field trips to geological sequences, younger granites, metasediments and migmatite/gneiss complexes, Cretaceous sequences basement/sedimentary basin margins locations in various parts of Nigeria, thus exposing students to a wide aspects of geology;
3. independent student research projects allow students to explore topics of interest in great depth, and with the guidance of a competent supervisor; and
4. geosciences based entrepreneurship skills for the students and the industrial attachment which provides hands-on experience on industrial workflow and ethics thereby enhancing employability

Employability Skills

1. Geology graduates acquired a wide variety of skills applicable to water exploration and production, oil and gas exploration and production, solid mineral exploration and extraction, and investigation of earth materials that serves as foundation for civil constructions such as dam, tarmac, highways, and pipelines.
2. Students are also skilled at pollution management, environmental impact assessment and geological surveying and consultancy. They are able to bid for jobs, deliver the jobs and write reports.

21st Century Skills

1. Communication
2. Critical Thinking
3. Collaboration
4. Creativity
5. Innovation
6. Technology literacy
7. Flexibility
8. Innovation

Admission and Graduation Requirements

Admission Requirements

The entry requirements shall be at least credit level passes in five subjects including English Language, Mathematics, Physics and Chemistry to form the core subjects with additional credit in any other one relevant science subject, at the Senior Secondary Certificate (SSC) or its equivalent. In addition, an acceptable pass in the Unified Tertiary Matriculation Examination (UTME) is required for admission into 100 level for a four-year degree programme. UTME subjects are: English, Chemistry, Physics, and Biology or Mathematics.

Candidates who fulfil the requirements above and who have obtained at least two 'A' level passes at the GCE Advanced Level in two relevant subjects (Chemistry, Mathematics or Physics) may be admitted into 200 level to undertake the three – year degree programme.

Graduation Requirements
To be eligible for graduation, UTME students must obtain a minimum of 120 credits and direct entry students must obtain a minimum of 90 credits.

Global Course Structure

100 Level

Course Code	Course Title	Units	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
GEY 101	Introduction to Geology I	2	C	15	45
GEY 102	Introduction to Geology II	2	C	15	45
	Total	**15**			

200 Level

Course Code	Course Title	Units	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	
ENT 211	Entrepreneurship and Innovation	2	C	15	45
GEY 202	Crystallography and Systematic Mineralogy	2	C	15	45
GEY 203	Introduction to Petrology	2	C	15	45
GEY 205	Invertebrate Palaeontology	2	C	15	45
GEY 207	Principles of Stratigraphy	2	C	30	-
GEY 209	Introduction to Surveying	3	C	15	90
GEY 210	Introduction to Structural Geology and Geological Map Interpretation	2	C	15	45

Course Code	Course Title	Units	Status	LH	PH
GEY 212	Introduction to Field Mapping	2	C		90
	Total	**19**			

300 Level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
GEY 301	Geochronology & Precambrian Geology of Africa	2	C	30	-
GEY 305	Sedimentary Depositional Environments and Basins of Africa	2	C	30	-
GEY 308	Principles of Geophysics	2	C	30	-
GEY 310	Independent Geological Mapping	3	C	-	90
GEY 312	Photogeology and Remote Sensing	3	C	30	45
GEY 313	Structural Geology	3	C	30	45
GEY 315	Geochemistry	2	C	15	45
GEY 399	Industrial Attachment	3	C		
	Total	**24**			

400 Level

Course Code	Course Title	Units	Status	LH	PH
GEY 404	Economic Geology	2	C	30	
GEY 406	Micropalaeontology and Palynology	3	C	30	45
GEY 408	Petroleum Geology	2	C	30	-

Course Code	Course Title	Units	Status	LH	PH
GEY 409	Applied Geophysics	3	C	30	45
GEY 410	Engineering Geology	2	C	30	-
GEY 411	Hydrogeology	2	C	30	-
GEY 414	Entrepreneurship in Geosciences	3	C	30	45
GEY 415	Geology of Nigeria	2	C	-	90
GEY 416	Seminar in Geology	1	C	-	45
GEY 417	Project in Geology	6	C	-	270
	Total	**26**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. identify possible sound patterns in English Language;
2. list notable Language skills;
3. demonstrate an appreciable level of the art of public speaking and listening; and
4. write simple and technical reports.

Course Contents
Sound patterns in English Language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and Deductive Argument and Reasoning Methods, Analogy, Generalisation and Explanations). Ethical considerations, Copyright Rules and Infringements. Writing Activities: (Pre-writing , Writing, Post writing, Editing and Proofreading; Brainstorming, outlining, Paragraphing, Types of writing, Summary, Essays, Letter, Curriculum Vitae, Report writing, Note making etc. Mechanics of writing). Comprehension Strategies: (Reading and types of Reading, Comprehension Skills, 3RsQ). Information and Communication Technology in modern Language Learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of Trade, Economic and Self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building;
6. analyse the role of the Judiciary in upholding people's fundamental rights;
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification. Judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation; Re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption(WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. explain basic definition of set, subsets, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers, integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers, algebra of complex numbers, the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative as limit of rate of change. Techniques of differentiation. Extreme curve sketching. Integration as an inverse of differentiation. Methods of integration. Definite integrals. Application to areas, volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

GEY 101: Introduction to Geology (2 Units C: LH 15; PH 45)

Learning Outcomes
Students should be able to:
1. describe the structure and composition of the earth;
2. identify the major minerals and rocks; and
3. recognise and explain driving forces within the earth and the manifestations.

Course Contents
Elements of physical geology and physiographic features of the Earth. The solar system. Origin and characteristics of the atmosphere and hydrosphere. Classification, properties and description of major minerals, rock types and occurrence of economic minerals. History of the Earth and Universe. Earth internal structure. Plate tectonics and earthquakes.

GEY 102: Introduction to Geology II (2 Units C: LH 15; PH 45)

Learning Outcomes
At the completion of the course, students should be able to:
1. describe how fossils are formed;
2. state the uses of fossils in geological studies;
3. define and explain key ancient geological events; and
4. discuss the evolution of organism.

Course Contents
Theory of evolution of organism. Major uses of fossils in geology. Distribution and classification of major fossil groups and their occurrence and uses. Principles of historical geology, and stratigraphy. Concepts of paleoclimates, paleogeography, palaeoceanography, palaeomagnetism and paleoenvironment.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa, and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents
Concept of Entrepreneurship (Entrepreneurship, Intrapreneurship/Corporate Entrepreneurship,). Theories, Rationale and relevance of Entrepreneurship (Schumpeterian and other perspectives, Risk-Taking, Necessity and opportunity-based entrepreneurship and Creative destruction). Characteristics of Entrepreneurs (Opportunity seeker, Risk taker, Natural and Nurtured, Problem solver and change agent, Innovator and creative thinker). Entrepreneurial thinking (Critical thinking, Reflective thinking, and Creative thinking). Innovation (Concept of innovation, Dimensions of innovation, Change and innovation, Knowledge and innovation). Enterprise formation, partnership and networking (Basics of Business Plan, Forms of business ownership, Business registration and Forming alliances and join ventures). Contemporary Entrepreneurship Issues (Knowledge, Skills and Technology, Intellectual property, Virtual office, Networking). Entrepreneurship in Nigeria (Biography of inspirational Entrepreneurs, Youth and women entrepreneurship, Entrepreneurship support institutions, Youth enterprise networks and Environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

GEY 202: Crystallography and Systematic Mineralogy (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. determine physical properties of minerals;
2. describe and identify some minerals;
3. describe the crystal system; and
4. list and identify various crystal system

Course Contents
The main morphological properties of crystals. Classification and mode of occurrence of rock forming minerals. Crystal system and identification.

GEY 203: Introduction to Petrology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the completion of the course, students should be able to:
1. describe igneous, metamorphic, and sedimentary rocks;
2. identify igneous, metamorphic, and sedimentary rocks;
3. describe the texture of igneous, metamorphic, and sedimentary rocks; and
4. classify igneous, metamorphic, and sedimentary rocks

Course Contents
Origin, occurrence, geologic setting and systematic description and classification of igneous rocks. Metamorphism and description of metamorphic rocks. Metamorphic minerals and textures of metamorphic rocks and classification. Sediments and description of sedimentary rocks. Textures, mineral composition and classification of sedimentary rocks.

GEY 205: Invertebrate Palaeontology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, sstudents should be able to:
1. describe the morphology of the fossil groups;
2. classify major invertebrate fossil groups;
3. define and describe the stratigraphic range and ecology of the fossils;
4. explain paleobiologic models;
5. draw and label the morphological elements of the fossils; and
6. identify the fossils.

Course Contents
Major invertebrate fossil groups, their morphology, taxonomy, classification, ecology. Stratigraphic distribution and evolutionary trends. Paleotonlogical principles and paleobiologic models. Micro and macro evolution.

GEY 207: Principles of Stratigraphy (2 Units C: LH 30)

Learning Outcomes
At the end of the course, Students should be able to;
1. define stratigraphy and classify stratigraphy;
2. list and discuss techniques and parameters of stratigraphic analysis;
3. discuss the geologic time scale and its applications;
4. review the facies concept and application of Walthers law; and
5. explain correlation and correlation criteria

Course Contents
Importance of stratigraphy. Stratigraphic classification. Basic principles of stratigraphy applied to sedimentary sequences in geologic time. Geologic time scale. Facies concept and facies changes. Stratigraphyy of sedimentary basins in Nigeria. Introduction to facies map. Correlation. Stratigraphic cross-sections.

GEY 209: Introduction to Surveying (3 Units C: LH 15; PH 90)

Learning Outcomes
At the end of the course, students should be able to:
1. list the surveying instruments and their uses; and
2. state the methods of surveying

Course Contents
Introduction to surveying instruments and their uses, e.g. the chain, steel measuring tape, ranging poles, land chain arrows, dumping levels, theodolite, planimeters. Methodologies and techniques of linear and areal surveying. Types of surveys: land, topographic, route, city/municipal, construction, hydrographic, marine, mine, forestry, geological surveys. Photogrammetric, as-built, control surveys. Geographic Information System. Geological and mining evaluation.

GEY 210: Introduction to Structural Geology and Geological Map Interpretation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the completion of the course, students should be able to:
1. define and illustrate geological structures;
2. relate and represent scales of maps;
3. read topographic maps;
4. prepare a base map; and
5. prepare and interpret geological maps;

Course Contents
Folds. Faults. Foliations. Joints. Contours and contouring. Recognition of basic geological and geographic features. Geological structures. Preparation and interpretation of topographic and base maps. Detailed interpretation of simple geological maps. Recognition of different types of folds, faults, and unconformities on maps. Determination of throw of faults from simple geologic maps. Igneous intrusions and their recognitions on maps.

GEY 212: Introduction to Geological Field Mapping (2 Units C: PH 90)

Learning Outcomes
At the completion of the course, students should be able to:
1. use simple geological equipment in the field;
2. prepare a base MA observe and record field geology data;
3. prepare and interpret geological maps; and
4. write geological reports.

Course Contents
Training on the usage of compass-clinometer and other geological mapping instruments. Field measurement of distance, strike (bearing) and dip. Concept of scale. Usage of topographic and geological maps and interpretation; identification of rock types, minerals and geologic structures and description. Practical observation and recording of geological features in sedimentary and crystalline rock terrains. Sampling and labelling of samples. Application of field techniques. Field data management and report writing.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict, and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building

Concepts of Peace, Conflict and Security in a multi-ethnic nation. Types and Theories of Conflicts: Ethnic, Religious, Economic, Geo-political Conflicts; Structural Conflict Theory, Realist Theory of Conflict, Frustration-Aggression Conflict Theory. Root causes of Conflict and Violence in Africa: Indigene and settlers Phenomenon; Boundaries/boarder disputes; Political disputes; Ethnic disputes and rivalries; Economic Inequalities; Social disputes; Nationalist Movements and Agitations; Selected Conflict Case Studies – Tiv-Junkun; Zango Kartaf, Chieftaincy and Land disputes etc. Peace Building, Management of Conflicts and Security: Peace & Human Development. Approaches to Peace & Conflict Management --- (Religious, Government, Community Leaders etc.). Elements of Peace Studies and Conflict Resolution: Conflict dynamics assessment Scales: Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice; The Nigeria Legal System. Insurgency and Terrorism. Peace Mediation and Peace Keeping. Peace & Security Council (International, National and Local levels) Agents of Conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of International Organizations in Conflict Resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping. Media and Traditional Institutions in Peace Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students, through case study and practical approaches, should be able to:
1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;

3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents
Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/Market Research, Unutilised resources, Social and climate conditions and Technology adoption gap). New business development (business planning, market research). Entrepreneurial Finance (Venture capital, Equity finance, Micro finance, Personal savings, Small business investment organizations and Business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, Customer Acquisition & Retention, B2B, C2C and B2C models of e-commerce, First Mover Advantage, E-commerce business models and Successful E-Commerce Companies,). Small Business Management/Family Business: Leadership & Management, Basic book keeping, Nature of family business and Family Business Growth Model. Negotiation and Business communication (Strategy and tactics of negotiation/bargaining, Traditional and modern business communication methods). Opportunity Discovery Demonstrations (Business idea generation presentations, Business idea Contest, Brainstorming sessions, Idea pitching). Technological Solutions (The Concept of Market/Customer Solution, Customer Solution and Emerging Technologies, Business Applications of New Technologies - *Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy etc.* Digital Business and E-Commerce Strategies).

GEY 301: Geochronology & Precambrian Geology of Africa
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, the students should be able to:
1. discuss evolution of precambrian rocks;
2. determine chronology of rocks; and
3. list and explain the techniques of dating rocks

Course Contents
Principles of geochronology. Radiometric age determination. Rb/Sr, and K/Ar, U/Pb dating methods. Stable isotopes. Geology and evolution of Precambrian domains and rocks in Nigeria. Precambrian stratigraphy and application to major shield areas of Africa. Regional tectonic structures of Africa. Nappes, transcurrent faults with special reference to Africa.

GEY 305: Sedimentary Depositional Environments & Basins of Africa
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, the student should be able to:
1. differentiate types of flow;

2. classify depositional environments;
3. determine and understand various controls on sedimentation;
4. evaluate the criteria for recognising or interpreting depositional environments;
5. review economic resources associated with each depositional setting; and
6. illustrate the stratigraphy and geological evolution of some sedimentary basins in Africa.

Course Contents
Properties of flows and bed forms. Walthers law of facies. Sedimentary facies. Physical, chemical and biological influence on marine and continental depositional environments and their sedimentation patterns. Classification of environments. Alluvial fans braided and meandering rivers deposits. Coastal environments. Marine and deep marine system. Criteria for paleoenvironmental analysis. Analysis of the African sedimentary basins.

GEY 308: Principles of Geophysics (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the students should be able to:
1. list and describe various methods of geophysical survey;
2. explain the principles of geophysics; and
3. interpret geophysical data.

Course Contents
The nature and scope of geophysics. Role of geophysics in geological prospecting and exploration. Principles, techniques (data acquisition, presentation, and interpretation) and applications of gravity, electrical, seismic and electromagnetic prospecting methods. Introduction to geophysical well logging; types of well logs, principles, and applications. Hydrocarbon, mineral and groundwater exploration using geophysical prospecting methods. Applications of geophysics in solving engineering and environmental problems.

GEY 310: Geological Mapping Techniques and independent mapping (3 Units C: PH 90)

Learning Outcomes
At the end of the course, the students should be able to:
1. carry out an independent field mapping of an area;
2. produce geological maps;
3. interpret geological maps; and
4. write and present geological report.

Course Contents
Independent field study of specific areas. Production of geological maps and reports. Study and interpretation of geological maps. Writing of field geology report.

GEY 312: Photogeology and Remote Sensing (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. describe the techniques of photogrammetry.

2. interpret aerial photos;
3. recognise and interpret satellite imageries; and
4. write and present geological report

Course Contents
Electromagnetic radiation and spectrum. Techniques of photogrammetry. Study and interpretation of aerial photographs; satellite imageries; applications to mineral resources and environmental evaluation. Remote sensing basic concepts (platform, sensor, satellite, spatial, spectral, radiometric, and temporal resolutions, multispectral scanning and thermal imaging). Satellite data reception and transmission. image processing and interpretation techniques; geological applications of remote sensing techniques and data. Overview of non-geological applications of remote sensing techniques and data.

GEY 313: Structural Geology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. identify and describe various geological structural elements: fault, fold, shears, etc.;
2. evaluate earth dynamics that control the deformational structures; and
3. describe preparation and interpretation of structural maps.

Course Contents
Dynamics of rock. Stress-strain relationships. Faults, folds, ring dykes. Introduction to crustal tectonics. Major deformational structures of the earth; study and interpretation of geological maps. Problems concerning geological maps. Structures stereographic projection in Structural Geology. Structural Mapping Practice.

GEY 314: Sedimentary Petrology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. recognise and identify the mineral and textural characteristics of sedimentary rocks using microscopes;
2. describe and classify sedimentary rocks;
3. evaluate the origin of sedimentary rocks; and
4. interpret the provenance of sedimentary rocks.

Course Contents
Types of sediments. Sources, transportation and deposition of sediments. Diagenesis and lithification. Grain size analysis; textures and structures of sediments and sedimentary rocks. Pebble morphometry; mineral composition of the sedimentary rocks and microscopy. Petrographic classification of sandstones. Heavy minerals. Provenance of ancient sediments.

GEY 315: Geochemistry (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. classify the elements into major, trace and rare earth elements;

2. state the element composition of major rocks;
3. discuss the relative mobility of the elements;
4. apply geochemical data to explore mineral resources; and
5. determine the provenance and tectonic settings of rocks.

Course Contents
Abundance, classification and distribution of elements in rocks and materials. Principles of major and trace elemental analysis. Preparation of samples and analytical procedures; geochemistry of different rock types and mineral deposits; weathering and soil formation. Principles and methods of exploration geochemistry and geochemical analysis. Colloids and clays. Aspect of geochemistry in relation to petrology, prospecting and environments.

GEY 399: Industrial Attachment II (12 Weeks) (3 Units C: PH 135)

Learning Outcomes
At the end of the course, the students should be able to:
1. get used to workplace environment;
2. get hands on experience on industrial skills;
3. apply relevant professional skills; and
4. write and present reports.

Course Contents
Students should be attached to some industrial organizations for 12 Weeks at the end of 300 Level during the long vacation for industrial experience. Students are to be assessed based on seminar presentation, their reports and assessment by supervisors.

400 Level

GEY 404: Economic Geology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. explain how mineral deposits are formed;
2. classify mineral deposits;
3. describe and understand exploration methods;
4. plan mineral mine development and processing;
5. calculate ore reserves; and
6. discuss mineral economics.

Course Contents
Definition of economic minerals and economic mineral deposits. Ore and gangue minerals, tenor, and cut-off grade. Geological characteristics of ore deposits. Dispersed, confined, discordant and concordant deposits. Veins, pipes and stockwork; stratiform, strata bound, syngenetic and epigenetic deposits. Principles and processes of formation of mineral deposits. Prospecting and exploration mine development and mineral treatment. Ore reserve calculation and mineral economics.

GEY 406: Micropalaeontology and Palynology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the morphology of major groups of microfossils;
2. identify and classify the microfossils;
3. evaluate the stratigraphic range and significance of the microfossils; and
4. discuss the paleoecologic significance of the fossils.

Course Contents
Morphology and classification of foraminifera, coccoliths and diatoms. Morphology and classification of pollen, spores, dinoflagellates and acritarchs. Distribution, classification, and stratigraphical application of major groups of microfossils. Paleoecological interpretations of the microfossils and models; biofacies analysis. Preparation of rock samples for biostratigraphy analysis. Photomicrography.

GEY 408: Petroleum Geology (2 Units C: LH 30)

Learning outcomes
At the end of the course, the students should be able to:
1. state the characteristics of hydrocarbons;
2. discuss the concept of source rocks;
3. explain how source rocks are formed and different types of source;
4. List the various methods of evaluating source rock potential;
5. discuss the reservoir properties;
6. Recognise and describe various types of traps and understand the trapping mechanism;
7. explain principles and application of well logs; and
8. prepare various subsurface maps and calculate reserves.

Course Contents
Forms of petroleum: solid, liquid and gaseous forms. Surface and subsurface occurrence of petroleum. Accumulation of organic matter and concept of source rock; transformation of organic matter and hydrocarbon generation. Migration of hydrocarbon. Properties of petroleum reservoir, traps, and seals. Abnormal pressure. Exploration methods. Reserves and basin classification. Subsurface maps. Well-logging and interpretation. Examples of major oil deposits. Bitumen and conventional oil deposits in Nigeria. Stages in licensing, exploration, and production. Introduction to the use of relevant computer packages for data analyses and graphical presentation. Origin, occurrence and distribution of hydrocarbon deposits and fields.

GEY 409: Applied Geophysics (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. carry out geophysical investigations;
2. discuss the fundamentals of geophysics;
3. apply the principles of geophysics; and
4. interpret geophysical data;

Course Contents
Fundamentals of seismic method. Gravity method. Electrical methods. Interpretation of geophysical data. Application of the geophysical principles to solving geological problems. Introduction to geophysical interpretation using workstation applications and other geophysical software applications.

GEY 410: Engineering Geology (2 Units C: LH 30)

Learning Outcomes
Upon completion of the course, the students should be able to:
1. explain the principles and applications of soil mechanics;
2. outline and describe the geotechnical techniques;
3. carry out site investigations;
4. interpret geotechnical; and
5. write and present geological report.

Course Contents
Geotechnique and application in engineering geology. Terrain classification principles and application of soil mechanics. Water retaining structures, dams, highways, foundation, slope stability, settlement, design of structures. Site investigations. Principles and methods of: tunnelling, drilling and sampling techniques. Engineering-geological maps. Erossion problems and material quality control. Aplication of geology to engineering problems in roads, bridge, and dam construction.

GEY 411: Hydrogeology (2 Units C: LH 30)

Learning Outcomes
At the completion of the course, the students should be able to:
1. relate the hydrological cycle;
2. describe groundwater hydraulics;
3. define the hydrodynamic laws; and
4. evaluate groundwater potential of an area.

Course Contents
Hydrogeology and hydrology-definition and scope. Hydrological cycle. Hydrological properties of rocks; origin, occurrence and movement of groundwater. Groundwater and well hydraulics; fundamental hydrodynamics laws. Hydrometeorology: rainfall, overland flow, through flows interception. Hydropgraphs: unit hydrograph, theory and application. Explanation of the basic hydrological equation. Regional groundwater resource evaluation.

GEY 412: Global Tectonics and Structures (2 Units C: LH 30)

Learning outcomes
At the end of the course, the students should be able to:
1. illustrate the driving forces in the earth;
2. explain the concept of plate tectonics;
3. identify and describe major tectonic provinces; and
4. discuss tectonic evolution of basins and classify basins structurally.

Course Contents
Study of the major structures of the Earth. Continental separation and sea floor spreading. Mid oceanic ridges. Plate tectonics; patterns of crystal evolution in specific regions. Heat flow and vertical movements of the crust; plate tectonics: causes, relations to mineral resources genesis, diversity and extinction of species. Origin and growth of basins. Rift valley basin and other type of basins. Orogeny and orogenesis.

GEY 414: Entrepreneurship Skills in Geosciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. develop business plan;
2. bid for jobs;
3. carry out geophysical surveys;
4. prepare maps; and
5. process minerals for ornamentations.

Course Contents
Fundamentals of geoscience and mining enterprises. Business plan. Bid invitation and tendering. Drilling. Geophysical survey methods and instrumentation. Rock cutting and polishing. Processing of minerals and fossils for ornamentation. Map preparation and cartography.

GEY 415: Geology of Nigeria (2 Units C: PH 90)

Learning outcomes
At the conclusion of the course, the students should be able to;
1. locate and describe strategic geologic sequences in Nigeria;
2. discuss the Cretaceous and Tertiary sequences;
3. describe the location of various Precambrian rock belts and provinces; Older granites, younger granites, Schist belts;
4. recognise the location of some mineralised zones, mines, and quarries; and
5. recognise the field characteristics of the geological exposures.

Course Contents
Field study through 2-week excursion to major geological features and type localities within the basement complex and sedimentary domain of Nigeria.

GEY 416: Seminar in Geology (1 Unit C: PH 45)

Learning outcomes
At the conclusion of the course, the students should be able to;
1. write report;
2. search and review literature; and
3. make oral presentation of technical papers.

Course Contents
Literature search. write-up and oral presentation on a topic in Geology.

GEY 417: Project in Geology **(6 Units C: PH 270)**

Learning outcomes
At the conclusion of the course, the students should be able to:
1. Carry out independent research work;
2. Use basic geology equipment to generate data;
3. review literature;
4. evaluate and interpret data; and
5. write report.

Course Contents
Geological investigation and independent research involving field, laboratory and library studies.

Minimum Academic Standards

Equipment
1. Atomic Absorption Spectrophotometer
2. Ultra-violet/Visible Spectrophotometer
3. Rock Cutting and Grinding Machine
4. Hydraulic Press
5. Rock Cutler-Cut rock
6. Lathe Machine
7. Jaw Crusher Colorimeter
8. Sieve Shaker
9. pH Meter
10. Brunton Compasses
11. Field Hammers (Geological)
12. Rock/Mineral Polishing Machine
13. Electron Microprobe Analyser
14. Titration Potentiometer
15. Lloyd Gas Analyser
16. Petrographic polarizing Microscopes
17. Binocular Microscopes
18. Hotspot Furnace (Muffle)

Staffing

Academic Staff
The guidelines on academic staff/student ratio of 1:20 for Science Programmes shall apply. There should be a minimum of six academic staff. There is need to have a reasonable number of staff with Ph.D. degrees accounting for at least 70% of the total number and having adequate teaching experience for every programme in the Discipline.

Administrative Support Staff
The services of the administrative support staff are indispensable in the proper administration of departments and faculty offices. It is important to recruit very competent, computer literate senior staff.

Technical Support Personnel
The services of technical support staff, which are indispensable in the proper running of laboratories and workshops, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

Library
Universities should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition, well stock and current hard copies of reference and other textual materials should be provided centrally at the level of the faculty. A well network digital library should serve the entire university community. Availability of wireless facilities (Wi-Fi) with adequate bandwidth should enhance access to these electronic resources.
In any case, there should be internet ready workstations available in the library for least 25% of the total student enrolled in each academic programme. The funding of the library should be in line with NUC guidelines.

Classrooms, Laboratories, Workshops and Office Space
The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

B.Sc. Industrial Chemistry

Overview

Industrial Chemistry is the index of industrial development everywhere in the world. The frontiers of chemistry are very large, ranging from one extreme of natural products to those synthesized by man. The enormous strides made by man in the understanding, exploitation of nature and synthesis of new products all have their roots in chemistry and chemical technology. For economic sustenance and technological breakthrough, the undergraduate programme is designed to encompass an appreciation of the centrality of chemical sciences in the entire undergraduate curricula. The programme is designed to equip students for employment in virtually all types of industries. Consequently, a lot emphasis is placed on practical work and industrial training during the course of the programme which may be run as a 4-year programme or a 5-year programme. For institutions opting for the 4-year programme, students are to undertake two industrial attachments of 12 weeks duration each, the first at 200-level and the second at 300-level. Institutions wishing to expose their students to more intensive industrial training should adopt the 5-year programme in which case the students will spend the entire 400-level (36 weeks) on industrial attachment. The programme is also planned to arouse entrepreneurial spirits needed for self-employment and economic emancipation.

Philosophy

The philosophy is to train graduates who will apply scientific approach through verifiable and reproducible methodologies to solving developmental needs of the society.

Objectives

Objectives of the Industrial Chemistry programme include:

1. provide students with scientific knowledge and skills from which they can proceed to further studies in specialized and/or multi- disciplinary areas;
2. provide students with a broad and balanced foundation of scientific knowledge and practical skills as may be applicable in their different programmes;
3. develop in students the ability to apply scientific knowledge and skills to solving theoretical and practical problems;
4. develop in students, a range of transferable skills that are of value in any employment and society they might find themselves;
5. provide, through training and orientation, an appreciation of the rewards inherent in inter- and multi- disciplinary approach to the solution of complex life problems, and
6. engender in students an appreciation of the fact that no nation can develop without science and its application.

The specific objectives of the Industrial Chemistry Programme are as follows:

1. provide students with a thorough grounding in principles and sound knowledge of scientific methods of the chemical sciences;
2. arouse a sense of curiosity and enquiring mind, in order to encourage and develop creative thinking and research aptitudes;
3. generate in students an awareness of the enormous resources in their immediate environment so as to enhance solutions to the challenges of our time in a march towards nation building;
4. educate and train chemists, particularly applied chemists, who can think fundamentally about their subject and who can acquire as graduates, a meaningful picture of the chemical industry; and

5. inculcate in students appropriate skills and abilities to manage and administer technological operations within the field of chemistry and allied areas.

Unique Features of the Programme

The unique features of the programme include:

1. the programme is rich through a combination of various subjects for a better understanding of industrial chemistry;
2. cognitive abilities and skills relating to solution of problems in industrial chemistry and other allied chemical industries;
3. practical skills relating to the conduct of laboratory work in chemical industries. mastering industrial processes that take place in pharmaceutical, food and beverages, petroleum and petrochemical, paints and textile industries and metallurgical and ceramic industries;
4. general skills relating to non-subject specific competencies, communication, interpersonal, organization skills; and
5. graduate of industrial chemistry will be equipped for graduate self-employment.

Employability Skills

Industrial chemistry graduates are specially equipped for employment in various industries in such areas as production supervision, quality control, research and development, technical marketing etc. Some typical industries where industrial chemistry graduates can be employed include chemical, food and beverage, pharmaceuticals, petroleum and petrochemicals, metallurgical and ceramic industries, textile, paper and wood, paint, and environmental agencies as well as several other regulatory agencies. The programme is also designed to equip students for self – employment.

21st Century Skills

1. Creativity
2. Computer Literacy
3. Organization Skills
4. Communication And It Skills
5. Teamwork
6. Innovation
7. Problem Solving Skills
8. Critical Thinking

Admission and Graduation Requirements

Admission Requirements

There are two different pathways by which candidates can be admitted into the programmes in the discipline: the Indirect Entry and the Direct Entry.

Indirect Entry

Admission through indirect entry shall take the student to 100 level. The candidate must have Senior Secondary Certificate (SSC) credit passes in five subjects at not more than two sittings in SSCE, NECO or GCE (ordinary level). The credit passes are required in the following subjects:

English language, Mathematics, Chemistry, Physics and Biology. The UTME subjects are: English Language, Physics, Biology and Chemistry.

Direct Entry
Admission by direct entry is into second year (200 level) of the programme. Candidates for direct entry should possess passes at GCE (advanced level) at one sitting in at least two of the following subjects: Physics, Mathematics, Biology and Chemistry or National Diploma (ND) at a minimum of Upper Credit level in Lab technology (chemistry option) and any other related course from any recognized institution.

Graduation Requirements
To be eligible for the award of a Bachelor's Degree in Industrial chemistry, a student must pass a minimum 120 credit units for those admitted through UTME and 90 units for Direct Entry, including all the compulsory courses of the Department, the Faculty courses namely A student admitted through UTME must complete the programme in 4 years (8 semesters), while a student admitted through Direct Entry must complete the programme in 3 years (6 semesters); both can be given extra two years (4 semesters) to complete their programme provided their CGPA is not below 1.0.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	
MTH 101	Elementary Mathematics I	2	C	45	-
MTH 102	Elementary Mathematics II	2	C	45	-
COS 101	Introduction to Computing Science	3	C	30	45
CHM 101	General Chemistry I	2	C	45	-
CHM 107	General Practical Chemistry I	1	C	-	45
CHM 108	General Practical Chemistry 11	1	C		45
CHM 102	General Chemistry11	2	C	30	
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 107	General Practical Physics I	1	C	-	45
PHY 108	General Practical Physics II	1	C	-	45
GET 102	Engineering Graphics and Solid Modelling	2	C	30	45
	Total	**22**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	
ENT 211	Entrepreneurship and Innovation	2	C	30	
CHM 210	Physical Chemistry I	2	C	30	
CHM 211	Organic Chemistry I	2	C	30	
CHM 212	Inorganic Chemistry I	2	C	30	
CHM 207	General Practical Chemistry 1	1	C		45
CHM 208	General Practical Chemistry 11	1	C		45
ICH 213	Analytical Chemistry I	2	C	30	
ICH 251	Process Science I	3	C	45	-
ICH 252	Process Science II	3	C	45	-
COS 201	Computer programming 1	2	C	30	45
	Total	**20**			

300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict resolution	2	C	30	
ENT 312	Venture Creation	2	C	15	45
ENT 314	Entrepreneurial skill in Industrial Chemistry	3	C	30	45
CHM 301	Physical Chemistry II	2	C	30	
CHM 302	Inorganic Chemistry II	2	C	30	
CHM 303	Organic Chemistry II	2	C	30	
ICH 305	Petroleum Chemistry	2	C	30	-
ICH 306	Polymer Chemistry	2	C	30	
ICH 317	Industrial Raw Materials Resource Inventory	1	C	15	-
ICH 318	Management and Chemical Industry I	2	C	30	-
ICH 319	Glass blowing Practical	1	C		45
*ICH 399	Industrial Attachment (12 Weeks)Industrial Attachment II (12 Weeks)	3	C		
	Total	**23**			

***CHM 399 is only for students in institutions running a 4-year industrial chemistry programme.**

400 Level:

Course Code	Course Title	Units	Status	LH	PH
ICH 422	Entrepreneurship for Industrial chemistry	2	C	30	
ICH 400	Seminar in Chemistry	2	C		

Course Code	Course Title	Units	Status	LH	PH
ICH 401	Research Project	6	C	-	270
ICH 453	Chemistry of Industrial Processes	3	C	45	-
ICH 454	Chemical Processes Technology	3	C	45	-
ICH 455	Macromolecular Chemistry II	3	C	45	-
*ICH 499	Industrial Attachment (36 Weeks)	6	C		
	Total	**25**			

*ICH 499 is only for students in institutions running Industrial Chemistry as a 5-year programme. In such a case the 4th year will be spent entirely on Industrial Attachment and all the other indicated 400-Level will be taken in the 5th year as 500-Level courses
There are institutions running B.Sc. Industrial and Environmental Chemistry, Industrial Attachment I (12 Weeks) is usually a whole semester of the third session'

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to
1. identify possible sound patterns in English Language;
2. list notable Language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English Language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and Deductive Argument and Reasoning Methods, Analogy, Generalisation and Explanations). Ethical considerations, Copyright Rules and Infringements. Writing Activities: (Pre-writing , Writing, Post writing, Editing and Proofreading; Brainstorming, outlining, Paragraphing, Types of writing, Summary, Essays, Letter, Curriculum Vitae, Report writing, Note making etc. Mechanics of writing). Comprehension Strategies: (Reading and types of Reading, Comprehension Skills, 3RsQ). Information and Communication Technology in modern Language Learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture (2units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of Trade, Economic and Self-reliance status of the Nigerian people towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building
6. analyse the role of the Judiciary in upholding people's fundamental rights
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification. Judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation; Re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption(WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes

At the end of this course students should be able to:

1. explain basic definition of Set, Subset, Union, Intersection, Complements and use of Venn diagrams;
2. solve quadratic equations;
3. Solve trigonometric functions;
4. identify various types of numbers; and
5. solve some problems using Binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, venn diagrams. Real numbers, integers, rational and irrational numbers. Mathematical induction, real sequences and series. Theory of quadratic equations. Binomial theorem. Complex numbers. Algebra of complex numbers. The Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of this course students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative, as limit of rate of change. Techniques of differentiation. Extreme curve sketching; Integration as an inverse of differentiation. Methods of integration, Definite integrals. Application to areas, volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

CHM 101: General Chemistry I **(2 Units C: LH 30)**

Learning Outcomes
At the end of this course, the students should be able to:
1. define atom, molecules and chemical reactions;
2. discuss the Modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. illustrate shapes of simple molecules and hybridized orbitals;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents
Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence Forces. Structure of solids. Chemical equations and stoichiometry; Chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry. Rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II **(2 Unit C: LH 30)**

Learning Outcomes
At the end of this course, the students should be able to:
1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reactions;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. describe basic properties of Transition metals.

Course Contents
Historical survey of the development and importance of Organic Chemistry. Fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures, nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction

mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The Chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify the differences between primary and secondary standards;
5. perform redox titration;
6. recording observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents
Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify and carry out preliminary tests which includes ignition, boiling point, melting point, test on known and unknown organic compounds;
5. perform solubility tests on known and unknown organic compounds;
6. conduct elemental tests on known and unknown compounds; and
7. conduct functional group/confirmatory test on known and unknown compounds which could be acidic / basic / neutral organic compounds.

Course Contents
Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the student should be able to:
1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;

3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics.
4. apply Newton's laws to describe and solve simple problems of motion.
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects.
6. explain and apply the principles of conservation of energy, linear and angular momentum.
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Courses Contents

Space and time. Units and dimension, Vectors and Scalars. Differentiation of vectors: displacement, velocity and acceleration. Kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). Relative motion. Application of Newtonian mechanics. Equations of motion.Conservation principles in physics. Conservative forces. Conservation of linear momentum. Kinetic energy and work. Potential energy. System of particles. Centre of mass. Rotational motion:Torque, vector product, moment, rotation of coordinate axes and angular momentum. Polar coordinates. Conservation of angular momentum. Circular motion. Moments of inertia. gyroscopes and precession. Gravitation: Newton's Law of Gravitation. Kepler's Laws of Planetary Motion. Gravitational Potential Energy. Escape velocity. Satellites motion and orbits.

PHY 102: General Physics II (Electricity & Magnetism) (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the student should be able to:

1. describe the electric field and potential, and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;
5. describe electromagnetic induction and related concepts, and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters; and
8. determine the characteristics of ac voltages and currents in resistors, capacitors, and Inductors.

Course Contents

Forces in nature. Electrostatics; electric charge and its properties, methods of charging. Coulomb's law and superposition. electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators, current, voltage and resistance. Ohm's law and analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step-down transformers: Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, resistance, and combinations.

PHY 107: General Practical Physics I (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the student should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasizes quantitative measurements, the treatment of measurement errors and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity etc., covered in PHY 101 and PHY 102. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

PHY 108: General Practical Physics II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the student should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data; and
6. prepare and present practical reports.

Course Contents
This practical course is a continuation of PHY 107 and is intended to be taught during the second semester of the 100 level to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements. The treatment of measurement errors, and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

GET 102: Engineering Graphics and Solid Modelling I (2 Units C: LH 15; PH 45)

Learning Outcomes
Upon completion of this course students should be able to:
1. recognise design thinking and be obsessed with the determination to apply such to solving simple every day and also complex problems;
2. explain the fundamental concepts of engineering drawing and graphics;
3. exhibit skills to represent the world of engineering objects in actionable solid models, and put such models in a form where they can be inputs for simulation and analyses;
4. analyse such models for strength, cost and improved upon;

5. prepare the objects for modern production and manufacturing techniques of additive and subtractive manufacturing;
6. demonstrate the idea that engineering is multidisciplinary in the sense that mechanical, electrical and other parts of physical structures are modelled in context as opposed to the analytical nature of the courses they take;
7. master the basics of mechanical and thermal loads in engineering systems.

Course Contents
Introduction to design thinking and engineering graphics. First and third angle orthogonal projections. Isometric projections; Sectioning, conventional practices, conic sections and development. Freehand and guided sketching – pictorial and orthographic. Visualization and Solid modelling in design, prototyping and product-making. User Interfaces in concrete terms. Design, Drawing, Animation, Rendering and Simulation Workspaces. Sketching of 3D objects. Viewports and sectioning to Shop drawings in Orthographic projections and perspectives. Automated viewports. Sheet Metal and surface modelling. Material selection and rendering. This course will use latest professional design tools such as Fusion 360, Solid Works, Solid Edge or equivalent.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students should be able to:

1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world;
8. state the basic principles of e-commerce.

Course Contents

Concept of Entrepreneurship (Entrepreneurship, Intrapreneurship/Corporate Entrepreneurship,). Theories, Rationale and relevance of Entrepreneurship (Schumpeterian and other perspectives, Risk-Taking, Necessity and opportunity-based entrepreneurship and Creative destruction). Characteristics of Entrepreneurs (Opportunity seeker, Risk taker, Natural and Nurtured, Problem solver and change agent, Innovator and creative thinker). Entrepreneurial thinking (Critical thinking, Reflective thinking, and Creative thinking). Innovation (Concept of innovation, Dimensions of innovation, Change and innovation, Knowledge and innovation). Enterprise formation, partnership and networking (Basics of Business Plan, Forms of business ownership, Business registration and Forming alliances and join ventures). Contemporary Entrepreneurship Issues (Knowledge, Skills and Technology, Intellectual property, Virtual office, Networking). Entrepreneurship in Nigeria (Biography of inspirational Entrepreneurs, Youth and women entrepreneurship, Entrepreneurship support institutions, Youth enterprise networks and Environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

CHM 210: Physical Chemistry I (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

1. state the kinetic theory of gases and solve problems related to ideal and real gases;
2. derive the formula for molecular velocity of gases and use the derived formula to solve problems;
3. describe and explain the fundamental concepts of physical chemistry including those of statistical mechanics, chemical Kinetics, quantum mechanics and spectroscopy;
4. apply simple models to predict properties of chemical systems;
5. define and state type of solutions; define different concentration terms which include molarity, normality etc. explain vapour pressure lowering of the solvent, boiling point elevation of solutions, freezing point depression of solution and measurement of osmotic pressure;
6. apply numerical or computational methods to calculate physical properties of Chemical systems and assess the appropriateness of different computational techniques and numerical approximations for solving chemistry problems;

7. design and plan an investigation by selecting and applying appropriate practical, theoretical, and/or computational techniques or tools; and
8. states Ohms law and describe the electrolytic conduction, states the Faraday's Law and Conductance Law of solution and calculation on electrical conductance on different electrolyte solution.

Course Contents
Kinetic theory of gases; science of real gases; the laws of thermodynamics; entropy and free energy; reactions and phase equilibria; reaction rates; rate laws; mechanism and theories of elementary processes; photochemical reactions; basic electrochemistry.

CHM 211: Organic Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe and solve problems in chemistry of aromatic compounds;
2. describe the structures of simple sugars, starch and cellulose, peptides and proteins and show the difference in their conformation structure;
3. describe and solve problems in chemistry of bifunctional compounds;
4. explain he mechanisms of substitution, elimination, addition and rearrangement reactions;
5. describe stereochemistry and its application;
6. describe condition and pathways of the following organic reactions - Grignard reaction, Aldol and related reactions; and
7. describe simple alicyclic carbon compounds and their synthesis.

Course Contents
Chemistry of aromatic compounds. Structures of simple sugars, starch and cellulose, peptides, and proteins. Chemistry of bifunctional compounds. Energetics, kinetics, and the investigation of reaction mechanisms. Mechanisms of substitution, elimination, addition, and rearrangement reactions. Stereochemistry. Examples of various named organic reactions e.g., Grignard reaction, Aldol and related reactions. Simple alicyclic carbon compounds and their synthesis.

CHM 212: Inorganic Chemistry I (2 Units C: LH 30)

Learning Outcomes
1. At the end of this course, the students should be able to:

2. list the first-row transition elements and explain their characteristics and properties;
3. explain crystal field theory (CFT) and draw the diagram to illustrate with examples of coordination compounds;
4. state the advantages of CFT over other bonding theories;
5. discuss the comparative Chemistry of the following elements. (I) Ga, In, Tl (II). Ge, Sn, Pb (III). As, Sb, Bi (IV). Se, Te, Po;
6. define organometallic Chemistry;
7. give relevant examples with illustrations;
8. classify organometallic compounds with examples;
9. list the roles of metals in biochemical systems;
10. discuss the concepts of hard and soft acids and bases.

11. list examples of item 9 above;
12. explain oxidation and reduction reaction; and
13. illustrate the above (11) with appropriate reactions.

Course Contents
Chemistry of first row transition metals. Introduction to coordination chemistry including elementary treatment of crystal field theory. Comparative Chemistry of the following elements: (a) Ga, In, TI, (b) Ge, Sn, Pb, (c) As, Sb, Bi (d) Se, Te, Po.
Elementary introduction to organometallic chemistry. Role of metals in biochemical systems. Concepts of hard and soft acids and bases. Oxidation and reduction reactions.

ICH 213: Analytical Chemistry I (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, the students should be able to:

1. explain analytical processes which include description of chemist as a problem solver;
2. describe and differentiate forms of error;
3. explain its implication on laboratory analysis;
4. state different statistical tool use in treatment of data;
5. solve practical problems using the statistical tools;
6. define sampling and give reasons for sampling in field work;
7. state and describe different sampling techniques;
8. state different forms of sample collection and processing;
9. describe volumetric method of analysis and solve some practical problems; and
10. describe gravimetric method of analysis and solve some practical problems.

Course Contents
Theory of errors; and statistical treatment of data: Theory of sampling. Chemical methods of analysis including volumetric, gravimetric, data analysis and presentation and Physicochemical methods, Optical methods of analysis; separation methods.

CHM 207: General Chemistry Practical III (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students will be able to:
1. describe the measurement of pH;
2. determine the relative molar mass from the colligative properties;
3. demonstrate the partition coefficient of two immiscible solvents;
4. demonstrate temperature measurements and heat of dissolution, heat of neutralization and many others
5. determine the critical solution temperature of water-Phenol system; and
6. measure the molar volume of a gas and universal gas constant.

Course Contents
pH Measurement. Determination of Relative Molar Mass from Colligative Properties. Demonstration of Partition Coefficient in two Immiscible Solvents. Temperature Measurement and Heat of Dissolution Heat of Neutralisation. Determination of Critical Solution Temperature of

Water- Phenol System Ideal Gas Law. Measuring the Molar Volume of a Gas and the Universal Gas Constant.

CHM 208: General Chemistry Practical IV (1 Unit C: PH 45)

Learning outcomes.
At the end of this course, the students will be able to:
1. identify general laboratory rules;
2. demonstrate the preparation of simple organic compounds (esters, aldehydes and ketones);
3. describe the analysis of vinegar;
4. demonstrate A simple experiment on thin layer chromatography;
5. perform an experiment on the dehydration of alcohol; and
6. conduct experiments on qualitative analysis of common functional groups.

Course Contents
The Preparation of Esters. The preparation of Aldehydes and Ketones. Vinegar Analysis. Chromatography. Thin Layer Chromatography. Dehydration of Alcohol. Qualitative Analysis of Common Functional Groups

ICH 251: Process Science I (3 Units C: LH 45)

Learning Outcomes
After completing the course, the students will be able to:
1. explain the problems of scale and cost;
2. discuss handling of fluids;
3. describe the mechanism of heat transfer;
4. explain change of phase correlation of heat transfer data; and
5. demonstrate handling of continuous fractional distillation.

Course Contents
Commercial process, problems of scale and cost. Process flow sheet and stoichiometry.
Handling of fluids; conservation laws and dimensional analysis applied to a moving fluid.
Process heat transfer, mechanisms of heat transfer coefficients in batch and continuous processes. Use of mean temperature difference. Change of phase correlation of heat transfer data. Distillation differential, batch, fractional and continuous fractional distillation; number of stages; effects of operating variables.

ICH 252: Process Science II (3 Units C: LH 45)

Learning Outcomes
After completing the course, the students will be able to:
1. discuss mass transfer processes such as drying and solid-liquid-separation;
2. know the process of absorption and extraction;
3. predict rate, determine steps;
4. discuss solid –liquid separation; and
5. discuss Stoichemistry.

Course Contents
Mass transfer processes; single phase and inter-phase, mass transfer drying as a heat-mass transfer process. Extraction and Absorption; solvent extraction in mixer settlers and columns; number of ideal stages; number of stages in gas absorption by HTU method; gas film and liquid film rate determining steps. Solid-liquid separation by filtration and sedimentation. Stoichiometry for systems involving recycles.

COS 201: Computer Programming I (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. Explain the principles of good programming and structured programming concepts;
2. Explain the programming constructs, syntax and semantics of a higher-level language;
3. Describe the chosen programming language variables, types, expressions, statements and assignment; simple input and output;
4. Describe the programme control structures, functions and parameter passing, and structured decomposition; and
5. Develop simple programmes in the taught programming language as well as debug and test them.

Course Contents
Introduction to computer programming. Functional programming; Declarative programming; Logic programming; Scripting languages. Introduction to object-orientation as a technique for modelling computation. structured, and even some level of functional programming principles; Introduction of a typical object-oriented language, such as Java; Basic data types, variables, expressions, assignment statements and operators; Basic object-oriented concepts: abstraction; objects; classes; methods; parameter passing; encapsulation. Class hierarchies and programme organisation using packages/namespaces; Use of API – use of iterators/enumerators, List, Stack, Queue from API; Searching; sorting; Recursive algorithms; Event-driven programming: event-handling methods; event propagation; exception handling. Introduction to Strings and string processing; Simple I/O; control structures; Arrays; Simple recursive algorithms; inheritance; polymorphism.
Lab work: Programming assignments; design and implementation of simple algorithms, e.g., average, standard deviation, searching and sorting; Developing and tracing simple recursive algorithms. Inheritance and polymorphism.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building

Course Contents
Concepts of Peace, Conflict and Security in a multi-ethnic nation. Types and Theories of Conflicts: Ethnic, Religious, Economic, Geo-political Conflicts; Structural Conflict Theory, Realist Theory of Conflict, Frustration-Aggression Conflict Theory. Root causes of Conflict and Violence in Africa: Indigene and settlers Phenomenon; Boundaries/boarder disputes; Political disputes; Ethnic disputes and rivalries; Economic Inequalities; Social disputes; Nationalist Movements and Agitations; Selected Conflict Case Studies – Tiv-Junkun; Zango Kartaf, Chieftaincy and Land disputes etc. Peace Building, Management of Conflicts and Security: Peace & Human Development. Approaches to Peace & Conflict Management --- (Religious, Government, Community Leaders etc.). Elements of Peace Studies and Conflict Resolution: Conflict dynamics assessment Scales: Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice; The Nigeria Legal System. Insurgency and Terrorism. Peace Mediation and Peace Keeping. Peace & Security Council (International, National and Local levels) Agents of Conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of International Organizations in Conflict Resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping. Media and Traditional Institutions in Peace Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students, through case study and practical approaches, should be able to:
1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents
Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/Market Research, Unutilised resources, Social and climate conditions and Technology adoption gap). New business development (business planning, market research). Entrepreneurial Finance (Venture capital, Equity finance, Micro finance, Personal savings, Small business investment organizations and Business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, Customer Acquisition & Retention, B2B, C2C and B2C models of e-commerce, First Mover Advantage, E-commerce business models and Successful E-Commerce Companies,). Small Business Management/Family Business: Leadership & Management, Basic book keeping, Nature of family

business and Family Business Growth Model. Negotiation and Business communication (Strategy and tactics of negotiation/bargaining, Traditional and modern business communication methods). Opportunity Discovery Demonstrations (Business idea generation presentations, Business idea Contest, Brainstorming sessions, Idea pitching). Technological Solutions (The Concept of Market/Customer Solution, Customer Solution and Emerging Technologies, Business Applications of New Technologies - *Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy etc.* Digital Business and E-Commerce Strategies).

ENT 314: Entrepreneurship skill in industrial Chemistry (3 Unit C: LH 30; PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. demonstrate the entrepreneurial skills;
2. identify international entrepreneurship opportunities;
3. develop competency in identification of new business ventures;
4. identify legal issues and business environments;
5. discuss marketing strategies; and
6. identify cost accounting.

Course Contents
Entrepreneur perspectives and strategies. International entrepreneurship opportunities, identification, pursuit of new ventures (Water treatment, production of bio -renewable plastics such as polylactic acids PLA, textile and clothing: medical textiles, military and industrial textiles, electronics: semiconductors, food and drinks, packaging, drug designs, soap and hand sanitizers etc), marketing strategies in business ventures, creativities and the business ideas, legal issues and business environment, and cost accounting. Field trips.

CHM 301: Physical Chemistry II (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students will be able to:
1. describe the general knowledge of Gibbs function;
2. explain the concept of thermodynamics compare to kinetics; and
3. explain the concept of statistical thermodynamics and use statistical equation to solve problems in ideal and non-ideal solution.

Course Contents
A review of Gibbs Function. Chemical thermodynamics. Introduction to statistical thermodynamics. Ideal solutions and non-Ideal solutions. Properties of electrolytes. Colligative Properties. Studies on biochemical systems.

CHM 302: Inorganic Chemistry II (2 Units C: LH 30)

Learning outcomes
At the end of this course, students will be able to:
1. analyse inorganic chemistry information;
2. demonstrate and apply knowledge of inorganic chemistry;

3. explain the electronic structure and general properties of group 1A and Group IIA elements;
4. compare Group IA and Group IIA in terms of the parameters mentioned in 3 above;
5. explain the chemistry of Boron; carbon and Silicon; Nitrogen and phosphorus; Oxygen and sulphur;
6. explain the halogen chemistry;
7. explain the periodic properties of the transition metals and to use these to predict and/or rationalise the chemistry of these metal ions and their complexes;
8. use Crystal Field Theory to explain and understand some of the key features of complexes of the first-row transition metals including their shapes, colours, and magnetic properties;
9. synthesis and characterise a metal coordination compound using practical inorganic chemistry techniques;
10. describe ligand and crystal field theories;
11. draw the diagram showing crystal and ligand field theories with specific examples;
12. list advantages and limitations of these bonding theories;
13. define radioactive decay processes and nuclear radiation;
14. explain the principles of utilizing radioactivity applied to chemistry, chemical processes and adjacent fields where chemistry is an integral part;
15. discuss the principles of radiation hygiene and the interaction of radiation and matter;
16. explain current methods in radiochemistry;
17. define radioactivity;
18. define and describe all three types of radioactivity (alpha, beta, and gamma radiation); and
19. explain the roles of metals in living systems.

Course Contents

The Noble gases. Hydrogen. Electronic structure and general properties and comparative study of Group IA and Group IIA elements. Chemistry of Boron. Carbon and Silicon. Nitrogen and Phosphorus. Oxygen and Sulphur. The halogens. Transition elements. Separation of metals. Introduction to co-ordination chemistry. Introductory organo-metallic chemistry. Ligand and Crystal field theories. Introduction to radiochemistry. Radioactivity and the periodic table. Role of metals in living systems.

CHM 303: Organic Chemistry II (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

1. recognize and distinguish between aromatic and Alicyclic compounds by their structures;
2. identify the properties of aromatic and Alicyclic compounds, and the chemical consequences of aromaticity;
3. recognize and be able to write the mechanism of electrophilic aromatic and Alicyclic substitution;
4. outline the completed electrophilic aromatic substitution reactions of the following types: halogenation, nitration, sulfonation, and Friedel-Crafts acylation & alkylation;
5. explain the chemistry of heterocyclic Chemistry (3,4,5 and 6-membered ring of O, N, S heterocyclic compounds);
6. describe the Reactive intermediates – carbocations, carbanions, carbenes, nitrenes;

7. express the rearrangement reactions e.g., Beckmann, Baeyer-Villiger etc.
8. illustrate with various reaction mechanisms and types; and
9. organize Forensic analysis of biological samples, pharmaceutical samples, organic analytes and macromolecular samples.

Course Contents

Pre –requisite –CHM 211

Aromatic and Alicyclic chemistry. Survey of representative polycyclic compounds. Heterocyclic Chemistry (3,4,5 and 6-membered ring of O, N, S heterocyclic compounds). Reactive intermediates – carbocations, carbanions, carbenes, nitrenes etc. Selected rearrangement reactions such as, Beckmann, Baeyer-Villiger, and many others to illustrate various reaction mechanisms and types. Forensic analysis of biological samples, pharmaceutical samples, organic analytes and macromolecular samples.

ICH 305: Petroleum Chemistry (2 Units C: LH 30)

Learning Outcomes

After completing the course, the students will be able to:

1. Give an overview of the chemical composition and physical properties of petroleum, petroleum products and renewable motor fuels;
2. Specify quality criteria for petroleum products and renewable motor fuels;
3. Present the chemistry of the most important refinery processes;
4. Give an overview of the resource base for petroleum and renewable alternatives;
5. Find information and perform individual evaluations of questions pertaining to production and use of petroleum from different sources and renewable motor fuels;
6. Use geophysical and geological knowledge to interpret and map data for identification of potential prospects;
7. Contribute to development of geo-based technology for exploration and improved recovery of petroleum resources;
8. Explain the theory of hydraulics applied to fuels in pump-pipeline systems;
9. Explain the fundamentals of electricity with emphases on electrical safety in petroleum; and
10. List lubrication and wear with importance attached to physical and chemical properties of lubricants.

Course Contents

Petroleum in the contemporary energy scene. Nature, classification and composition of crude petroleum and natural gases. Natural product chemical markers of petroleum and geological sediments. Distribution of petroleum and natural gas resources (the global and Nigerian situations). Petroleum technology, survey of refinery products and process. Petrochemicals in industrial raw materials. Prospects for the petrochemical industry in Nigeria. Aviation fuels; present and future Formulation of Lubricants. Theory of Hydraulics, as applied to fuels in pump-pipeline systems. Fundamentals of electricity with emphases on electrical safety in petroleum
Lubrication and wear, with importance attached to the physical and chemical properties of lubricants.

ICH 306: Polymer Chemistry (2 Units C: LH 30)

Learning outcome
At the end of this course, the students should be able to:
1. explain the nature of polymer and their nomenclature;
2. outline the sources of raw materials for polymers;
3. explain polymer processes in details, condensation polymerisation in details;
4. explain Solubility and solution properties of polymers;
5. explain structure and physiochemical properties polymers and their uses;
6. explain in detailed the mechanisms of polymerisation; addition process; stereospecific reactions.; copolymerisation reaction;
7. identify and discuss phase system reactions;
8. define thermoplastic and thermosetting and their industrial importance;
9. explain the electrical and mechanical properties of polymers;
10. carry out standard Analyses and testing on polymers; and
11. explain polymer degradation.

Course Contents
The nature of polymer nomenclature. Outline of sources of raw materials for polymers. Polymerisation process, condensation polymerisation in details. Solubility and solution properties of polymers. Structure and properties of polymers. Electrical conducting organic wires, smart/sim cards, flat screen televisions. Fibre forming polymers. Bullet proof vests and vehicle bodies from polymers. Polymerisation mechanisms; detailed treatment of addition processes. Stereospecific reactions, copolymerisation reactions. Phase systems for reactions. Industrially important thermoplastic and thermosetting polymers: Polyurethanes. Rubber elasticity. Mechanical properties of polymers. Analysis and testing of polymers. Degradation of polymers.

ICH 317: Industrial Raw Materials Resource Inventory (1 Unit C: LH 15)

Learning Outcomes
At the end of this course, the students should be able to:
1. explain the industrial raw materials and resource inventory;
2. describe the types of inventory costs;
3. survey industries in Nigeria and their raw material requirements;
4. describe the chemistry of minerals, fossils and their uses;
5. describe plants and animal products;
6. define the followings: Nuclear; aerodynamic; wind and hydrodynamic sources of energy;
7. explain the listed items in 5 above;
8. describe the potentials and applications of locally available raw materials as industrial feed stock; and
9. describe how service firms apply inventory management methods to their operations.

Course Contents
Survey of Nigeria's industries and their raw material requirements. Mineral chemistry. Fossils and their uses. Plant and animal products. Nuclear, solar, aerodynamic/wind and hydrodynamic

sources of energy. Potentials and applications of locally available raw materials as industrial feed stocks.

CHM 318: Industrial Chemical Processes (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

1. identify production of primary intermediate and synthesis of industrial and organic chemicals;
2. define the following terms: Polymers, adhesives, dyes, explosives, insecticides, pesticides, herbicides, flavouring agents and pharmaceuticals;
3. describe fermentation processes;
4. describe chemical processing of materials;
5. describe Metallurgy and hydrometallurgical processes;
6. use basic electrochemical concepts and relationships for analysis of electrochemical processes;
7. perform simple electrochemical experiments and evaluate data to draw conclusions from the results;
8. describe electrochemical applications as batteries, fuel cells, electrolytic processes;
9. describe different types of electrochemical energy storage (batteries, fuel cells, electrolysis for hydrogen production) in a future sustainable energy system; and
10. identify important reagents used in the manufacturing of some heavy inorganic chemicals; Cement and binding materials; Inorganic fertilizers.

Course Contents

Production of primary intermediates and synthesis of industrial organic chemicals; Polymers, adhesives, dyes, explosives, insecticides, pesticides, herbicides, flavouring agents and pharmaceuticals. Fermentation process. Chemical processing of minerals. Metallurgy and hydrometallurgical processes. Industrial electrochemistry. Manufacture of some heavy inorganic chemicals. Cement and binding materials. Inorganic fertilizers.

ICH 319: Management and Chemical Industry II (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students will be able to:

1. explain the concept of anatomy of management, industrial relation and production;
2. demonstrate organisational design;
3. explain and discuss management of personnel;
4. plan for productivity; and
5. solve process of creative thinking.

Course Contents

An introduction to the anatomy of management. Industrial Relation. Public Relations. Industrial Psychology. Organizational Design: Management of Personnel. An introduction to the production functions. planning for productivity General Problem-solving processes and creative thinking. Analytical methods of investigation.

CHM 319: Glassblowing Practical (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. students will be able to explain the concept of glass production, types of glass and identification of basic tools;
2. recognise glass coefficient of expansion, working temperature;
3. identifies basic tools for glass production;
4. know basic safety measure during glass production; and
5. Produce various shapes of glass

Course Contents
Properties of glass in general use. Manufacturers' symbols and what they represent. Types of glass used for laboratory wares. Identification methods, working temperatures. Coefficient of expansion, annealing, thermal resistance, correlation of these factors. Identification of basic tools, Gas supplies, safety measures, Cutting, rotation techniques, drawing simple butt joining bulb blowing and bending, rounding off end of tube, taper drawing and reaming, ring seal and side grinding and polishing.

CHM 399: Industrial Attachment II (12 Weeks) (3 Units C: PH 135)

Learning Outcomes
At the end of this course, the students should be able to:
1. have basic knowledge Production report writings;
2. identify basic elements of research which includes: Introduction, literature reviews, methodology/experimentation/materials and methods, results and discussion, conclusion, recommendations and referencing;
3. identify various types of referencing e.g., APA, Chicago, Harvard etc
4. identify Spacing and paragraph used in presentation writings; and
5. identify the use of multimedia in seminar presentations.

Course Contents
Students should be attached to some industrial organizations for additional 12 Weeks at the 300 Level preferably during the long vacation for more real-time relevant industrial experience. Students to be assessed based on seminar presentations, their reports and assessment by supervisors. This only applies to institutions that operate a 4-year industrial chemistry programme.

400 Level

ICH 400: Seminar in Chemistry (2 Units C: PH 90)

Restricted Special topics to be covered include the following: -
1. Mining and Metallurgy**:** Mineral Processing: performance and separation criteria. Crystalline and non-crystalline structures. Metal solidification and heat treatment. Phase transformation and microstructure. Fabrication and uses of materials;

2. Ceramics and Glasses**:** The crystal structure of ceramic materials including silicates, phosphates and nitrides, crystallization of glass formation, glass forming materials. Forming process of glass and ceramic. Chemotherapeutic agents;
3. Chemistry of Paints and Adhesives**:** Classification of paints in terms of use and constitution. The manufacturing process and principles of formulation. The paints and their physical properties. Composition and classification of adhesives. Physical properties, formulation and application of paints and adhesives;
4. Cement Chemistry**:** Classification of cements, cement raw materials and process of manufacture. Structure of cements. Physical and chemical properties of cement. Cement production processes;
5. Leather Chemistry**:** Chemistry of animal skin. Theory of tanning. Pretanning processes. Vegetable tanning process. Materials, their properties and chemistry. Synthetic tanning materials: Chrome and other tonnages. Leather/Tanning;
6. Chemistry of Brewing**:** Bio-organic chemistry of malting and mashing. Chemistry of hop constituents, wart boiling and hop extraction. Techniques in the brewing process. Fermentation. Additive and preservatives. Quality control in Brewing;
7. Soaps and Non-Soap Detergents**:** Introduction to surface chemistry. Micelle formation and the detergency process. The manufacturing processes of soaps and detergents. Synthetic surfactants Anionic, cationic and non-ionic surfactants. Synthetic surfactants. Soaps and Detergents; and
8. (8) Writing Research Proposals**:** Methodology and Process
   *Topics may be chosen from any three of the above in addition to (8) above.

ICH 401: Research Project (6 Units C: PH 270)

Learning Outcomes
At the end of this course, the students should be able to:
1. have basic knowledge Production report writings;
2. choose a Chemistry related Topic for the final year project;
3. identify basic elements of research which includes: Introduction, literature reviews, methodology/experimentation/materials and methods, results and discussion, conclusion, recommendations and referencing;
4. identify various types of referencing e.g. APA, Chicago, Harvard etc;
5. identify Spacing and paragraph used in presentation writings;
6. express the use of multimedia in project seminar presentations; and
7. assessment and grading of the written and oral presentation.

Course Content
Research projects into selected topics in industrial chemistry. Students will be expected to carry out literature survey on chosen topics, perform experiments and produce reports. Students will be subjected to both seminar and oral examinations on their projects.

ICH 453: Chemistry of Industrial Processes (3 Units C: LH 45)

Learning Outcomes
At the end this course, students will be able to:
1. explain chemical process, raw materials availability and industrial reactions;
2. identify location of raw materials;

3. highlight the main uses of primary products;
4. describe legal aspect of factory acts; and
5. recognise industrial products such as oil, fertiliser, plastics and detergents

Course Contents

Overview of chemical processes and products with emphasis on the nature, origin and application of the products of the chemical and allied industries. Raw materials; availability, location, energy, primary chemical products: Industrial reactions, chemical plant, process costing. Consumer and Secondary products: main uses of primary products. Legal aspects; Factory Acts. Etc. Case studies based on industries and/or chemical networks e.g. Industries: Oil, fertilizer, plastics, Detergents etc, chemical networks; Alkali, Chlorine, Fluorine, Coal/Oil etc.

ICH 454: Chemical Process Technology (3 Units C LH 45)

Learning Outcomes

At the end of this course, the students should be able to:
1. use approximate design of multi-component distillation column;
2. recognise the concepts of mixing and agitation, liquid-liquid, solid-liquid and gas-liquid systems;
3. distinguish the types of control systems, primary and final elements;
4. list the types of controls; and
5. use of effectiveness number of transfer units applied to heat exchangers.

Course Contents

Mixing and agitation; liquid-liquid, solid-liquid and gas-liquid systems. Scale up. Residence distribution functions for continuous flow systems. Correlation of heat transfer data. Use of effectiveness number of transfer units applied to heat exchangers. Solvent extraction with partially mixable liquids, selection of suitable extracting agents. Column height and cross section in gas washing. Multi-component vapour-liquid equilibria, bubble points and dew points; key components partial material balances.

The approximate design of Multi-component distillation columns. Minimum reflux ration, minimum number of theoretical stages; feed point location. Rigorous simulation procedure; multi-component composition profiles. Small refinery configurations. Optimization. Case studies covering fluid mechanics, heat and mass transfer processes. Linear Programming. The need for process control. Types of control; open loop, feed forward, feed-back, cascade feedback and adaptive control. Primary elements, final elements. Nature of offset; one, two and three term algorithms. Response to disturbances. Controller optimization. Control of systems with non-linear response characteristics. Direct digital control. Programmed control regimes.

ICH 455: Macromolecular Chemistry (3 Units C: LH 45)

Learning Outcomes

At the end of this course, the students should be able to:
1. use approximate design of multi-component distillation column;
2. explain the concepts of mixing and agitation, liquid-liquid, solid-liquid and gas-liquid systems;
3. identify types of control systems, primary and final elements;

4. list the types of controls; and
5. use of effectiveness number of transfer units applied to heat exchangers.

Course Contents
Polymerization processes; mechanism and kinetics of free radical, ionic and stereo-specific polymerization. Additions of polymerization in bulk, solution, suspension and emulsion. Ring opening polycondensation processes. Gelation Theory. Copolymerization: Addition copolymerization, reactivity ratios, the copolymer-equation. Prediction of reactivity ratios. Degradation of polymers: by thermal, oxidative, photochemical and chemical environments. Kinetics and mechanism of degradation. Inhibitors and retarders. Biopolymers: Organization in protein and nucleic acid structures, super-cooling. Inorganic macromolecules; condensed oxyanion structures, silicates; silicon. Solution properties of macromolecules: Thermodynamics of polymers solutions. Morphology, Crystallinity and Orientation

CHM 499: Industrial Attachment (6 months) (6 Units C: PH 270)

Learning Outcomes
After completing the course, the students will be able to:
1. use various analytical equipment for quality control.
2. apply basic knowledge acquire in the classroom to solve practical problems in the laboratory.
3. give a seminar presentation of new knowledge gain during the industrial training.
4. demonstrate the use of multimedia for seminar presentation.

Course Contents
All candidates enrolled in a 5-year Industrial Chemistry Programme and who have successfully completed all specified required courses for this degree option are required to proceed on industrial attachment normally during their 7th & 8th semesters of residence. A student enrolled in this course would be required to submit a report and give presentation at the end of the period of industrial attachment. The grading will normally be based on the reports, seminars and assessment of supervisors. For 4-year Industrial chemistry programme, students should be attached to some industrial organizations for additional 12 Weeks at the 300 Level preferably during the long vacation for more industrial experience. Students to be assessed based on seminar presentation, their reports and assessment by supervisors.

Minimum Academic Standards

Equipment
1. Gas chromatography (GC)
2. GCMS
3. HPLC
4. GCFID
5. Mass spectrometry
6. UV/ visible
7. IR
8. Carbon/Nitrogen analyser
9. Sulphur analyser

10. AAS
11. XRF
12. XRD
13. Murful furnace
14. Electrophoresis
15. Flame photometer

*** These equipment and laboratory requirements are in addition to the equipment and laboratories required for the B.Sc. Chemistry programme.**

Staffing

Academic Staff

To start any programme in science, there should be a minimum of six academic staff. There is need to have a reasonable number of staff with PhD degrees accounting for at least 70% of the total number and having adequate teaching experience for every programme in the Discipline.

Administrative Support Staff

The services of the administrative support staff are indispensable in the proper administration of departments and faculty offices. It is important to recruit very competent, computer literate senior staff.

Technical Support Personnel

There should be adequate number of qualified technical staff in the various cadres listed below, with a minimum of school certificate and National Diploma in Laboratory Technology or its equivalent:

Chief Technologist
Assistant Chief Technologist
Senior Technologist
Technologist I
Technologist II

There should also be adequate number of Laboratory Assistants with a minimum of school certificate

In addition, there should be supporting Office Staff: Secretary, Typist, Higher Executive Officer and Messenger

Library

Universities should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition well stock and current hardcopies of reference and other textual materials should be provided centrally at the level of the Faculty. A well network digital library should serve the entire university community. Availability of wireless facilities (Wifi) with adequate bandwidth should enhance access to these electronic resources.

There should be a Departmental Library that can contain a minimum of 50 students and equipped with relevant books, journal articles and other relevant news articles particularly on Industrial chemistry.

The Department shall maintain both physical and electronic libraries that shall comprise of the following Units:

Conventional
Circulation Section

Reference/Reserve Section with core Subject textbooks.
Serial/ Special journals
E- library with Internet connectivities
Reading area
Learning common which shall include (Stationary laptops
Wi-Fi, Sofa sitters, Smart boards).
Story rooms (Stratified into levels) for specialised institutions.
Computers (DESKTOPS AND LAPTOPS.)
Internet connectivity (broad band)
Workstation available in the library for at least 25% of the total students enrolled in each academic year/ programme.
Wide screen projection facilities.
Librarian with at least three staff.
Space should be dependent on the population of students enrolled.
Funding of the library's hold be in line with NUC guideline.

Classrooms, Laboratories, Workshops and Office Space
The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

B.Sc. Industrial Mathematics

Overview
Industrial Mathematics is an area with potential beneficial innovations if only it is designed and applied by qualified and appropriate professionals in the industry. It is the application of mathematics and computer programmi
ng skills to solve solutions to certain problems in the industry. Its body of knowledge can be applied
to solve some complex, industrial, finance and economic problems.

Philosophy
The philosophy of the programme is to prepare graduates for career as mathematicians in business and industry. It should produce graduates of high technical abilities in the applications of mathematical solutions to real-world problems.

Objectives
The objectives of the programme are to:
1. prepare the students to meet the demand of mathematical professionals in both existing and emerging industrial sectors;
2. develop in students a sense of enthusiasm for mathematics; and to involve them in an intellectually stimulating and satisfying experience of learning and studying;
3. provide students a broad and balanced foundation in general undergraduate mathematics knowledge and practical skills in its applications in industry;
4. develop in students the ability to apply their mathematics knowledge and skills to the solution of theoretical and practical problems in mathematics;
5. develop in students a range of transferable skills of value in mathematical and non-mathematical related employment;
6. provide students with knowledge and skills base from which they can proceed to further studies in specialized areas of applied mathematics or multi-disciplinary areas involving mathematics; and
7. generate in students an appreciation of the importance of mathematics in an industrial, economic, environmental and social context.

Unique Features of The Programme
The B. Sc. Industrial Mathematics Programme is designed to train the needed skilled manpower to bring to bear the applications of Mathematics to address industrial problems: financial, stock, etc. towards development of the country, taking advantage of current innovations in technology, which Pure and Applied Mathematics have not really addressed directly.

Employability Skills
Graduates from the programme will be able to have the ability to apply knowledge and skills to solving theoretical and practical problems in Mathematics and other related areas in relation to national and societal needs. These skills include the following:
1. creative and critical thinking;
2. problem solving;
3. analytical thinking;

4. initiative;
5. quantitative reasoning;
6. technology;
7. ability to manipulate precise and intricate ideas;
8. logical thinking;
9. Communication;
10. time management;
11. teamwork;
12. independence; and
13. numeracy.

21st Century Skills

1. Problem solving skills
2. Teamwork
3. Computer and digital literacy
4. Critical thinking; and
5. Communication skills.

Admission and Graduation Requirements

Admission Requirements

There are two different pathways by which candidates can be admitted into the programmes in the discipline: the indirect entry mode and the Direct Entry.

Indirect entry mode

Admission through the indirect mode shall take the student to 100 Level. To be eligible for admission, the candidate must have, a minimum of credit pass in five subjects at not more than two sittings in Senior Secondary Certificate or its equivalent. The credit passes are required in the following subjects: English language, Mathematics, Chemistry, Physics and Biology/Agric. Science or Economics. In addition, the candidate is expected to pass both the Unified Tertiary Matriculation Examination (UTME) and the University screening test. The UTME subjects are: English Language, Physics, Mathematics and Chemistry or Economics.

Direct Entry

Candidates with two 'A' level passes (graded A-E) at the GCE/JUPEB Advanced Level in two or more relevant subjects (Mathematics, Further Mathematics, Physics and Chemistry/Economics) or Good Diploma at minimum of Upper Credit in Mathematics, Physics and Engineering, may be admitted into 200-level.

Graduation Requirements

To be eligible for the award of B.Sc. in Industrial Mathematics, a student must have:

1. passed all the core courses, University/Faculty/School required courses and electives;
2. accumulated a **minimum of 120 course units** for students admitted through UTME and **90 course units** for students admitted through Direct Entry; and
3. pass all required courses.

Global Course Structure

100 LEVEL

Course Code	Course Title	Units	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
MTH 101	Elementary Mathematics I	2	C	30	
MTH 102	Elementary Mathematics II	2	C	30	
MTH 103	Elementary Mathematics III	2	C	30	
STA 112	Introduction to Statistics and Probability	3	C	45	
ECO 101	Principles of Economics I	2	C	30	
ECO 102	Principles of Economics II	2	C	30	
	Total	**20**			

200 LEVEL

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	
ENT 211	Entrepreneurship and Innovation	2	C	15	45
COS 201	Computer Programming I	3	C	30	45
MTH 201	Mathematical Methods	2	C	30	
MTH 202	Elementary Differential Equations	2	C	30	
MTH 203	Sets, Logics and Algebra	2	C	30	
MTH 204	Linear Algebra I	2	C	30	
MTH 205	Linear Algebra II	1	C	30	-
IMT 206	Abstract Algebra	2	C	30	

Course Code	Course Title	Unit(s)	Status	LH	PH
MTH 207	Real Analysis	2	C	30	
MTH 209	Introduction to Numerical Analysis	2	C	30	
MTH 210	Vector Analysis I	2	C	30	
	Total	**24**			

300 LEVEL

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace and Conflicts Resolutions	2	C	30	
ENT 312	Venture Creation	2	C	15	45
IMT 301	Financial Mathematics	2	C	30	
MTH 302	Ordinary Differential Equations	2	C	30	
IMT 303	Mathematical Computing	2	C	15	45
MTH 305	Complex Analysis II	2	C	30	
IMT 306	Introduction to Operations Research	2	C	30	
IMT 307	Functional Analysis	2	C	30	
MTH 308	Introduction to Mathematical Modelling	2	C	30	
IMT 312	Financial Derivatives	2	C	30	
IMT 320	Industrial Attachment – (12 weeks)	3	C	-	135
	Total	**23**			

400 LEVEL

Course Code	Course Title	Units	Status	LH	PH
MTH 401	Theory of Ordinary Differential Equations	2	C	30	

Course Code	Course Title	Units	Status	LH	PH
MTH 402	Theory of Partial Differential Equations	2	C	30	
IMT 404	Optimization Theory	2	C	30	
MTH 405	General Topology	2	C	30	
IMT 411	Mathematical Economics I	2	C	30	
IMT 412	Mathematical Economics II	2	C	30	
IMT 499	Project	6	C		270
	Total	**18**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. identify possible sound patterns in English Language;
2. list notable language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and Deductive Argument and Reasoning Methods, Analogy, Generalisation and Explanations). Ethical considerations, Copyright Rules and Infringements. Writing Activities: (pre-writing, writing, post writing, editing and proofreading; brainstorming, outlining, paragraphing, types of writing, summary, essays, letter, curriculum vitae, report writing, note making etc. mechanics of writing). Comprehension Strategies: (reading and types of reading, comprehension skills, 3RsQ). Information and communication technology in modern language learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies.

Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigeria Peoples and Culture (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of trade, economic and self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building analyse the role of the Judiciary in upholding people's fundamental rights identify acceptable norms and values of the major ethnic groups in Nigeria; and
6. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents
Nigerian history; culture and art up to 1800 (yoruba, hausa and igbo peoples and culture, peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria, colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914, formation of political parties in Nigeria. Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics, Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification). Judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values. Patterns of citizenship acquisition. Citizenship and civic responsibilities. Indigenous languages, usage and development. Negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – reconstruction, rehabilitation and re-orientation). Re-orientation strategies. Operation feed the nation (OFN). Green revolution and austerity measures. War against indiscipline (WAI). War against indiscipline and corruption (WAIC). Mass mobilization for self-reliance, social justice and economic recovery (MAMSER). National orientation agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic definition of set, subsets, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers, integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers, algebra of complex numbers, the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative as limit of rate of change. Techniques of differentiation. Extreme curve sketching. Integration as an inverse of differentiation. Methods of integration. Definite integrals. Application to areas, volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

MTH 103: Elementary Mathematics III (Vectors, Geometry and Dynamics)
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. solve some vectors in addition and multiplication;
2. calculate force and momentum; and
3. solve differentiation and integration of vectors.

Course Contents
Geometric representation of vectors in 1-3 dimensions, components, direction cosines. Addition, scalar, multiplication of vectors, linear independence. Scalar and vector products of two vectors. Differentiation and integration of vectors with respect to a scalar variable. Two-dimensional co-ordinate geometry. Straight lines, circles, parabola, ellipse, hyperbola. Tangents, normals. Kinematics of a particle. Components of velocity and acceleration of a particle moving in a plane. Force, momentum, laws of motion under gravity, projectiles and resisted vertical motion. Elastic string and simple pendulum. Impulse, impact of two smooth spheres and a sphere on a smooth surface.

ECO 101: Principles of Economics I (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the students should be able to:
1. identify the basic concepts in economics including scarcity, choice and scale of preference; basic laws of demand and supply;
2. explain the nature of elasticity and its applications, as well as short and long run production functions; and
3. explain pricing of factors of production and market structure consisting of perfect competitive market and imperfect competitive markets.

Course Contents
An introduction to the nature of economic science and its basic problem of scarcity and choice; the methodology of economics and major areas of specialization; historical development of ideas from the classical, neoclassical, utilitarian and welfare economists. Major findings in the various areas of specialization and elementary principles of microeconomics, as well as partial equilibrium analysis. Demand and Supply: the laws. Determinants and types in statement and graphical format. The firms and production functions, as well as market structure.

ECO 102: Principles of Economics II (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the students should be able to:
1. discuss the basic concept of functions, index numbers and dependent and independent variables in functions, as well as national income accounting; and
2. discuss circular flow of income with simple two-sector model, as well as elementary issues on consumption, savings, investment, and, government's revenue, expenditure and roles of domestic money and foreign exchange.

Course Contents
Treatment of Functions, Index numbers, variables and functional relationships. Basic concept of national income accounting. The circular flow of income, withdrawals and injections. National Income determination and analysis. Introduction to consumption, savings and investments. Elementary understanding of government activities: taxation and government expenditure; money and the banking system. Aggregate supply, unemployment and inflation. The basic terminology in external economy such as exchange rates, balance of payment and global interdependence.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and innovation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk-taking state the characteristics of an entrepreneur
2. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence engage in entrepreneurial thinking;
3. identify key elements in innovation; describe stages in enterprise formation, partnership and networking including business planning;
4. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
5. state the basic principles of e-commerce.

Course Contents
Concept of entrepreneurship (entrepreneurship, intrapreneurship/corporate entrepreneurship). Theories, rationale and relevance of entrepreneurship (Schumpeterian and other perspectives, risk-taking, necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of entrepreneurs (opportunity seeker, risk taker, natural and nurtured, problem solver and change agent, innovator and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking, and creative thinking). Innovation (concept of innovation, dimensions of innovation, change and innovation, knowledge and innovation); enterprise formation, partnership and networking (basics of business plan, forms of business ownership, business registration and forming alliances and join ventures). Contemporary entrepreneurship Issues (knowledge, skills and technology, intellectual property, virtual office, networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, youth and women entrepreneurship, entrepreneurship support institutions, youth enterprise networks and environmental and cultural barriers to entrepreneurship); basic principles of e-commerce.

COS 201: Computer Programming I (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the principles of good programming and structured programming concepts;
2. explain the programming constructs, syntax and semantics of a higher-level language;
3. describe the chosen programming language variables, types, expressions, statements and assignment; simple input and output;
4. describe the programme control structures, functions and parameter passing, and structured decomposition; and
5. develop simple programmes in the taught programming language as well as debug and test them.

Course Contents
Introduction to computer programming. Functional programming; Declarative programming; Logic programming; Scripting languages. Introduction to object-orientation as a technique for modelling computation. structured, and even some level of functional programming principles; Introduction of a typical object-oriented language, such as Java; Basic data types, variables, expressions, assignment statements and operators; Basic object-oriented concepts: abstraction; objects; classes; methods; parameter passing; encapsulation. Class hierarchies and programme organisation using packages/namespaces; Use of API – use of iterators/enumerators, List, Stack, Queue from API; Searching; sorting; Recursive algorithms; Event-driven programming: event-handling methods; event propagation; exception handling. Introduction to Strings and string processing; Simple I/O; control structures; Arrays; Simple recursive algorithms; inheritance; polymorphism.

Lab work: Programming assignments; design and implementation of simple algorithms, e.g., average, standard deviation, searching and sorting; Developing and tracing simple recursive algorithms. Inheritance and polymorphism.

MTH 201: Mathematical Methods 1 (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain real-valued functions of a real variable;
2. solve some problems using mean value theorem and Taylor series expansion; and
3. evaluate line integral, surface integral and volume integrals.

Course Contents
Real-valued functions of a real variable. Review of differentiation and integration and their applications. Mean value theorem. Taylor series. Real-valued functions of two and three variables. Partial derivatives chain rule, extrema, lagrangian multipliers. Increments, differentials and linear approximations. Evaluation of line integrals. Multiple integrals.

MTH 202: Elementary Differential Equations (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. define the following: order and degree of a differential equation;
2. describe some techniques for solving first and second order linear and non-linear equations; and
3. solve some problems related to geometry and physics.

Course Contents
Derivation of differential equations from primitive geometry, physics etc. Order and degree of differential equation. Techniques for solving first and second order linear and non-linear equations. Solutions of systems of first order linear equations. Finite linear differential equations. Application to geometry and physics.

MTH 203: Sets, Logic and Algebra I (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. solve various problems using the concept of set theory;
2. recognise Algebraic structures; and
3. describe the meaning of logic in Mathematics.

Course Contents
Introduction to the language and concepts of modern mathematics. Topics include: basic set theory: mappings, relations, equivalence and other relations, Cartesian products, binary logic, methods of proof, binary operations. Algebraic structures, semi-groups, rings, integral domains, fields. Homeomorphics. Number systems; properties of integers, rationals, real and complex numbers.

MTH 204: Linear Algebra I **(2 Units C: LH 30)**

Learning Outcomes
At the end of the course, students should be able to:
1. explain vector space;
2. describe linear transformations and their representation by matrices; and
3. calculate algebra of various matrices.

Course Contents
Vector space over the real field. Sub-spaces, linear independence, basis and dimension. Linear transformations and their representation by matrices – rings, null space, rank. Singular and non-singular transformation and matrices. Algebra of matrices.

MTH 205: Linear Algebra II **(1 Unit C: LH 15)**

Learning Outcomes
At the end of the course, students should be able to:
1. recognise systems of linear equations.
2. calculate the Eigen values and Eigen vectors.
3. describe the Cayley-Hamilton theorem and its uses.

Course Contents
Systems of linear equation, change of basis, equivalence and similarity. Eigen values and Eigen vectors. Minimum and characteristic polynomials of a linear transformation (matrix). Cayley-Hamilton theorem. Bi-linear and quadratic forms, orthogonal diagonalisation. Canonical forms.

MTH 207: Real Analysis I **(2 Units C: LH 30)**

Learning Outcomes
At the end of the course, students should be able to:
1. describe convergence of sequence of numbers;
2. discuss the monotone, cauchy sequences;
3. test for convergence of series; and
4. state roles and mean value theorem.

Course Contents
Bounds of real numbers, convergence of sequence of numbers. Monotone sequences, the theorem of nested intervals. Cauchy sequences, tests for convergence of series. Absolute and conditional convergence of series and re-arrangements. Completeness of reals and incompleteness of rationals. Continuity/and differentiability of functions. Rolles' mean and value theorems for differentiable functions, Taylor series.

MTH 209: Introduction to Numerical Analysis **(2 Units C: LH 30)**

Learning Outcomes
At the end of the course, students should be able to:
1. solve some numerical solution of algebraic and transcendental equations;
2. describe curve fitting;

3. discuss error analysis;
4. calculate interpolation and approximation;
5. solve some numerical differentiation and numerical integration problems; and
6. solve some numerical problems in ordinary Differential equations with initial value problems;

Course Contents
Solution of algebraic and transcendental equations. Curve fitting. Error analysis. Interpolation and approximation. Zeros of non-linear equations 'in one variable'. Systems of linear equations. Numerical differentiation and integration. Initial value problems in ordinary differential equation.

MTH 210: Vector Analysis (1 Unit C: LH 15)

Learning Outcomes
At the end of the course, students should be able to:
1. describe vector algebra;
2. explain geometrical equation of lines and planes; and
3. outline problems in gradients, divergent and curl.

Course Contents
Elementary vector algebra, vector and vector triple, vector products (more application solution of vector equation, plain curves and space curves. Geometrical equation of lines and planes. Linear independence of vectors; components of vectors, direction cosines; position vector and scaler products; Frenet-Serret formulas; differential definition of gradients, divergent and simple multiplication)

IMT 206: Abstract Algebra (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. state various group, subgroup, ring, field and Integral Domain;
2. calculate the H.C.F and L.C.M of Polynomials;
3. elucidate the concept of groups, subgroups, normal subgroup, rings, fields;
4. apply the concept of groups, subgroups, normal subgroup, rings, fields to integral domain, sub-domain, direct sum and linear transformations.

Course Contents
Introduction to the language and concepts of Modern Mathematics: Basic Sets Theory, mappings, equivalence and other relations, Cartesian Products, Binary Logic, Method of Proof, Binary Operations, Algebraic Structures, Semi-groups, Rings, Integral Domain Fields, Homomorphism, Number Systems, Properties of Integers, Rational, Real and Complex Numbers; Euclidean algorithm for polynomials H.C.F. and L.C.M. of polynomials..

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents
Concepts of Peace, conflict and security in a multi-ethnic nation. Types and theories of Conflicts: ethnic, religious, economic, geo-political conflicts. Structural conflict theory, realist theory of conflict, frustration-aggression conflict theory. Root causes of conflict and violence in Africa: indigene and settlers' phenomenon. Boundaries/boarder disputes. Political disputes. Ethnic disputes and rivalries. Economic inequalities. Social disputes. Nationalist movements and agitations. Selected conflict case studies – Tiv-Junkun. Zango Kartaf. Chieftaincy and land disputes etc. Peace building, management of Conflicts and Security: Peace & human Development. Approaches to peace & conflict management --- (Religious, Government, Community Leaders etc.). Elements of peace studies and conflict resolution. Conflict dynamics assessment scales: constructive & destructive. Justice and legal framework. Concepts of social justice. The Nigeria legal system. Insurgency and terrorism. Peace mediation and peace keeping. Peace & security council (international, national and local levels) gents of conflict resolution – conventions, treaties Community Policing. Evolution and imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of international organizations in conflict resolution. (a). The United Nations, UN and its conflict resolution organs. (b). The African Union & peace security council (c). ECOWAS in peace keeping. Media and traditional institutions in peace building. Managing post-conflict situations/crisis: Refugees; internally displaced persons, IDPs. The role of NGOs in post-conflict situations/crisis.

ENT312: Venture Creation (2 Units C: LH 30; PH 45)

Learning Outcomes
At the end of this course, students, through case study and practical approaches, should be able to
1. describe the key steps in venture creation; spot opportunities in problems and in high potential sectors regardless of geographical location;
2. state how original products, ideas, and concepts are developed;
3. develop business concept for further incubation or pitching for funding;
4. identify key sources of entrepreneurial finance;
5. implement the requirements for establishing and managing micro and small enterprises;
6. conduct entrepreneurial marketing and e-commerce;
7. apply a wide variety of emerging technological solutions to entrepreneurship; and

8. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents
Opportunity identification (sources of business opportunities in Nigeria, environmental scanning, demand and supply gap/unmet needs/market gaps/market research, unutilised resources, social and climate conditions and technology adoption gap). New business development (business planning, market research); entrepreneurial finance (venture capital, equity finance, Micro finance, Personal savings, small business investment organizations and Business plan competition). Entrepreneurial marketing and e-commerce (principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first mover advantage, E-commerce business models and successful E-commerce companies,). Small business management/family business. Leadership & management. Basic book keeping. Nature of family business and family business growth model. Negotiation and business communication (Strategy and tactics of negotiation/bargaining. Traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological Solutions (the concept of market/customer solution, customer solution and emerging technologies. Business applications of new technologies - Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy etc. Digital Business and E-Commerce Strategies).

IMT 301: Financial Mathematics (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. demonstrate a firm understanding of modern theory of financial mathematics;
2. explain the basic concepts in Financial Mathematics; and
3. conduct transactions concerning annuities, actuarial, statistics and mortality analysis

Course Contents
Various topics in mathematics of finance are covered, including annuities. Actuarial. statistics and mortality analysis. principles and methods of actuarial treatment of statistical data, including the compilation and other rates. exposure to risk formula selection. multiple decrements. history and distinctive features of the principle's actuarial tables in common use. vital statistics, including censuses of births, deaths, marriages, and migration statistics. forecasting rates of mortality. General Theory of Projection.a short account of the population of Nigeria. construction of national life table, sickness and other rates. construction of tables. valuation of liabilities under life policies and special topics. multiple decrement (service) and associated single decrement tables. values of and contribution for sickness benefits. pension benefits, disability benefits and widows and orphans benefits.

MTH 302: Ordinary Differential Equations (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. describe line dependence, Wronskian, reduction order, variation of parameters, series solution about ordinary and regular points; and
2. discuss orthogonal polynomials.

Course Contents
Ordinary differential equations: linear dependence, Wronskian, reduction order, variation of parameters, series solution about ordinary and regular points. Special functions: Gamma, Beta, Bessel, Legendre's theorem, hyper geometric. Laplace transform and applications to initial value problems

IMT 303: Mathematical Computing (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able:
1. demonstrate knowledge of computer systems and its historical development;
2. give a general overview of computer architecture, hardware, software and liveware;
3. use computers to process information;
4. create documents;
5. demonstrate knowledge in basic information technology;
6. exhibit deep knowledge of principles of application programs;
7. give an overview of MAPLE environment (Document mode and worksheet
8. explain simulating models and MATLAB; Matlab fundamentals
9. write programmes to solve simple real-life problems; and
10. use Latex.

Course Contents
Introduction to computer systems and its historical development. contribution from mathematicians (e.g. Leibnitz, Boole, Pascal, Babbage, Turing, von Neumann). numerical computation and mechanical computing devices. general overview of computer architecture, hardware, software and liveware, programming languages, application packages, the present day use of computers and its future. introduction to Linux Operating System: UNIX commands, directory structure, text editors, user accounts and file permissions, text editors, virtual terminals in text mode. programming with C on Unix system. editing (with emacs), compilation, debugging etc. formatted input-output, control structures, loops, C-functions, pointers, File input/output, command-line arguments (the above shall be discussed with mathematical applications). introduction to X-Windows system;overview of MAPLE environment (document mode and worksheet): basic mathematical operations in maple and their commands, assignment, equation. Boolen equality, lists, sets, expressions, simplify, factor, expand. solving ordinary differential equations, evaluating and differentiating functions. Writing programmes to solve simple real-life problems. plotting graphs, exporting and printing graphs. simulating models. overview of MATLAB. Matlab fundamentals. Variable and Workspace. operators, expression and statements. vectors and matrices. controlling command window, input and output, executing matrix linear algebra with Matlab. defining Matlab functions and creating scripts, Function M-file. and flow control (Condition and Loop controls).

MTH 305: Complex Analysis II (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. discuss Laurent expansion, Isolated singularities and Residues; and
2. define Residue theorem and Rouche's theorem

Course Contents
Laurent expansions. Isolated singularities and residues. Residue theorem. Calculus of residue, and application to evaluation of integrals and to summation of series. Maximum modulus principle. Argument principle. Rouche's theorem. The fundamental theorem of algebra. Principle of analytic continuation. Multiple valued functions and Riemann surfaces.

IMT 306: Introduction to Operations Research (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. build their own formulations;
2. expand existing formulations;
3. critically evaluate the impact of model assumptions and choose an appropriate solution technique for a given formulation.

Course Contents
Phases of operation research study. classification of operation research models' linear dynamic and integer programming. Decision Theory. Inventory Models, Critical Path Analysis and Project Controls.

IMT 307: Function Analysis (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. define Hilbert spaces, Banach spaces and vector spaces; and
2. describe Banach Algebra.

Course Contents
Hilbert Spaces. bounded linear functionals. operators on Banach spaces. topological vector spaces. and Banach algebra.

MTH 308: Introduction to Mathematical Modelling (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. develop some mathematical models in Biology, Physics, Chemistry, and Social Science;
2. describe flow Diagrams;
3. discuss method of Analysis of models formulated; and
4. describe the method of solutions to the models formulated.

Course Contents
Methodology of model building; identification, formulation and solution of problems, cause-effect diagrams. Equation types: algebraic, ordinary differential, partial differential, difference, integral and functional equations. Applications of mathematical models to physical, biological, social and behavioural sciences.

IMT 312 - Financial Derivatives (2 Units C: LH 30)

Learning Outcomes
Upon the completion of this course, students should be able to:
1. explain the concept of Simple Market Model, Basic Notions and Assumptions, No-Arbitrage Principle, One-Step Binomial Model;
2. handle risk and return, forward and futures contracts and risk-free asset;
3. handle dynamics of stock prices;
4. apply investment strategies to the Binomial Tree Model and other stock models.

Course Contents
Introduction: A Simple Market Model, Basic Notions and Assumptions. No-Arbitrage Principle, One-Step Binomial Model. Risk and Return. Forward and futures Contracts. Options, Risk-Free Asset, Money Market, Zero-Coupon Bonds, Coupon Bonds, Money Market Account. Risky Assets: dynamics of stock prices, return, expected return. Model: Risk-Neutral Probability, Martingale Property, Other Models, Trinomial Tree Model, Stock and Money Market Models. investment strategies, application to the Binomial Tree Model and Fundamental Theorem of Asset Pricing.

IMT 320: Industrial Attachment (12 Weeks) (3 Units C: PH 135)
Students should be attached to some industrial organizations for 12 Weeks at the 300 Level preferably during the long vacation for more industrial experience. Students to be assessed based on seminar presentation, their reports and assessment by supervisors.

400 Level

MTH 401: Theory of Ordinary Differential Equations (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. define existence and uniqueness theorems;
2. describe Volterra and Fredholm types; and
3. solve some problems of reduction of ordinary differential equations to integral equations.

Course Contents
Existence and uniqueness theorems, dependence of solutions on initial data and parameters. Properties of solutions. Sturm comparison and Sonin-Polya theorems. Linear and non-linear systems. Floquet's theory and stability theory. Integral equations: classification, Volterra and Fredholm types, Neumann series. Fredholm alternative for degenerate Hilbert – Schmidt kernels. Reduction of ordinary differential equations to integral equations. Symmetric kernels, eigenfunction expansion with application.

MTH 402: Theory of Partial Differential Equations (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. define first and second order linear equations;
2. describe Cauchy problems; and
3. solve some problems in parabolic, hyperbolic and elliptic equations.

Course Contents
Theory and solutions of first-order and second order linear equations. Classification, characteristics and canonical forms. Cauchy problems. Elliptic equations: Laplace's and Poisson's formulas, properties of harmonic functions. Hyperbolic equations; wave equations, retarded potential: transmission line equation, Riemann method. Parabolic equation: diffusion equation, singularity function, boundary and initial – value problems.

IMT 404: Optimization Theory (2 Units C: LH 30)

Learning Outcomes
At the end of the of this course, students should be able:
1. develop a fundamental understanding of the role of optimization technique;
2. describe and explain complex systems ;
3. and enumerate the theoretical and computational tools needed to solve equations that arise as models.

Course Contents
Linear programming models. the simplex method, formulation and theory. quality integer programming. transportation problem. Two-person zero-sum games. nonlinear programming. quadratic programming Kuhn-tucker methods. optimality criteria. simple variable optimization. multivariable techniques. gradient methods.

MTH 405: General Topology (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. define the following: topological spaces, continuous functions and topological invariants;
2. describe pointwise and uniform convergence.

Course Contents
Topological spaces, definition, open and closed sets neighbourhoods. Coarser, and finer topologies. Basis and sub- basis. Separation axioms, compactness, local compactness, connectedness. Construction of new topological spaces from given ones. Sub-spaces and quotient spaces. Continuous functions, homeomorphisms and topological invariants. Spaces of continuous functions: Pointwise and uniform convergence.

IMT 411: Mathematical Economics I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. discuss the concepts and theory of microeconomic;
2. explain the mathematical approach to address multi market equilibrium well as Pareto optimality problem;
3. account for the general economic optimization over time, linear models such as Input-Output (I-O) models; and
4. discuss the linear programming concepts and solutions.

Course Contents
Microeconomic theory is treated with a mathematical approach. Topics will include the following: theory of consumer behaviour, constrained optimizing behaviour. the Slutsky equation, construction of utility number. theory of the firm. constrained optimizing behaviour, CES production function, market equilibrium with lagged adjustment and continuous adjustment. multi-market equilibrium. Pareto optimality. general economic optimization over time. linear model. input-output (I-O) models, linear programming concepts and solutions.

IMT 412 - Mathematical Economics II (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. exhibit a sound understanding of mathematical techniques;
2. formulate economic problems in mathematical terms;
3. apply relevant tools for analyzing economic problems; and
4. provide students with the mathematical tools required for economic analysis at the undergraduate level.

Course Contents
Micro-economic theory is treated with a mathematical approach in the following areas: Simple model of income determination. consumption and investment. the IS curve, monetary equilibrium, the LM curve. labour wages and price (inflation) models. full employment equilibrium models of income determination. aggregate demand and supply analysis. balance of trade (payments). model of income determination. stabilization policy. comparative statistics. analysis of monetary fiscal policy. the Harold Domar growth model and the neo-classical growth model.

IMT 499 – Project (6 Units C: LH 270)

Learning Outcomes
This course is the project component of the research method and proposal writing, therefore, the course will:
1. equip students with the skills and knowledge in the analysis and interpretation of data; and
2. expose the students to report writing.

Course Contents
A research project and dissertation to be undertaken on any topic of mathematical interest / its areas of application in the Industrial Mathematics

Minimum Academic Standards

Equipment

Acquisition of a sufficient number equipment to enable adequate implementation of the benchmark statements as they relate to programmes to Science / Mathematics Professional practice such as:
Computers
Computer software
Flash drives
Printers
Projectors
Smart board
Smart TV
Video machine
Screen board
Pen drive
Loudspeaker with microphones

Staffing

Academic Staff

1. The established staff/students ratio of 1:20 for Science should be met. There should be a minimum of six academic staff
2. Training and retaining of academic staff and students should be pursued vigorously.
3. All academic staff should have computing skills.
4. 75% of the academic staff should possess PhDs.
5. At least 20% of the academic staff should be Professors/Readers and 35 % Senior Lecturer and 45% others.

Non-Academic Staff /Administrative Staff

The Non-Academic - Academic staff ratio in the University should be 1: 4 maxima.

Technical Support Personnel

The services of technical support staff, which are indispensable in the proper running of laboratories and workshops, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

Qualified Laboratory Technologists – Qualification/Areas of specialization: BSc or HND in Computer / Electronic Engineering, Industrial Mathematics knowledgeable in the use of Maths Application Packages (MatLabs, Mables, LaTex, etc).

Administrative Support Staff

The services of the administrative support staff are indispensable in the proper administration of departments and faculty offices. It is important to recruit very competent, computer literate senior staff.
All Administrative, Secretarial and Clerical Staff should have computing skills.

Library

The University should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition, well stock, current hardcopies of reference/ professional journals and other textual materials, to complement the University central library, should be provided. A well network digital library should serve the entire university community. Availability of wireless facilities (Wifi) with adequate bandwidth should enhance access to these electronic resources.

In any case, there should be internet ready workstations available in the library for least 25% of the total student enrolled in each academic programme. The funding of the library should be in line with NUC guidelines

Classrooms, Laboratories, Workshops and Office Space

The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

B. Sc. Industrial Physics

Overview
In this document, the Core Curriculum and Minimum Academic Standards (CCMAS) for the education and training of students studying for first degree in the programme of the Industrial Physics discipline in the Nigerian University System is prescribed. It is expected that the components of the minimum standards described here will enable the graduates of the programme to acquire sufficient theoretical and practical knowledge to contribute to national advancement and be competitive in the globalised environment. Institutions are expected to use these standards as the minimum guidelines in the innovative design of their own specific programmes.

Philosophy
The programme aims at using sound knowledge of physical principles and analytical skills to develop new products, manage/operate industrial systems, as well as ensure optimization of industrial processes. The aim of the four-year programme in Industrial Physics is to produce graduates who will not only have a good foundation of physics, but will at same time possess adequate training and applicable knowledge of industrial operations.

The programme's curriculum is therefore specifically designed to enable graduates begin their careers in industry by instilling in them knowledge of scientific skills and techniques needed in relevant industries. Graduates will be equipped with special expertise in key industrial activities such as semiconductor technology, instrumentation, electronics and communications engineering, materials science and technology, energy and power and industrial research.

Objectives
The objectives of the programme are to:
1. provide students with a broad and balanced foundation of Industrial Physics knowledge and practical skills;
2. instil in students a sense of enthusiasm for Industrial Physics and appreciation of its applications in different contexts;
3. develop in students the ability to apply their knowledge and skills in Industrial Physics to the solution of theoretical and practical problems;
4. develop in students through an education in Industrial Physics a range of transferable skills of value in physics and other areas; and
5. provide students with a knowledge and skills base for further studies in Industrial Physics or multi-disciplinary areas involving industrial physics.

Unique Features of the Programme
The unique features of the programme include:
1. the programme of Industrial Physics offers course on Physics entrepreneurship;
2. the students will apply knowledge gained in designing and fabrication of solar cells and panels;
3. build windmills and generate energy;
4. design and construct solar distillation systems;
5. install solar panels in houses;

6. use different materials: polymer, ceramics, metals and semiconductors for industrial applications; and
7. utilize modern electronics.

Employability Skills
1. Time management
2. Creativity
3. Resourcefulness
4. Critical thinking
5. Organisation

21st Century Skills
1. ICT skills
2. written and oral communication skills
3. teamwork
4. interpersonal skills
5. sound ethical standards
6. entrepreneurship
7. creativity
8. collaboration
9. critical thinking

Admission and Graduation Requirements

Admission Requirements
1. The entry requirements for four-year degree programme shall be at least passes at credit level at the Senior Secondary Certificate (SSC) or equivalent in five subjects at not more than two sittings. Such subjects include, English Language, Mathematics, Physics, Chemistry and Biology/ Agriculture. In addition, an acceptable pass in the Unified Tertiary Matriculation Examination (UTME) is required for admission into 100 Level. Acceptable UTME subjects are: English Language, Physics, Mathematics and Chemistry.
2. Candidates with at least two 'A' level passes in Physics and any of Mathematics, Chemistry or Biology at the GCE Advanced Level or IJMB or JUPEB, may be considered for admission into 200 Level, provided they satisfy the 'O' level requirements.

Graduation Requirements
Expected duration for UTME candidates shall be 4 years and students are required to pass a minimum of 120 units, while for Direct Entry students, expected duration for graduation shall be 3 years and would be expected to pass a minimum of 90 units which must include all compulsory courses.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 103	General Physics III	2	C	30	-
PHY 104	General Physics IV	2	C	30	-
PHY 107	General Physics Practical I	1	C	-	45
PHY 108	General Physics Practical II	1	C	-	45
CHM 101	General Chemistry I	2	C	30	-
CHM 102	General Chemistry II	2	C	30	-
CHM 107	General Chemistry Practical I	1	C	-	45
CHM 108	General Chemistry Practical II	1	C	-	45
	Total	**27**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
PHY 201	General Physics V (Elementary Modern Physics)	2	C	30	-

Course Code	Course Title	Unit(s)	Status	LH	PH
PHY 202	Electric Circuits and Electronics	2	C	30	-
PHY 204	General Physics IV (Waves and Optics)	2	C	30	-
PHY 205	Thermal Physics	2	C	30	-
PHY 207	Experimental Physics I	1	C	-	45
PHY 208	Experimental Physics II	1	C	-	45
	Total	**14**			

300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolutions	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
PHY 303	Electromagnetism I	3	C	45	-
PHY 305	Quantum Physics	3	C	45	-
PHY 306	Statistical and Thermal Physics	3	C	45	-
PHY 307	Experimental Physics III	1	C	-	45
PHY 308	Experimental Physics IV	1	C	-	45
PHY 314	Solid State Physics I	3	C	45	-
PHY 315	Electronics	2	C	30	-
PHY 398	12 WEEKS SIWES	3	C		
	Total	**23**			

400 Level

Course Code	Course Title	Units	Status	LH	PH
PHY 401	Quantum Mechanics	2	C	30	-
PHY 403	Mathematical Methods in Physics	2	C	30	-
PHY 423	Solid State Physics II	3	C	45	-
PHY 415	Science of Materials	2	C	30	-
PHY 432	Electromagnetic Theory II	3	C	30	-
PHY 455	Student Research Project	6	C	-	-
PHY 490	Physics Entrepreneurship	2	C	15	45
	Total	**20**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. identify possible sound patterns in English Language;
2. list notable language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English Language (vowels and consonants, phonetics and phonology. English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). grammar and usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and critical thinking and reasoning methods (logic and syllogism, inductive and deductive argument and reasoning methods, analogy, generalisation and explanations). Ethical considerations, copyright rules and infringements. Writing activities: pre-writing (brainstorming, outlining); writing (paragraphing); post writing (editing and proofreading). Types of writing: summary, essays, letter, curriculum vitae, report writing, note making, etc. Mechanics of writing. Comprehension strategies: (Reading and types of Reading, Comprehension Skills, 3RsQ). Information and

Communication Technology in modern language learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening; and report writing.

GST 112: Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of trade, economic and self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards nation building;
6. analyse the role of the Judiciary in upholding people's fundamental rights;
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justices and national development. Law definition and classification. Judiciary and fundamental rights; individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts; cultism, kidnapping and other related social vices); re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation); re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption(WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA; and current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes

At the end of the course students should be able to:

1. explain basic definition of set, subset, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;

4. discuss various types of numbers; and
5. sole some problems using Binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements and venn diagrams. Real numbers, integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations and binomial theorem. Complex numbers, algebra of complex numbers, the argand diagram. De-Moivre's theorem, nth roots of unity. circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course students should be able to:
1. identify the types of rules in differentiation and Integration;
2. describe the meaning and function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity; the derivative, as limit of rate of change; techniques of differentiation; extreme curve sketching; integration as an inverse of differentiation; methods of integration; definite integrals and application to areas and volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

PHY 101: General Physics I **(2 Units C: LH 30)**

Learning Outcomes
On completion of the course, the student should be able to:

1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents
space and time. units and dimension. vectors and scalars. differentiation of vectors: displacement, velocity and acceleration. Kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). relative motion. Application of Newtonian mechanics. equations of motion. conservation principles in physics, conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass. Rotational motion. torque, vector product, moment, rotation of coordinate axes and angular momentum, polar coordinates. conservation of angular momentum; Circular motion. Moments of inertia, gyroscopes and precession. gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General Physics II **(2 Units C: LH 30)**

Learning Outcomes
At the end of the course, the student should be able to:

1. describe the electric field and potential, and related concepts, for stationary charges,
2. calculate electrostatic properties of simple charge distribution using Coulomb's law, Gauss's law and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;
5. describe electromagnetic induction and related concepts, and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters; and
8. determine the characteristics of ac voltages and currents in resistors, capacitors, and Inductors.

Course Contents
Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and

resistance. Ohm's law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

PHY 103: General Physics III (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. explain the concepts of heat and temperature and relate the temperature scales;
2. define, derive, and apply the fundamental thermodynamic relations to thermal systems;
3. describe and explain the first and second laws of thermodynamics, and the concept of entropy;
4. state the assumptions of the kinetic theory and apply techniques of describing macroscopic behaviour;
5. deduce the formalism of thermodynamics and apply it to simple systems in thermal equilibrium; and
6. describe and determine the effect of forces and deformation of materials and surfaces.

Course Contents

Heat and temperature (temperature scales). Gas laws. General gas equation. Thermal conductivity. First Law of thermodynamics (heat, work and internal energy, reversibility). Thermodynamic processes (adiabatic, isothermal, isobaric). Second law of thermodynamics (heat engines and entropy). Zero's law of thermodynamics. Kinetic theory of gases. Molecular collisions and mean free path. Elasticity (Hooke's law, Young's, shear and bulk moduli). Hydrostatics (Pressure, buoyancy, Archimedes' principles). Bernoulli's equation and incompressible fluid flow. Surface tension (adhesion, cohesion, viscosity, capillarity, drops and bubbles).

PHY 104: General Physics IV (2 Units C: LH 30)

Learning Outcomes

On completion, the students should be able to:

1. describe and quantitatively analyse the behaviour of vibrating systems and wave energy;
2. explain the propagation and properties of waves in sound and light;
3. identify and apply the wave equations;
4. explain geometrical optics and principles of optical instruments.

Course Contents

Simple harmonic motion (SHM): energy in a vibrating system, Damped SHM, Q values and power response curves, forced SHM, resonance and transients, coupled SHM. Normal modes. Waves: types and properties of waves as applied to sound; Transverse and Longitudinal waves; Superposition, interference, diffraction, dispersion, polarisation. Waves at interfaces, Energy and power of waves, the 1-D wave equation, 2-D and 3-D wave equations, wave energy and power, phase and group velocities, echo, beats, the doppler effect, propagation of sound in gases, solids and liquids and their properties. Optics: Nature and propagation of light; reflection, refraction, and internal reflection, dispersion, scattering of light, reflection and refraction at plane and

spherical surfaces, thin lenses and optical instruments, wave nature of light; Huygens's principle, interference and diffraction.

PHY 107: General Practical Physics I (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, the student should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasizes quantitative measurements, the treatment of measurement errors, and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc., covered in PHY 101. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

PHY 108: General Practical Physics II (1 Unit C: PH 45)

Learning Outcomes
On completion of the course, the student should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasizes quantitative measurements, the treatment of measurement errors, and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc., covered in PHY 102. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

CHM 101: General Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. define atom, molecules and chemical reactions;
2. explain modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;

4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. illustrate shapes of simple molecules and hybridized orbitals;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using Le Chatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents
Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence Forces. Structure of solids. Chemical equations and stoichiometry. Chemical bonding and intermolecular forces. Kinetic theory of matter. Elementary thermochemistry. Rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions. Introduction to electrochemistry and radioactivity.

200 Level

CHM 102: General Chemistry II (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reaction;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. describe basic properties of transition metals.

Course Contents
Historical survey of the development and importance of Organic Chemistry. Fullerenes as fourth allotrope of carbon. Uses as nanotubules, nanostructures and nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds; introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify the differences between primary and secondary standards;
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents
Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory
4. identify and carry out preliminary tests which includes ignition, boiling point; melting point, test on known and unknown organic compounds;
5. execute solubility tests on known and unknown organic compounds;
6. execute elemental tests on known and unknown compounds; and
7. conduct functional group/confirmatory test on known and unknown compounds which could be acidic / basic / neutral organic compounds.

Course Contents
Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;

7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents
Concept of Entrepreneurship (Entrepreneurship, Intrapreneurship/Corporate Entrepreneurship,). Theories, Rationale and relevance of Entrepreneurship (Schumpeterian and other perspectives, Risk-Taking, Necessity and opportunity-based entrepreneurship and Creative destruction). Characteristics of Entrepreneurs (Opportunity seeker, Risk taker, Natural and Nurtured, Problem solver and change agent, Innovator and creative thinker). Entrepreneurial thinking (Critical thinking, Reflective thinking, and Creative thinking). Innovation (Concept of innovation, Dimensions of innovation, Change and innovation, Knowledge and innovation). Enterprise formation, partnership and networking (Basics of Business Plan, Forms of business ownership, Business registration and Forming alliances and join ventures). Contemporary Entrepreneurship Issues (Knowledge, Skills and Technology, Intellectual property, Virtual office, Networking). Entrepreneurship in Nigeria (Biography of inspirational Entrepreneurs, Youth and women entrepreneurship, Entrepreneurship support institutions, Youth enterprise networks and Environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

PHY 201: General Physics V (Elementary Modern Physics)
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, the student should be able to:
1. identify the circumstances, discoveries and people that launched modern physics;
2. enumerate and understand the postulate of relativity;
3. explain the problem of simultaneity and calculate time changes from one frame of reference to another;
4. describe relativistic length contraction;
5. describe the relativistic mass-energy relation;
6. explain the work of Planck, Bohr and Heisenberg; and
7. explain the uncertainty principle and the other features of Quantum mechanics.

Course Contents
Special relativity. Defects in Newtonian mechanics. The speed of light. The Lorentz transformation. Transformation of velocities. Experimental basis of quantum theory. Black body radiation. Electrons and quanta. Bohr's theory of atomic structure. De-Broglie hypothesis. The uncertainty principle. Schrodinger's equation and simple applications.

PHY 202: Electric Circuits and Electronics (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the student should be able to:
1. explain electric circuit and electronics;
2. mention all entire the different circuit theorem;
3. apply the concept to solve simple problems;
4. differentiate between N-type and P-type semiconductor;
5. solve basic A.C problems; and
6. design simple circuit.

Course Contents
D.C. Circuits. Kirxhoff's Laws. Sources of e.m.f and current. Network analysis and circuit theorems. A.C. Circuits. Inductance, capacitance, and the transformer. Sinusoidal wave-forms, r.m.s and peak values. Power, impedance and admittance series. RLC circuit, Q factor, and resonance. Network analysis and circuit theorems. Filters. Electronics, semiconductors, the pn-junction, field effect transistors, bipolar transistors, characteristics and equivalent circuits, amplifiers, feedback, oscillators.

PHY 204: General Physics IV (Waves and Optics) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the student should be able to;
1. explain the purpose and use of mathematical tools relating to waves and optics;
2. account the difference between wave equation of motion and the Newtonian mechanics;
3. discuss the working principle of optical system; and
4. design optical instruments.

Course Contents
Wave phenomena; Acoustical waves; the harmonic oscillator; waves on a string; energy in wave motion; longitudinal waves; standing waves; group and phase velocity; Doppler effect; Physical Optics; Spherical waves; interference and diffraction, thin films; crystal diffraction, holography; dispersion and scattering. Geometrical Optics; Waves and rays; reflection at a spherical surface, thin lenses, optical lenses; mirrors and prisms.

PHY 205: Thermal Physics (2 Units C: LH 30)

Learning Outcomes
Upon the successful completion of this course, the student should be able to:
1. explain and understand the basic foundation of classical thermodynamics;
2. explain the basic application of thermodynamics laws and potentials;
3. apply some real life applications; and
4. further apply the course to their respective field of learning.

Course Contents
The Foundations of classical thermodynamics including the zeroth and definition of temperature. The first law: work, heat and internal energy. Carnot cycles and the second law. Entropy and irreversibility. Thermodynamic potentials and the Maxwell relations. Application: qualitative discussion of phase transitions. Third law of thermodynamics. Ideal and real gases. Elementary kinetic theory of gases including Boltzmann counting, Maxwell-Boltzmann law of distribution of velocities. Simple applications of the distribution law.

PHY 207/208: Experimental Physics I & II (2 Units C: PH 90)

Learning Outcomes
Upon the completion of the course, the students should be able to:
1. identify the two physical quantities to be measured as independent and dependent variables;
2. determine the relationship between the two variables in form of graph;
3. determine some physical constants such as acceleration due to gravity, force constant of a spring, refractive index of a prism and focal length of converging and diverging lenses using different methods;
4. determine momentum of inertia of a fly wheel and determine coefficient of static and dynamic friction for wood.

Course Contents
The laboratory course consists of a group of experiments drawn from diverse areas of Physics (optics, electromagnetism, mechanics, Modern Physics, etc.). It is accompanied by seminar studies of standard experimental techniques and the analyses of famous and challenging experiments.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents
Concepts of peace, conflict and security in a multi-ethnic nation; types and theories of Conflicts: ethnic, religious, economic, geo-political conflicts; structural conflict theory, realist theory of conflict, frustration-aggression conflict theory; root causes of conflict and violence in Africa: indigene and settlers phenomenon, boundaries/boarder disputes, political disputes, ethnic disputes and rivalries, economic inequalities, social disputes; Nationalist Movements and Agitations; selected conflict case studies: Tiv-Junkun, Zango Kartaf, chieftaincy and land disputes, etc.; peace building, management of conflicts and security: Peace & Human Development; approaches to peace & conflict management: (religious, government, community leaders etc.); elements of peace studies and conflict resolution: conflict dynamics assessment scales: constructive & destructive; justice and legal framework: Concepts of Social Justice, the Nigeria legal system; insurgency and terrorism; peace mediation and peace keeping; Peace & Security Council (International, National and Local levels); agents of conflict resolution: conventions, treaties community policing; evolution and imperatives; Alternative Dispute Resolution (ADR): (a) dialogue (b). arbitration, (c). negotiation (d). collaboration, etc.; roles of International Organizations in conflict resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping; media and Traditional Institutions in peace building; managing post-conflict situations/crisis: Refugees. Internally Displaced Persons (IDPs); and the role of NGOs in post-conflict situations/crisis.

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students, through case study and practical approaches, should be able to:
1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents
Opportunity Identification (Sources of business opportunities in Nigeria, environmental scanning, demand and supply gap/unmet needs/market gaps/market research, unutilised resources, social and climate conditions and technology adoption gap); new business development (business planning, market research); entrepreneurial finance (venture capital, equity finance, micro finance, personal savings, small business investment organizations and business plan competition); entrepreneurial marketing and e-commerce (principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, First Mover Advantage, e-commerce business models and successful e-commerce companies); Small Business Management/Family Business; leadership & management, basic book keeping, nature of family business and Family Business Growth Model; negotiation and business communication (strategy and tactics of negotiation/bargaining, traditional and modern business communication methods); opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, Idea pitching); technological solutions (the concept of market/customer solution, customer solution and emerging technologies; Business Applications of New Technologies: Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy, *etc.;* Digital Business and E-Commerce Strategies).

PHY 303: Electromagnetism I (3 Units C: LH 45)

Learning Outcomes
On the completion of the course, the student should be able to:
1. explain basic physical laws and concepts in electricity and electromagnetism;
2. use fundamental laws and relation to solve problems in electricity and electromagnetism;
3. explain Maxwell's equation as a fundamental law of nature integral and the differential form of the equation;
4. give solution for Maxwell's equation for electrostatic field; and
5. elucidate the Lorentz's transformation of the electric and magnetic field.

Course Contents
Electrostatics and magnetostatics. Laplace's equation and boundary value problems. Multiple expansions. Dielectric and magnetic materials. Faraday's law. A.C. Circuits. Maxwell's equations. Lorentz's covariance and special relativity.

PHY 305: Quantum Physics (3 Units C: LH 45)

Learning Outcomes
Upon the successful completion of the course, the student should be able to:
1. discuss the process leading to the development of quantum physics (origin of quantum physics);
2. classify and explain the basic difference between classical and quantum physics;
3. explain the purpose and use of mathematical tools of quantum mechanics;
4. solve Schrodinger equation for simple 1D and 3D system; and
5. apply mathematical and physics skills to solve modern physics problem**.**

Course Contents
Wave-particle duality and the uncertainty principle. Basic principles of the quantum theory. Energy levels in potential wells. Reflection and transmission of potential barriers. Atomic and molecular structure. Nuclear reactions. Fission and fusion. Magnetic resonance and elementary particles.

PHY 306: Statistical and Thermal Physics (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. describe the laws of thermodynamics from both a macroscopic and microscopic point of view;
2. apply the laws of thermodynamics to real physical system and processes;
3. describe the properties of ideal gases using Boltzmann statistics;
4. describe the differences between systems of bosons and fermions and how they arise from microscopic consideration.

Course Contents
Basic concept of statistical mechanics. Microscopic basis of thermodynamics and applications to macroscopic systems. Condensed states. Phase transformations. Quantum distributions. Elementary kinetic theory of transport processes. Fluctuation phenomena and applications.

PHY 307/308: Experimental Physics III & IV (2 Units C: PH 90)

Learning Outcomes
Upon completion of the course the student should:
1. be familiar with the basic physical principles underlying a variety of fundamental phenomenon in solid state;
2. classify solid state matter according to their bandgap;
3. account for the characteristic physical properties of different categories of sold materials, with an emphasis on the crystalline state;
4. give a wide spectrum of theoretical approach to model the mechanical, thermal and electrical properties of solid materials;
5. define superconductivity qualitatively relate it to lattice vibration and density of states.

Course Contents
A session long of series of mini courses on important experimental techniques. Topics to be covered include electronics, optics, electricity, atomic, molecular nuclear and low temperature physics, statistics and data handling and scientific writing.

PHY 314: Solid State Physics I (3 Units C: LH 45)

Learning Outcomes
Upon completion of the course, the student should be able to:
1. demonstrate knowledge of arrangement of atoms, crystal, lattice, unit cell, translational vector;
2. account for the basic physical principles underlying a variety of fundamental phenomenon in solid state;
3. classify solid state matter according to their bandgap;

4. explain the characteristic physical properties of different categories of solid materials, with an emphasis on the crystalline state;
5. elucidate a wide spectrum of theoretical approach to model the mechanical, thermal and electrical properties of solid materials; and
6. define superconductivity and qualitatively relate it to lattice vibration and density of states.

Course Contents
Crystal structure and crystal binding. Elastic properties. Lattice vibrations. Super-conductivity.

PHY 315: Electronics (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the properties of semiconductors;
2. identify and list the properties of p-n junction, capacitors and inductors;
3. state the characteristics and uses of the components in rectification;
4. explain Op amps and analog computers; and
5. list and explain the transistor parameters, power supplies and causes of break down voltages.

Course Contents
Semiconductors, p-n junction. Capacitors and inductors. Transistors: Bipolar, FET. Amplifiers. Feedback. Transformers. Diodes: characteristics and uses in rectification. Zener diodes. Voltage doublers. Operational amplifiers (Op amps) and analog computers. Digital electronics: binary, octal and hexadecimal codes. Number system, designs and construction of simple circuits. Multivibrators: astable, monostable and bistable. Transistor parameters, power supplies, causes of break down voltages. Rectification.

400 Level

PHY 401: Quantum Mechanics (2 Units C: LH 30)

Learning Outcomes
Upon completion of the course, the student should be able to:
1. demonstrate a clear and structured approach for solving problems;
2. compute the angular momentum of a wave function using operators;
3. describe and compute Eigen functions of the angular momentum operators;
4. explain the relationship between quantum spin and angular momentum; and
5. apply spin operators to a simple ½ system to perform calculations.

Course Contents
The formulation of quantum mechanics in terms of state vectors and linear operators. Three-dimensional spherically symmetric potentials. The theory of angular momentum and spin. Identical particles and the exclusion principle. Methods of approximation and multielectron atoms.

PHY 403: Mathematical Methods in Physics (2 Units C: LH 30)

Learning Outcomes

After successfully completing the course, the student should be able to:

1. use complex analysis in solving physical problems;
2. solve ordinary and partial differential equation of second order that are common in the physical science;
3. use the orthogonal polynomials and other special functions;
4. use fourier series and integral transformation; and
5. use the calculus of variations.

Course Contents

Linear Algebra and Functional Analysis. Transformations in linear vector spaces and matrix theory. Hilbert space and complete sets of orthogonal functions. Special functions of Mathematical Physics: the gamma function, hypergeometric functions, Legendre functions, Bessel functions, Hermite and Laguerre function. The Dirac Delta function. Integral Transforms. Fourier Series: Fourier series and Fourier transforms. Laplace transform. Applications of transform methods to the solution of elementary differential equations of interest in physics and engineering. Partial differential equations. Solution of boundary value problems of partial differential equations by various methods which include: separation of variables, the method of integral transforms, Sturm-Liouville theory. Uniqueness of solutions. Calculus of residues and applications to evaluation of integrals and summation of series. Applications to various physical situations, which may include electromagnetic theory, quantum theory and diffusion phenomena.

PHY 415: Science of Materials (2 Units C: LH 30)

Learning Outcomes

After successfully completing the course, the student should be able to:

1. differentiate between ductility and hardness;
2. differentiate between toughness and hardness;
3. explain glass transition temperature, amorphous semiconductor and fibre optics;
4. distinguish between cis and trans polymers;
5. explain steel phase diagram;
6. explain interface properties; and
7. discuss the principles of imaging techniques in nano structures.

Course Contents

General introduction of materials. Mechanical properties of materials: stress, strain, ductility, hardness, toughness and fatigue. Non–Crystalline materials: glasses, amorphous, semiconductors, fibre optics. Organic materials: conducting polymers, organic metals. Alloys: steel, phase diagram. Surfaces: reconstruction, relaxation, work function. Interfaces: magnetoresistance, integral and fractional quantum hall effect, giant magnetoresistance, heterostructures. Nanomaterials: Imaging techniques, electrical and thermal properties.

PHY 423: Solid State Physics II (3 Units C: LH 45)

Learning Outcomes
After studying the course, the student should be able to:
1. explain the dielectric properties of solid;
2. define dielectric constant, polarizability and susceptibility;
3. explain magnetization of materials;
4. differentiate between diamagnetism and Para magnetism;
5. differentiate between ferromagnetism and anti-ferromagnetis; and
6. explain magnetic resonance and the various imperfection in solids.

Course Contents
Dielectric properties. Magnetism: paramagnetism and diamagnetics. Ferromagnetism and antiferromagnetism. Magnetic resonance. Imperfections in solids.

PHY 432: Electromagnetic Theory II (3 Units C: LH 45)

Learning Outcomes
On completion of the course, the student should be able to:
1. use Maxwell's equation describe propagation of electromagnetic waves;
2. solve for retarded and advanced potentials;
3. classify and design antenna arrays; and
4. apply radiation from moving charges.

Course Contents
Maxwell equations. Poynting vectors. Propagation of electromagnetic waves. Polarization, reflection and refraction of electromagnetic waves. Retarded and advanced potentials.
Transmission lines, wave guides, resonant cavities, antenna arrays and radiation from moving charges.

PHY 455 Student Research Project (6 Units C: PH 270)
The course offers students the opportunity to do research in contemporary physics and under the supervision of staff. A detailed report on the research is presented by the students when the project is completed.

Learning Outcomes
On completion of this course, student should be able to:
1. apply knowledge in design and fabrication of solar panels;
2. build wind mills and generate energy;
3. design and construct solar distillation systems; and
4. install solar panels in houses.

Course Contents
Fabrication and installation of solar panels for electricity generation. Design and construction of solar cookers. Design and construction of solar distillation systems. Demonstration of different forms of renewable energy.

Minimum Academic Standards

Equipment

Description	**Quantity**
Meter rule	40
½ Meter rule	40
Venier Callipers	10
Screw Gauge	10
Beaker-various sizes	10 each
Chemical Balance	5
Travelling Microscope	15
Spring Balance (various)	5 each
Stop Watch	20
Retort Stand	20
Slotted Weights	
Spiral Spring	
Knife Edge	
Inclined Plane	10
Prisms (various)	
Optical Pins (boxes)	15
Drawing Board	15
Optical Benches	10
Converging lens (Various Focal lengths)	10 each
Ray box	10
Diverging lens (various focal lengths)	10 each
Ammeter (various types and ranges)	0 each
Voltmeter (various types and ranges)	10 each
Rheostat (various ranges)	10each
Resistors (various ranges)	20 each
Resistance box (various ranges)	5 each
Key	20
Potentiometer	10
Metre bridge	10
Galvanometers (various types and ranges)	10 each
Daniel Cell	10
Leclanche Cell	10
Calorimeter	10
Thermometer (various types and ranges)	100
Battery (various ranges)	10
Lee's conductivity apparatus	5
Connecting wires (various Lengths)	20 each
Boyle's Law apparatus	5
Linear expansion apparatus	5
Equation of State of Ideal gas apparatus	5
Maxwellian velocity distribution apparatus	5
Tuning fork (various)	10

Resonance tube	10
Ripple tank	10
Air Track	10
Specific gravity bottle	10
Glass Capillary tubes	100
Young's Modulus apparatus	5
Rectangular glass block	20
Moment of inertia& angular momentum apparatus	5
Free fall apparatus	5
Phite Screen	10
Lens Holder	100
Sonometer box	10
Concave mirror (various radii)	20 each
Convex Mirror (various radii)	20 each
Bunsen Burner	10
Spectrometer	5
Mercury Lamps	5
Sodium Lamps	5
Water Distillation apparatus	2
Battery Charger and accessories	2
Wall Clock	2
Refrigerator	2
Centre-zero (universal moving coil) Galvanometer	5
Thermal Conductivity apparatus	5
Vapour Pressure apparatus	20
Oscilloscope (various types)	10
Dry Batteries	20

Intermediate and Advanced Physics

As in the case of General Physics, the list below is not exhaustive. Some of the equipment listed under General Physics are also used in this level and so need not be listed here.

	Description	**Quantity**
1.	Signal generator (various types)	10
2.	Low voltage power supply	10
3.	H.T. Power Supply	5
4.	Transformers (various grades)	5
5.	Avometers	5
6.	Refractometers	5
7.	Polarimeter	5
8.	Leser spectral unit with power supplies	5
9.	Michelson interferometer	5
10.	Digital Meters	5
11.	Plotters	10
12.	Capacitance meter	10
13.	Recorder	10
14.	Video Monitor	5

15.	Stabilizers	10
16.	Pulse generators	5
17.	Microscope	5
18.	Amplifier	10
19.	Multivibrator	5
20.	Transistor (various types)	
21.	Radioactive Source	2
22.	Ionization Chamber	5
23.	Ratemeter	5
24.	Digital Counter	5
25.	Diffraction grating	5
26.	X-ray tube	5
27.	Cathode ray tube	5
28.	Helmholtz Coils	
29.	Electric oven	
30.	Thermocouple	5
31.	Filters	
32.	Electromagnet	5
33.	GM – Counter	5
34.	Atomizer	5
35.	Frank Hertz Tube	5
36.	Cadmium Lamp and accessories	5
37.	Lummer-Gehrcke Plate	5
38.	Coils	5
39.	Inductors	
40.	Capacitors	
41.	Thermistor	5
42.	Photocell	
43.	Diodes	
44.	Loudspeaker	
45.	Digital Multimeter	5
46.	Function generator (various ranges)	5
47.	Biprisms	
48.	Simpson meter	5
49.	Noise generator	5
50.	Flux Meter	5
51.	Microphones	
52.	Coaxial cable	
53.	Electrostatic voltmeter	5
54.	Van de graaf Generator	2
55.	Luminescence tube	5
56.	Immersion heater	5
57.	Diesel engine model four stroke	2
58.	Model of four stroke engine	2
59.	Micro-computers	20
60.	Softwares	Several

Staffing

Academic Staff
There should be a minimum of six academic staff available for the industrial physics programme.

Staff-Student Ratio
Determination of the number of academic staff required for an academic programme is contingent on the approved staff-student ratio for each discipline. The approved Staff-Student ratio for Sciences Discipline is 1:20.

Staff – Mix by Rank
Academic staff in the Universities are broadly classified into three categories; Professorial (Professor/Reader), Senior Lectureship and Lecturers Grade I and below. The Professorial cadre should constitute a maximum of 20 percent of the staff strength while the remaining two should constitute 35 and 45 percent respectively.

Academic Support Personnel
Teaching Assistants/Demonstrators to help lecturers in the conduct of tutorials, practicals and field work.

Senior Administrative Staff
The faculty shall have the following senior administrative staff who shall be responsible to the Dean:
1. Faculty Officer – not below Assistant Registrar
2. Two Executive Officers
3. A Secretary

The services of the administrative support staff are indispensable in the proper administration of Departments and Faculty offices. It is important to recruit very competent, computer literate senior staff. Each Department should have a Secretary to each Head of Department.

Technical Support Personnel
The services of technical support staff, which are indispensable in the proper running of laboratories and workshops, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

Junior Staff
The faculty shall have non-teaching support staff who shall be responsible to the Dean such as Secretary, Clerical Officer, Driver, etc. Each Department shall have a Secretary, Clerical Officer and other support staff as may be required.

Library
Universities should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition well stock and current hardcopies of reference and other textual materials should be provided centrally at the level of the Faculty. A well network digital library should serve the entire university community. Availability of wireless facilities (Wifi) with adequate bandwidth should enhance access to these electronic resources.

In any case, there should be internet ready workstations available in the library for least 25% of the total student enrolled in each academic programme. The funding of the library should be in line with NUC guidelines.

Classroom, Laboratories, Workshops and Offices

Classroom Accommodation
The NUC standard requirement of 0.65m^2 per full-time student is maintained. Thus the minimum total space requirement of a Faculty or Department shall be the product of its total Full Time Equivalent student enrolment (FTE) and the minimum space requirement per full-time equivalent i.e. (FTE) 0.65m^2.

Office Accommodation
In this respect, each academic staff should have an office space of at least 25 square metres taking into cognisance the status/cadre of the staff.
In addition, there should be for the Faculty, a Dean's office and for each Department a Head of Department's office with attached offices for their supporting staff as specified below in m^2:

Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Staff Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space	-	7.50

Laboratories and Equipment
To achieve the benchmark statements for any programme, there should be:

1. minimum number of identifiable laboratories for each programme which should be in accordance with the recommended space requirements and, in addition, be adequately equipped; and

2. at least one large and reasonably equipped central laboratory for teaching and research.

B.Sc. Marine Science

Overview
Marine Science Programme richly spans through physical, chemical, biological and geological oceanography in order to understand the marine environment, marine life and their interactions. Graduates of the programme will acquire sufficient theoretical and practical knowledge to enhance sustainability of a better environment, contribute to national advancement and also be competitive in the globalised environment.

Philosophy
The main philosophy of the programme is to provide world-class training and research in marine science that will produce well-trained marine scientists qualified to practise in marine-based industries, institutions, and other establishments for national and international development. Graduates are empowered through multidisciplinary approach to tackle issues involved in the exploration and exploitation of the marine environment.

Objectives
The objectives of the programme are to:
1. impart basic and fundamental knowledge of marine science using multi-disciplinary approach;
2. train students with the capability to explore and exploit the marine environment in a sustainable manner;
3. equip the students with result-oriented research capability for industrial and academic development of the country;
4. train students that will occupy leadership positions in research institutes, higher institutions of learning, relevant ministries, coastal zone planning authorities, fishing industries, environmental studies companies, oil and gas and other related companies and
5. equip graduates with skills for self-employment.

Unique Features of the Programme
The unique features of the programme include:
1. a combination of various subjects for a better understanding of the marine environment, marine life and their interactions;
2. impartation of knowledge and skills in biological, chemical, physical and geological oceanography;
3. restoration of innovative ecological methods for preventing and repair of environmental damage; and
4. introduction of a course in entrepreneurship in Marine Science to empower students for self-empowerment in areas including environmental management, marine area conservation, marine tourism, fisheries and mariculture.

Employability Skills
Graduates from the programme will be empowered to:
1. demonstrate practical skills for solving problems in the marine environment
2. empower to acquire analytical skills and capacity to appraise key issues in marine environment, exploration and exploitation;
3. empowered to write scholarly and professional reports for professional and academic audience;

4. possess competitive tendencies;
5. empowered to synthesize, plan, design, construct and manage various explorative and exploitative procedures of the marine environment;
6. develop leadership skills and be capable of team-work; and
7. develop skills for self-employment.

21st Century Skills

1. Creativity, cognitive abilities and skills
2. Collaboration
3. Critical thinking
4. Computer literacy
5. Organization skills
6. Communication and IT skills as well as interpersonal skills
7. Team work

Admission and Graduation Requirements

Admission Requirements

There are two different pathways by which candidates can be admitted into the programmes in the discipline: the Indirect-entry mode and Direct Entry mode.

Indirect-entry Mode

Admission through the indirect-entry mode shall take the student to 100 level. The candidate must have credit passes in five subjects at not more than two sittings at Senior Secondary Certificate (SSC) or its equivalent. The credit passes are required in the following subjects: English language, Mathematics, Chemistry, Physics and Biology. The UTME subjects are: English Language, Physics, Biology and Chemistry.

Direct Entry

Admission by direct entry is into second year (200 level) of the programme. Eligible students for direct entry should possess good passes at GCE (advanced level) at one sitting in at least two of the following subjects: Physics, Mathematics, Biology and Chemistry or National Diploma (ND) at a minimum of Upper Credit level in Oceanography, Mineral Exploration, Mineral Resources Engineering, Geology, Geophysics, Meteorology, Marine Biology and any other related course from any recognized institution.

Graduation Requirements

To be eligible for the award of a Bachelor's Degree in Marine Science, a student must pass a minimum 120 units for those admitted through UTME and 90 units for Direct Entry.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
CHM 101	General Chemistry I	2	C	30	–
CHM 102	General Chemistry II	2	C	30	–
BIO 101	General Biology I	2	C	30	–
BIO 102	General Biology II	2	C	30	-
BIO 107	General Practical Biology I	1	C	-	45
CHE 107	General Practical Chemistry I	1	C	-	45
PHY 107	General Practical Physics I	1	C	-	45
BIO 108	General Practical Biology II	1	C	-	45
CHM 108	General Practical Chemistry II	1	C	-	45
PHY 108	General Practical Physics II	1	C	-	45
	Total	**29**			

200 Level

Course Code	Course Title	Units	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
MSE 201	Introductory Oceanography I	2	C	30	-
MSE 202	Introductory Oceanography II	2	C	30	-
MSE 203	Introduction to Weather and Climate	2	C	30	-
MSE 204	Oceanic Magmas and Volcanoes	2	C	30	-
MSE 205	Atmospheric Chemistry I	2	C	30	-
MSE 206	Marine Biology	2	C	15	45
MSE 207	Marine Ecology	2	C	30	-
MSE 208	Diving and Swimming Skills	2	C	15	45
MSE 209	Marine Meteorological Instrumentation	2	C	15	45
	Total	**22**			

300 Level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
MSE 301	Oceanic Crust and Ocean Floor	2	C	30	-
MSE 302	Physical Oceanography and Laboratory	2	C	15	45

MSE 303	Chemical Oceanography and Laboratory	2	C	15	45
MSE 304	Coastal Processes and Geomorphology	2	C	30	-
MSE 305	Marine Aquaculture	2	C	15	45
MSE 306	Underwater Operations	2	C	15	45
MSE 307	Marine Fluid Dynamics	2	C	30	-
MSE 399	S.I.W.E.S (Industrial Attachment)	3	C	-	135
	Total	**21**			

400 Level

Course Code	**Course Title**	**Units**	**Status**	**LH**	**PH**
MSE 401	Marine Monitoring and Analysis	2	C	15	45
MSE 402	Entrepreneurship and Management of Small Marine Science Business	2	C	15	45
MSE 403	Essay on a topic in Marine Science	2	C	30	-
MSE 404	Final Year Students Project	6	C	-	270
	Total	**12**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. identify possible sound patterns in English Language;
2. list notable Language skills;
3. demonstrate an appreciable level of the art of public speaking and listening; and
4. write simple and technical reports.

Course Contents
The course discusses sound patterns in English Language (vowels and consonants, phonetics, and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple, and

complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and critical thinking and reasoning methods (logic and syllogism, inductive and deductive argument and reasoning methods, analogy, generalisation and explanations). Ethical considerations, copyright rules, and infringements. Writing activities: (pre-writing, writing, post writing, editing and proofreading; brainstorming, outlining, paragraphing). Types of writing: summary, essays, letter, curriculum vitae, report writing, note making etc. Mechanics of writing. Comprehension Strategies: (reading and types of reading, comprehension skills, 3RsQ). Information and Communication Technology in modern Language Learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of trade, economic and self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building;
6. analyse the role of the Judiciary in upholding people's fundamental rights;
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

These address issues relating to Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; nationalist movements and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian civil war).Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigerian people; trade, skill acquisition and self-reliance).Social justices and national development (law definition and classification. Judiciary and fundamental rights. Individual, norms and values(basic Nigerian norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage, and development; negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation; Re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, austerity measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption (WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA) Current socio-political and cultural developments in Nigeria.

BIO 101: General Biology I **(2 Units C: LH 30)**

Learning Outcomes
At the end of lectures, students should be able to:
1. explain cell structure and organizations;
2. summarize functions of cellular organelles;
3. characterize living organisms and state their general reproduction;
4. describe the interrelationship that exists between organisms;
5. discuss the concept of heredity and evolution; and
6. enumerate habitat types and their characteristics.

Course Contents
This course focuses on cell structure and organization, functions of cellular organelles, characteristics and classification of living things, chromosomes, genes their relationships and importance, general reproduction, interrelationships of organisms (competitions, parasitism, predation, symbiosis, commensalisms, mutualism, saprophytism); heredity and evolution (introduction to Darwinism and Lamarckism, Mendelian laws, explanation of key genetic terms), elements of ecology and types of habitat.

BIO 102: General Biology II **(2 Units C: LH 30)**

Learning Outcomes
At the end of the lectures, students should be able to:
1. List the characteristics, methods of identification and classification of Viruses, bacteria and fungi;
2. state the unique characteristics of plant and animal kingdoms;
3. describe ecological adaptations in the plant and animal kingdoms;
4. explain nutrition, respiration, excretion and reproduction in plants and animals; and
5. describe growth and development in plants and animals.

Course Contents
Basic characteristics, identification and classification of viruses, bacteria and fungi.
A generalized survey of the plant and animal kingdoms based mainly on the study of similarities and differences in the external features. Ecological adaptations. Briefs on physiology to include nutrition, respiration, circulatory systems, excretion, reproduction, growth and development.

BIO 107: General Biology Practical I **(1 Unit C: PH 45)**

Learning Outcomes
At the end of the course, students should be able to:
1. outline common laboratory hazards;
2. provide precautions on laboratory hazards;
3. state the functions of the different parts of microscope;
4. use the microscope and describe its maintenance;
5. draw biological diagrams and illustrations; and
6. apply scaling and proportion to biological diagrams.

Course Contents
Common laboratory hazards. prevention and first aid. measurements in biology. uses and care of microscope. compound and dissecting microscope. Biological drawings and illustration, scaling, accuracy and proportion. use of common laboratory apparatus and laboratory experiments designed to illustrate the topics covered in **BIO 101.**

BIO 108: General Biology Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the anatomy of flowering plants;
2. differentiate types of fruit and seeds;
3. state ways of handling and caring for biological wares;
4. identify the basic histology of animal tissues; and
5. identify various groups in the animal kingdom.

Course Contents
Anatomy of flowering plants, primary vegetative body. stem, leaf and root to show the mature tissues namely parenchyma, collenchyma, sclerenchyma, xylem and phloem. Types of fruits and seeds. Care and use of dissecting kits and other biological wares. Dissection and general histology of animal tissues based on vertebrate forms. Morphology and functions of epithelial, muscular, nervous and connective tissues. Examination of various groups of lower invertebrates under microscopes, identification of various groups of organisms in Animal Kingdom. Andany experiment designed to emphasize the practical aspects of topics in BIO 102.

CHM 101: General Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, after studying all materials and resources presented in the course, the student should be able to:
1. define atom, molecules and chemical reactions;
2. discuss the modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems
6. illustrate shapes of simple molecules and hybridized orbitals;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy and
10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents
This treats atoms, molecules, elements and compounds and chemical reactions. modern electronic theory of atoms. electronic configuration, periodicity and building up of the periodic

table. hybridization and shapes of simple molecules. valence forces. structure of solids. chemical equations and stoichiometry. chemical bonding and intermolecular forces, kinetic theory of matter. elementary thermochemistry. rates of reaction, equilibrium and thermodynamics. acids, bases and salts. properties of gases. redox reactions and introduction to electrochemistry and radioactivity.

CHM 102: General Chemistry II (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reactions;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. describe basic properties of Transition metals;

Course Contents

Historical survey of the development and importance of Organic Chemistry. Fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures, nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The Chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes

At the end of this course, students should be able to:

1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify the differences between primary and secondary standards;
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents

The covers explores laboratory experiments designed to reflect topics presented in courses CHM101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II (1 Unit C: PH 45)

Learning Outcomes

At the end of this course, the students should be able to:

1. identify the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify and carry out preliminary tests which includes ignition, boiling point; melting point, test on known and unknown organic compounds;
5. execute solubility tests on known and unknown organic compounds;
6. execute elemental tests on known and unknown compounds; and
7. Conduct functional group/confirmatory test on known and unknown compounds which could be acidic / basic / neutral organic compounds.

Course Contents

The course is a continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods are treated,

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning outcomes

At the end of the course, students should be able to:

1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents

Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the basic definition of Set, Subset, Union, Intersection, Complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify the various types of numbers; and
5. solve some problems using Binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements and venn diagrams. Real numbers, integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations and binomial theorem. Complex numbers, algebra of complex numbers, the argand diagram. De-Moivre's theorem, nth roots of unity. circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and Integration.
2. describe the meaning of function of a real variable, graphs, limits and continuity.
3. solve some applications of definite integrals in areas and volumes.

Course Contents
The deal with the function of a real variable, graphs, limits and idea of continuity. the derivative, as limit of rate of change. techniques of differentiation. extreme curve sketching. integration as an inverse of differentiation. methods of integration, definite integrals. application to areas, volumes.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes
Upon the completion of course, the student should be able to:
1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents
space and time. units and dimension. vectors and scalars. differentiation of vectors: displacement, velocity and acceleration. Kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). relative motion. Application of Newtonian mechanics. equations of motion. conservation principles in physics, conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass. Rotational motion. torque, vector product, moment, rotation of coordinate axes and angular momentum, polar coordinates. conservation of angular momentum; Circular motion. Moments of inertia, gyroscopes and precession. gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General Physics II (Behaviour of Matter) (2 Units C: LH 30)

Learning Outcomes
Upon the completion of the course, the students should be able to:
1. describe the electric field and potential, and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law, and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savartand Ampere's law;
5. describe electromagnetic induction and related concepts and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters; and
8. determine the characteristics of AC voltages and currents in resistors, capacitors, and inductors.

Course Contents
Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and resistance. Ohm's law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

PHY 107: General Practical Physics I (1 Unit C: PH 45)

Learning Outcomes
Upon the completion of the course, the student should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data

Course Contents
This introductory course emphasizes quantitative measurements, the treatment of measurement errors, and graphical analysis. It also discusses variety of experimental techniques that should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc., covered in PHY 101, 102, 103 and PHY 104. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection and analysis and deduction.

PHY 108: General Practical Physics II (1 Unit C: PH 45)

Learning Outcomes
Upon the completion of the course, the student should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data; and
6. prepare and present practical reports.

Course Contents
This practical course is a continuation of PHY 107 and is intended to be taught during the second semester of the 100 levell to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements, the treatment of measurement errors, and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments,

logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students should be able to:

1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. State the basic principles of e-commerce.

Course Contents

Concept of Entrepreneurship (Entrepreneurship, Intrapreneurship/Corporate Entrepreneurship,). Theories, Rationale and relevance of Entrepreneurship (Schumpeterian and other perspectives, Risk-Taking, Necessity and opportunity-based entrepreneurship and Creative destruction). Characteristics of Entrepreneurs (Opportunity seeker, Risk taker, Natural and Nurtured, Problem solver and change agent, Innovator and creative thinker). Entrepreneurial thinking (Critical thinking, Reflective thinking, and Creative thinking). Innovation (Concept of innovation, Dimensions of innovation, Change and innovation, Knowledge and innovation). Enterprise formation, partnership and networking (Basics of Business Plan, Forms of business ownership, Business registration and Forming alliances and join ventures). Contemporary Entrepreneurship Issues (Knowledge, Skills and Technology, Intellectual property, Virtual office, Networking). Entrepreneurship in Nigeria (Biography of inspirational Entrepreneurs, Youth and women entrepreneurship, Entrepreneurship support institutions, Youth enterprise networks and Environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

MSE 201: Introductory Oceanography I (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able:

1. explain physical and geological oceanography;
2. acquire basic knowledge on the physical properties of oceans;
3. differentiate types of water motions – ocean currents, waves and tides and explain their effects and the forces that influence them;
4. describe the formation of different water motions; circulation and mixing of oceanic waters;
5. demonstrate a sound knowledge on energy fluxes and budgets in the ocean;

6. demonstrate a basic knowledge on geological oceanography - the history and formation of ocean floors/basins and coastal zones - and how they develop and change with time; and
7. state properties of rocks and sediments on the seafloor and coastal margins.

Course Contents
The course examines the geological and physical aspects of the ocean: structure, formation/history and general morphological features of ocean basins. Underwater landscape, development and changes. Properties of rocks, sediments found on seafloor and coastal margins. Water motions: currents, waves and tides among others - their occurrence, characteristics and activities; their effects and forces influencing them. Ocean energy and coastal development.

MSE 202: Introductory Oceanography II (2 Units C: LH 30)

Learning Outcomes
At the end of the lesson, students should be able to:
1. Explain the basic knowledge on chemical and biological oceanography;
2. discuss the chemical components of oceans: salinity – dissolved salts; dissolved gases; dissolved organic substances; their reactions and transformation; how they are related to ocean circulation, atmosphere, biosphere and geosphere;
3. state the diversity and characteristic features of marine organisms and identify various marine organisms
4. describe the processes that govern the distribution and abundance of marine organisms; and
5. explain marine ecological principles – maintaining or restoring native species, habitat diversity and heterogeneity, adaptation and interdependence.

Course Contents
Chemical and biological properties of the oceans: chemical and biochemical characteristics of seawater; seawater composition: elements present, dissolved gases, salts and so on. Properties and distribution of seawater. Fluxes and transformation of chemicals in the ocean.Chemical interactions of seawater with the atmosphere and seafloor. Biogeochemical cycles. Characteristics of marine organisms – their main features, general habitat and distribution; behaviour and relationships; processes influencing them. Marine ecological principles.

MSE: 203 Introduction to Weather and Climate (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. describe aspects of weather and climate that affect the totality of the marine environment;
2. characterise the natural and artificial factors influencing weather;
3. explain the transformation of water to vapour (evaporation) and its condensation;
4. describe how thermodynamics of the atmosphere is used in weather forecasting;
5. explain the climatic/weather factors and phenomena that affect the physical, chemical, biological and geological components of the marine environment; and
6. explain climate change and list the causes and effects, particularly the adverse effects

Course Contents
Structure, physics, dynamics and thermodynamics of the atmosphere. weather – major natural and artificial factors influencing weather – solar radiation water, moisture, human activities and

green house effects. transient and steady conditions. weather-forecasting. climate and climate change – causes and effects. ancient climates. climate-related and weather-related phenomena such as hurricanes, severe storms, global warming and acid rain – their causes and effects, particularly the adverse effects.

MSE 204: Oceanic Magmas and Volcanoes (2 Units C: LH 30)

Learning Outcomes

At the end of this course, students should be able to:

1. describe the formation, nature, activities and eruptions of marine volcanoes;
2. differentiate varieties of oceanic ridge systems, identify their characteristic features and describe their distribution;
3. explain magma and lava flows on the sea floor;
4. state the different rock types associated with marine volcanoes; and
5. describe the economic mineral and biological resources associated with marine volcanoes.

Course Contents

Occurrence, structure and types of volcanoes on ocean floor: distribution, formation, activities and eruptions of marine volcanoes. Oceanic ridge systems, varieties, distribution, characteristic, structures and features. Magma types and materials; lava flows on sea floor, their characteristics, structures and features. Mineral and rock types. Resources from marine volcanoes- economic minerals and associated biological species.

MSE: 205 Atmospheric Chemistry I (2 Units C: LH 30)

Learning Outcomes

At the end of the course, the students should be able to:

1. explain the chemistry of the atmosphere, its basic composition, chemical zonation and mixing in the atmosphere;
2. describe air pollution at the local and regional level;
3. state the health effects of air pollution ;
4. explain global change and global warming; and
5. describe effects of global change and global warming not only on the atmosphere but also on the general environment including living organisms.

Course Contents

Basic composition and chemistry of the atmosphere – chemical zonation and mixing in the atmosphere. Chemical processes involved in local and regional air pollution, acid rain and health effects of air pollution. Global change in the composition, climate of the atmosphere and stratospheric ozone. Global warming.

MSE: 206 Marine Biology (2 Units C: LH 30)

Learning Outcomes

At the end of this course, students should be able:

1. elucidate sampling and taxonomic knowledge and skills;
2. differentiate between various plankton, benthos, nekton, higher aquatic plants in the marine environment;
3. describe the functional morphology and physiology of marine organisms;
4. describe the adaptations of various organisms to the marine environment;
5. discuss the impacts of these organisms on humans; and
6. explain roles of microorganisms in productivity of the marine ecosystem.

Course Contents

Marine plants and animals: their classification, structure, physiology, ecology and adaptations to the marine environment. Overview of marine plankton, benthos, nekton (including bony and cartilaginous fishes, cephalopods, reptiles and mammals) as well as higher aquatic plants; a survey of their collection, identification/taxonomy, anatomy/ functional morphology and physiology of these groups of marine organisms including aspects of their relationships with humans. The role of microorganisms in the economy and productivity of the sea.

MSE 207: Marine Ecology (2 Units C: LH 30)

Learning Outcomes

At the end of the course, student should be able to:

1. demonstrate a firm knowledge on marine biotic communities and interactions with their environment;
2. explain the physical, chemical and biological factors governing diversity, distribution and abundance of all groups of marine organisms;
3. identify biotic communities specialized habitats such as rocky inter-tidal zones, sandy beaches, coral reefs, sub-tidal soft bottoms, fouling habitats and deep sea;
4. discuss the ecological organization of these biotic communities;
5. describe hydrothermal discharges and associated biotc communities;
6. discuss the ecology of marine zooplankton and their population dynamics; and
7. state the diversity, distribution and roles of protists and microbes in the marine environment

Course Contents

The course deal with the ecology of marine systems with emphasis on the interactions between organisms in biological communities and the environment; the physical setting and ecological organization of the communities found in the rocky inter-tidal zones, in the fouling habitat, on sandy beaches, in sub-tidal soft bottoms, coral reef and in the deep sea; ecology of marine micro and macro zooplankton: life histories, effects of physical, chemical, and biological factors on population dynamics; the diversity, distribution and roles of marine microbes, whose members include viruses, bacteria, archaea and protists; hydrothermal vent discharges and deep-sea communities.

MSE 208: Diving and Swimming Skills (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. acquire skills in diving and swimming techniques, and how to survive in the marine environment;
2. identify the necessary swimming and diving equipment;
3. operate diving equipment;
4. identify life-saving devices and know how to operate them;
5. rescue those in danger in the aquatic environment; and
6. state the safety regulations,

Course Contents
The course entails a sea-based practical course on diving to enable students acquire swimming and diving skills. Swimming, the first aspect of the training, may be done in shallow lagoon/coast/beach waters, but diving which is the later and core aspect, should be carried out in the deeper waters. The course also explores basic materials and principles of swimming; different swimming techniques; acquisition of skills: regular swimming practices in freshwater pools and rivers; diving in deep waters; aspects of marine safety operations: life-saving and life-saving devices: life jackets, lifeboats and others, marine search and rescue operations, safety regulations.

MSE: 209 Marine Meteorological Instrumentation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. identify different types of meteorological instruments;
2. state the functions of the various meteorological instruments;
3. operate and demonstrate how and where to use meteorological instruments to measure weather parameters; and
4. exhibit skill on how to install, standardize, maintain and repair the equipment.

Course Contents
Standard types of meteorological instruments and their uses Standardization of instruments. Measurement of weather parameters. Installation and maintenance of station facilities and equipment. Repair of meteorological instruments and equipment.

300 Level

GST 312: Peace and Conflict Resolution (2 units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and

5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents

Concepts of Peace, Conflict and Security in a multi-ethnic nation. Types and Theories of Conflicts: Ethnic, Religious, Economic, Geo-political Conflicts; Structural Conflict Theory, Realist Theory of Conflict, Frustration-Aggression Conflict Theory. Root causes of Conflict and Violence in Africa: Indigene and settlers Phenomenon; Boundaries/boarder disputes; Political disputes; Ethnic disputes and rivalries; Economic Inequalities; Social disputes; Nationalist Movements and Agitations; Selected Conflict Case Studies – Tiv-Junkun; Zango Kartaf, Chieftaincy and Land disputes etc. Peace Building, Management of Conflicts and Security: Peace & Human Development. Approaches to Peace & Conflict Management --- (Religious, Government, Community Leaders etc.). Elements of Peace Studies and Conflict Resolution: Conflict dynamics assessment Scales: Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice; The Nigeria Legal System. Insurgency and Terrorism. Peace Mediation and Peace Keeping. Peace & Security Council (International, National and Local levels) Agents of Conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of International Organizations in Conflict Resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping. Media and Traditional Institutions in Peace Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis

ENT 312: Venture Creation (2 Units C: LH 30; PH 45)

Learning Outcomes

At the end of this course, students through case study and practical approaches, should be able to:

1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/Market Research, Unutilised resources, Social and climate conditions and Technology adoption gap). New business development (business planning, market research). Entrepreneurial Finance (Venture capital, Equity finance, Micro finance, Personal savings, small business investment organizations and Business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, Customer Acquisition & Retention, B2B, C2C and B2C models of e-commerce, First Mover Advantage, E-

commerce business models and Successful E-Commerce Companies,). Small Business Management/Family Business: Leadership & Management, Basic bookkeeping, Nature of family business and Family Business Growth Model. Negotiation and Business communication (Strategy and tactics of negotiation/bargaining, Traditional and modern business communication methods). Opportunity Discovery Demonstrations (Business idea generation presentations, Business idea Contest, Brainstorming sessions, Idea pitching). Technological Solutions (The Concept of Market/Customer Solution, Customer Solution and Emerging Technologies, Business Applications of New Technologies - *Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy etc.* Digital Business and E-Commerce Strategies).

MSE 301: Oceanic Crust and Ocean Floor (2 Units C: LH 30)

Learning Outcomes

At the end of the course, the student should be able:

1. elucidate the geology and geochemistry of oceanic crust;
2. explain plate tectonics and the formation of oceans and continents;
3. describe the history of oceans – when and how oceans and continents were formed;
4. demonstrate some basic knowledge on rock layers and layering over time;
5. discuss the occurrence, distribution and significance of fractures and fault systems in ocean floors;
6. explain plate tectonics and ocean history;
7. list the types and describe the occurrence, distribution and ecological importance of hydrothermal vents;
8. state the different types and sources of marine sediments and describe how they are formed and their roles/importance in the marine ecosystem and climate in general.

Course Contents

Structural and oceanographic setting of continents and ocean basins: configuration and structures of the ocean floor with emphasis on fractures and fault systems – their occurrence, distribution and geological significance. Hydrothermal vents – types, occurrence, distribution and ecological significance. Marine stratigraphy and marine sediments. Plate tectonics and ocean history.

MSE 302: Physical Oceanography and Laboratory (2 Units C: LH 15; PH 45)

Learning Outcomes

Upon the completion of the course, student should be ablel to;

1. demonstrate knowledge of the physical properties of seawater;
2. exhibit knowledge on the dynamics of circulation of the various types of water masses in the ocean including their classification, formation, propagation, dispersion and refraction;
3. describe the dynamic theories governing circulation of different water masses;
4. describe sounds and optics in the oceans, their propagation and attenuation and be able to measure them;
5. explain the application of the laws of physics to the study of the properties and circulation of the world's oceans and atmosphere;
6. explain basic navigational techniques and skills in bathymetric measurements, maps and their interpretation; and
7. measure various physical parameters of water and sediment.

Course Contents
Ocean dimensions, physical properties of seawater, salt, water and heat budgets of the ocean. Dynamics of circulation of water masses in the ocean: wave characteristics including formation, propagation, dispersion and refraction. Dynamic and equilibrium theories of tides as well as tsunamis, seiche, and internal waves; classification of waves and tides. Application of the laws of physics to the study of the properties and circulation of the world's oceans and atmosphere. The basic techniques of oceanography including marine charts and navigation, bathymetry. Marine sediments. Techniques for measuring temperature, water motions including waves and tides; surface and deep circulation. Light and sound in seawater – their propagation, attenuation and measurement techniques. Field trips required.

MSE 303: Chemical Oceanography and Laboratory (2 Units C: LH 15; PH 45)

Learning Outcomes
This course will enable students to:
1. describe chemical components, chemical processes in the ocean and how they affect the marine environment and estuaries;
2. explain the diversity and chemical nature and processes of marine sediments and biogeochemical cycles in ocean systems;
3. describe radiometric dating – involving environmental and mineral-based isotopes;
4. demonstrate skills in analytical techniques and instrumentation; and
5. explain various chemical parameters of water and sediment.

Course Contents
Introduction to the chemistry of the oceans: descriptive chemical oceanography, chemical components of ocean waters (metals, gases, inorganic and organic compounds and nutrients). Chemical processes occurring in marine and estuarine waters and their impact on the near-shore and oceanic environments. Geochemistry of marine sediments – diversity of chemical nature and processes. Radiometric dating involving environmental and mineral-based isotopes; stable isotopes as water mass tracer. Biogeochemical cycles in oceanic systems. Chemical and physical methods in chemical oceanography; analytical and instrumentation techniques used to determine density, salinity, dissolved oxygen, nutrients and components of the carbonate system. Field trips required.

MSE: 304 Coastal Processes and Geomorphology (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. define and explain the concepts and issues of coastal zone;
2. describe the physical processes at the land-sea interface including estuaries, beaches and deltas;
3. state effects of water motion on coastal zones;
4. explain the elements of coastal geomorphology such as dynamics of coastal landforms and shoreline changes; coastal erosion and their consequences/effects;
5. explain submarine groundwater discharge and seawater intrusion, their interactions and impacts on coastal aquifers and marine ecosystem.

Course Contents

Coastal zone-definition, concepts and issues. Dynamics of wind-driven coastal flow. The physical processes at the land-sea interface including estuaries, beaches and deltas. Water waves, tides, storm surge, sea level, sediment transport, beaches, circulation and mixing. Elements of coastal geomorphology, temporal–spatial dynamics of coastal landforms, coastal landform analysis and shoreline changes. Effects of coastal flows on coastline geometry, bottom topography, friction, and density stratification. Coastal hydraulics: groundwater-seawater interactions.

MSE 305: Marine Aquaculture (2 Units C: LH 15 ; PH 45)

Learning Outcomes

At the end of the course, students should be ablel:

1. explain aquaculture, not only in the marine environment but also under artificial saline conditions
2. identify the water quality requirements suitable for aquaculture;
3. construct culture enclosures and where they should be located;
4. select suitable culturable species for mariculture;
5. Carry out artificial breeding for adequate seed production;
6. formulate and produce adequate feeds for enhanced aquaculture production ;
7. identify diseases of culture species and demonstrate skill on their treatment and control for viable mariculture;
8. harvest the cultured organisms in mariculture; and
9. generate possible self-employment through aquaculture business.

Course Contents

Selection criteria for fish, shellfish and other organisms such as weeds in marine aquaculture. Sea cage construction and location. Water quality requirements and monitoring for aquaculture species. Suitable physico-chemical parameters of water and sediment during culture. Fish feed formulation, production and storage. Adequate feeding of culture organisms. Fish seed production: fish breeding in hatcheries. Fish harvesting in mariculture. Common diseases and parasites of culture species.

MSE 306: Underwater Operations (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of the course, student shouldl be able to:

1. survey underwater activities;
2. state the tools of underwater operations;
3. handle and apply tools of underwater operations such as submersible diving apparatus, etc.;
4. explain human hyperbaric physiology and its applications in rescue operations in the ocean; and
5. handle rescue systems - decompression chambers, remotely operated vehicle, etc.

Course Contents

Survey of manned undersea activities in oceanography. the tools of underwater operations: decompression chambers, habitats, submersible diving apparatus. pertinent design criteria and applications as based on human hyperbaric physiology and performance.

MSE 307: Marine Fluid Dynamics (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain shallow water theory and boundary layer theory;
2. demonstrate an understanding of sea conditions – ocean circulation models and theories including stability theories of fluid flows;
3. explain linear stability theory of fluid flows;
4. apply stability theories in geophysical fluid dynamics;
5. describe thermocline and associated problems;
6. explain quasigeostrophic motion;
7. explain inviscid, viscous and stratified parallel flow; and
8. describe thermal convection, double-diffusive and rotating systems.

Course Contents
Shallow-water theory, Poincare, Kelvin, and Rossby waves. Boundary layer theory. Wind-driven ocean circulation models. Quasigeostrophic motion on a sphere. Thermocline and associated problems. Stability theories: classical linear stability. Theory of fluid flows with examples and applications in geophysical fluid dynamics. There are specific topics which include inviscid, viscous, and stratified parallel shear flow, thermal convection, double-diffusive systems and rotating systems.

MSE 399: Students Industrial Work Experience Scheme (3 Units C: PH 135)

Learning Outcomes
This a practical field course that would enable students to:
1. acquire work experience at the end of their exposure to relevant industry/establishment under supervision;
2. apply their theoretical knowledge in practical situations;
3. learn and demonstrate the use of various relevant equipment;
4. apply the work-related experience to complete their programme successfully and for their future endeavours; and
5. present seminars.

Course Contents
Mainly, it is supervised field- and industry-based practical course, with grading based on Industry and University Supervisors' assessments as well as the student's report and seminar presentation. Students will go for IT during the long vacation of 12 weeks.

400 Level

MSE 401: Marine Monitoring and Analysis (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this laboratory course, students should be able to;
1. demonstrate adequate knowledge on theoretical and practical planning and implementation for data collection and analysis from the marine environment;

2. use established international standard methods in sampling, sample preparation and analysis of water, sediment and biota samples;
3. measure physical, geological and chemical properties of the marine environment;
4. identify and estimate the abundance and diversity of various biota in the marine environment; and
5. demonstrate knowledge of ethical issues, quality assurance and control in the marine environment.

Course Contents
Methods of sampling, sample preparation, and analysis for priority pollutants. Methods of ultra-micro chemical analysis. Theoretical and practical planning and implementation of data collection and analysis of the marine environment: techniques include measuring geological, chemical, and physical oceanographic properties; estimating the abundance and diversity of plankton, nekton, and benthos. Quality assurance and quality control. Ethical issues and problems as they relate to the environment, particularly the marine environment.

MSE 402: Entrepreneurship and Management of Small Marine Science Business (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. display needed skills to implement new business ideas of small ventures in Marine Science;
2. Show competence in identifying business opportunities;
3. state the intricacies of marketing in business ventures;
4. identify and tackle challenges that entrepreneurs face
5. capable of establishing small business venture that will grow over time and be self-employed;
6. posses the ability of supervising larger business ventures; and
7. show skills in being an employer of labour over time,

Course Contents
The course focuses on entrepreneurial strategies: identification and pursuit of new venture opportunities. Development of business plans. Intricacies of marketing in business ventures. How to establish and manage small business ventures in Marine Science, includingg environmental management, marine area conservation, marine tourism, fisheries and mariculture. Field trips.

MSE 403: Essay on a topic in Marine Science (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. search for literature from different sources;
2. enrich their knowledge on the subject matter of their essay topic;
3. demonstrate knowledge on various subject matter of Marine Science and other relevant programmes/disciplines;
4. prepare papers for seminar presentations;
5. write essay reports scientifically.

Course Contents
The course involves a supervised essay based on review of the literature on a topic in Marine Science. Students will search for up-to-date information on the topic from various sources. Each student will present a seminar and submit a formal written report.

MSE 404: Final Year Student Project (6 Units C: PH 270)

Learning Outcomes
At the end of this project course, students should be able to:
1. carry out independent research, investigating a topic in Marine Science under a thorough supervision;
2. develop thought towards solving a problem or addressing an issue of concern in Marine Science;
3. demonstrate knowledge on how to collect, analyse and present scientific data;
4. use tables and figures to present results;
5. interpret results adequately; and
6. write and present research findings in a report scientifically.

Course Contents
Every final year student will undertake supervised individual research project which will involve independent data gathering, presentation and interpretation. Students will register for the course at the beginning of the first semester and the project will last two semesters. Each student will present a formal written report at the end of the session.

Minimum Academic Standards

Equipment
a. Physical and Chemical Parameters
Water Bottle
Secchi disc
Grab
Corer
Dredge
Anemometer
Transmissometer
Flow cytometer
Currents meters
Sound level meter
Thermometers (including wet and dry bulb thermometer)
Hydrometer
Hygrometer
Barometer
Radiometer
Oxygen meter
Conductivity meter
Turbidimeter
Salinometer

pH meter
Waterbath
Spectrophotometer
Colorimeter
Calorimeter
Photometer
Centrifuge
Hot-air oven
Distiller
Hand-held GPS

b. Biological Parameters

Plankton nets
Fishing nets
Grab
Dredge
Binocular microscopes
Microtome
Electrophoresis machine/apparatus
PCR machine

c. Others

Computers
Camera for digital photomicrographs
A land vehicle (for field trips)
Safety tools/devices for swimming and diving
life jackets
buoys
diving suits
oxygen cylinders
spears and arrows
darts

Boat (at least 10-passengers capacity) with outboard and inboard engines
Sea-going ship or its availability (for sea trips), with diving, rescue, scubas, navigation, bathymetric tools/equipment, (fins, masks, snorkels, divers suits, submersible, gyrocompass, radar, echo sounder, profilers, GPS receiver, ROV etc.).

Staffing

Academic Staff

The NUC guidelines on academic staff/student ratio of 1:20 for Science Programmes shall apply. There should be a minimum of six academic staff to begin with and at least 70% of the total number having a PhD with adequate teaching experience.

Non-Academic Staff

Administrative Support Staff

This should include recruit very competent, computer literate senior staff as Departmental Secretary and *Higher Executive Officer; others are Typist and Messenger.*

Technical Support Personnel
There should be adequate number of qualified technical staff in the various cadres listed below, with a minimum of school certificate and National Diploma in Laboratory Technology or its equivalent to maintain teaching and research equipment, procure or collect materials (specimens and chemicals etc.) for practicals as well as assist in running practicals:

Chief Technologist
Assistant Chief Technologist
Senior Technologist
Technologist I
Technologist II
There should also be adequate number of Laboratory Assistants with a minimum of school certificate. They are to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

Library
There should be a Departmental Library that can contain a minimum of least 25% of the total number of students enrolled in the Department. The library should be equipped with databases and other electronic/digital library and information resources, hard copies of well stocked relevant books, journal articles and other relevant news articles particularly on Marine Science.

Classrooms, Laboratories, Workshops and Office Space

The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

Number of Offices
Each lecturer should have an office (no sharing). Offices of Technologist should preferably be attached to their laboratories.

Number of Laboratories

There should be at least four (4) large laboratories calculated according to specifications of 7.5 m^2 per FTE; a minimum of four (4) preparatory rooms for each laboratory at the NUC specifications of 7 m^2 each.

Number of Lecture Rooms

There should be at least two lecture rooms, one capable of sitting at least 60 students and other capable of sitting at least 100 students at the specification of 1 m^2 per FTE.

Departmental Conference/Seminar Room

There should be a Departmental Conference/Seminar Room that can occupy up to 100 participants.

A Staff Common Room

There should be staff common room to sit all the senior staff.

B.Sc. Maritime Science

Overview
The maritime science programme proposal is well-packaged and holistic as it is interwoven with courses that will meet the needs of the Nigerian youth in the 21st Century. This spans across oceanography, navigation, seafaring and marine environment and safety, including the use of modern technology including radar in navigation. Apart from the core courses in maritime science, courses like entrepreneurship, ensure that the graduate of maritime science will be self-reliant and employer of labour. Courses in computer programming make them well-fitted in modern technology. Leadership courses will prepare the graduates to be leaders not only in maritime industry but in politics, government and the academia.

When fully delivered, the maritime science programme has the potentials of making the graduates very versatile with the ability to be relevant in the global competitiveness of the 21st Century.

Philosophy
The philosophy of the programme is to train graduates who will apply scientific approach through verifiable and reproducible methodologies in solving the maritime needs of the society.

Objectives
The objectives of the programme are to:
1. provide students with knowledge and skills from which they can proceed to further studies in specialized and multidisciplinary areas of the maritime science consisting of maritime environment for seafaring, port and harbour for stevedore, cargo handling and transportation from ports to ports and offshore platforms;
2. provide students with a broad and balanced foundation of maritime knowledge and practical skills as may be applicable in their different areas of specialization;
3. develop in students the ability to apply maritime knowledge and skills to solving theoretical and practical problems; and
4. develop in students, a range of transferable skills that are of value in any employment and society they might find themselves.

Unique features of the programme
The programme is multidisciplinary, thus enabling the graduates of maritime science to be versatile with skills in diverse sector of the economy.

Employability skills
Graduates of maritime science are expected to develop high cognitive abilities and skills related to maritime science. They are also expected to exhibit high practical skills in maritime sciences. They are expected to be able to transfer these skills to non-maritime science specific competencies. They will also be able to synthesize concepts: ability to plan, design, construct and manage various criteria in explorative and exploitative procedures of the maritime environment. They will be empowered with leadership skills and will be capable of team-work. Furthermore, they will be skilled for self-employment.

21st Century skills

1. Creativity, cognitive abilities and skills and analytical mind.
2. Computer literacy.
3. Organization skills.
4. Communication and information technology.
5. Interpersonal skills.
6. Teamwork.

Admission and Graduation Requirements

Admission Requirements

Admission by indirect-entry mode

The minimum admission requirements for four years bachelor's degree programme shall be five (5) subjects (including English language and mathematics) obtained at the credit level at Senior Secondary Certificate (SSC) or its equivalent, in not more than two (2) sittings. Such candidates shall be admitted into year one (1) of the degree programme. In addition, faculty and departmental requirement(s) shall be satisfied, with respect to level/UTME subject combinations.

Admission by direct entry

Holders of ND certificates in maritime courses are eligible for admission to Year II of the 4-year degree programme, provided that such candidates satisfy the requirements for admission through UTME. holders of Degree/HND not relevant to the programme. In addition to the above, such candidates must also satisfy the UTME requirements.

Candidates, who passed with upper credit in the national diploma (ND) from recognized institutions in maritime courses, may be admitted into the second year of the degree programme, provided such candidates also satisfy the requirements for admission through UTME.

Graduation Requirements

The student must earn a minimum of 120 credit units for a four-year programme, before graduation. For direct entry into year two, a minimum of 90 credit units must be earned before the student can graduate.

Global Course Structure

100 level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
COS 101	Introduction to Computer Science	3	C	30	45
BIO 101	General Biology I	2	C	30	-
BIO 102	General Biology II	2	C	30	-
BIO 107	General Biology Practical I	1	C	-	45
BIO 108	General Biology Practical II	1	C	-	45
CHM 101	General Chemistry I	2	C	30	-

Course Code	Course Title	Unit(s)	Status	LH	PH
CHM 102	General Chemistry II	2	C	30	-
CHM 107	General Chemistry Practical I	1	C	-	45
CHM 108	General Chemistry Practical II	1	C	-	45
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 107	General Physics Practical I	1	C	-	45
PHY 108	General Physics Practical II	1	C	-	45
MTS 101	Introduction to Maritime Science	2	C	15	45
MTS 102	Introduction to Oceanography	2	C	15	45
	Total	**33**			

200 level

Course Code	Course Title	Units	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
MTS 201	Introduction to Navigation	2	C	15	45
MTS 223	Introduction to Meteorology	2	C	15	45
MTS 235	Marine Techniques	2	C	15	45
MTS 232	Marine Operations & ISM Code	2	C	30	-
MTS 242	Field and Professional Skills	2	C	30	-
MTS 202	Introduction to Nautical Astronomy	2	C	15	45
	Total	**16**			

300 level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
MTS 315	Navigation Aids and Equipment	2	C	15	45
MTS 321	Radar/Electronic Navigation	2	C	15	45
MTS 361	Containerization and modern cargo storage	2	C	15	45
MTS 371	Research and Technical Report Writing	2	C	30	-
MTS 372	Students Industrial Work Experience Scheme (SIWES)	3	C	-	
	Total	**15**			

400 level

Course Code	Course Title	Units	Status	LH	PH
MTS 431	Marine Environmental problems	2	C	30	-
MTS 411	Advanced Navigation Safety	2	C	15	45
MTS 412	Coastal and Deep-Sea Navigation	2	C	15	45
MTS 414	Rules of the Nautical Road	2	C	30	-
MTS 472	Project	6	C	-	270
MTS 434	Ship Stability and Trim	2	C	30	-
MTS 432	Port Health and Safety	2	C	30	-
MTS 401	Mariculture entrepreneurship	2	C	15	45
MTS 421	Vessel Chattering and Brokering	2	C	30	-
	Total	**22**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. identify possible sound patterns in English Language;
2. list notable Language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English Language (vowels and consonants, phonetics, and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple, and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and critical thinking and reasoning methods (logic and syllogism, inductive and deductive argument and reasoning methods, analogy, generalisation and explanations). Ethical considerations, copyright rules, and infringements. Writing activities: (pre-writing, writing, post writing, editing and proof reading. Brainstorming, outlining, paragraphing). Types of writing: summary, essays, letter, curriculum vitae, report writing, note making etc. Mechanics of writing. Comprehension Strategies: (reading and types of reading, comprehension skills, 3RsQ). Information and communication technology in modern Language Learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of Trade, Economic and Self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building;
6. analyse the role of the Judiciary in upholding people's fundamental rights;
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture, and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture. peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria. Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914. formation of political parties in Nigeria. Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics. Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system.Indigenous apprenticeship system among Nigeria people. Trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification. Judiciary and fundamental rights. Individual, norms, and values (basic Nigeria norms and values, patterns of citizenship acquisition. Citizenship and civic responsibilities. indigenous languages, usage, and development. Negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation. Re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption (WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. explain basic definition of set, subsets, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers, integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers, algebra of complex numbers, the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative as limit of rate of change. Techniques of differentiation. Extreme curve sketching. Integration as an inverse of differentiation. Methods of integration. Definite integrals. Application to areas, volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

BIO 101: General biology I **(2 Units C: LH 30)**

Learning Outcomes
At the end of lectures, students should be able to:
1. explain cell structure and organizations;
2. summarise functions of cellular organelles;
3. characterise living organisms and state their general reproduction;
4. describe the interrelationship that exists between organisms;
5. discuss the concept of heredity and evolution; and
6. enumerate habitat types and their characteristics.

Course Contents
Cell structure and organisation, functions of cellular organelles. characteristics and classification of living things. chromosomes, genes; their relationships and importance. general reproduction. interrelationships of organisms (competitions, parasitism, predation, symbiosis, commensalisms, mutualism, saprophytism). heredity and evolution (introduction to Darwinism and Lamarkism, Mendelian laws, explanation of key genetic terms). elements of ecology and types of habitat.

BIO 102: General biology II **(2 Units C: LH 30)**

Learning Outcomes
At the end of the lectures, students should be able to:
1. list the characteristics, methods of identification and classification of viruses, bacteria and fungi;
2. state the unique characteristics of plant and animal kingdoms;
3. describe ecological adaptations in the plant and animal kingdoms;
4. explain nutrition, respiration, excretion and reproduction in plants and animals; and
5. describe growth and development in plants and animals.

Course Contents
Basic characteristics, identification and classification of viruses, bacteria and fungi. A generalized survey of the plant and animal kingdoms based mainly on study of similarities and differences in the external features. Ecological adaptations. Briefs on physiology to include nutrition, respiration, circulatory systems, excretion, reproduction, growth, and development.

BIO 107: General biology practical I **(1 Unit C: PH 45)**

Learning Outcomes
At the end of the course, students should be able to:
1. outline common laboratory hazards;
2. provide precautions on laboratory hazards;
3. state the functions of the different parts of microscope;
4. use the microscope and describe its maintenance;
5. draw biological diagrams and illustrations; and
6. apply scaling and proportion to biological diagrams.

Course Contents
Common laboratory hazards. Prevention and first aid. Measurements in biology. Use and care of microscope. Compound and dissecting microscope. Biological drawings and illustration. Scaling, accuracy and proportion. Use of common laboratory apparatus and laboratory experiments designed to illustrate the topics covered in BIO 101.

BIO 108: General biology practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the anatomy of flowering plants;
2. differentiate types of fruit and seeds;
3. state ways of handling and caring for biological wares;
4. describe the basic histology of animal tissues; and
5. identify various groups in the animal kingdom.

Course Contents
Anatomy of flowering plants. Primary vegetative body. Stem, leaf, and root to show the mature tissues namely parenchyma, collenchyma, sclerenchyma, xylem, and phloem. Types of fruits and seeds. Care and use of dissecting kits and other biological wares. Dissection and general histology of animal tissues based on vertebrate forms. Morphology and functions of epithelial, muscular, nervous, and connective tissues. Examination of various groups of lower invertebrates under microscopes, identification of various groups of organisms in animal kingdom. And any experiment designed to emphasize the practical aspects of topics in BIO 102.

CHM 101: General Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. define atom, molecules and chemical reactions;
2. discuss the Modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. illustrate shapes of simple molecules and hybridized orbitals;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents
Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence Forces. Structure of solids. Chemical equations and

stoichiometry. Chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry. Rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reactions;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. describe basic properties of Transition metals.

Course Contents

Historical survey of the development and importance of Organic Chemistry.Fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures, nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics.Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The Chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes

At the end of this course, the students should be able to:

1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify the differences between primary and secondary standards;
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents

Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify and carry out preliminary tests which includes ignition, boiling point, melting point, test on known and unknown organic compounds;
5. perform solubility tests on known and unknown organic compounds;
6. conduct elemental tests on known and unknown compounds; and
7. conduct functional group/confirmatory test on known and unknown compounds which could be acidic / basic / neutral organic compounds.

Course Contents
Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the student should be able to:
1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents
Space and time. Units and dimension. Vectors and scalars. Differentiation of vectors (displacement, velocity and acceleration). Kinematics. Newton laws of motion (Inertial frames, impulse, force and action at a distance, momentum conservation). Relative motion. Application of Newtonian mechanics. Equations of motion. Conservation principles in physics (conservative forces, conservation of linear momentum, kinetic energy and work, potential energy). System of particles. Centre of mass. Rotational motion (torque, vector product, moment, rotation of coordinate axes and angular momentum). Coordinate systems. Polar coordinates. Conservation of angular momentum. Circular motion. Moments of inertia (gyroscopes, and precession). Gravitation (Newton's Law of Gravitation, Kepler's laws of planetary motion, gravitational potential energy, escape velocity, satellites motion and orbits).

PHY 102: General physics II (Electricity & Magnetism) (2 Units C: LH 30)

Learning Outcomes

At the end of the course, the student should be able to:

1. describe the electric field and potential, and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law, and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savartand Ampere's law;
5. describe electromagnetic induction and related concepts and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters; and
8. determine the characteristics of AC voltages and currents in resistors, capacitors, and inductors.

Course Contents

Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and resistance. Ohm's law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

PHY 107: General Physics Practical I (1 Unit C: PH 45)

Learning Outcomes

At the end of the course, the student should be able to:

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents

This introductory course emphasizes quantitative measurements. Experimental techniques. The treatment of measurement errors. Graphical analysis. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc. (covered in PHY 101, 102, 103 and PHY 104). However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis, and deduction.

PHY 108: General Physics Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, the student should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data;
6. prepare and present practical reports.

Course Contents
This practical course is a continuation of PHY 107 and is intended to be taught during the second semester of the 100 level to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements, the treatment of measurement errors, and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

MTS 101: Introduction to Maritime Science (2 Units C: LH 15; PH 45)

Learning Outcomes
1. recognize the different marine crafts like ship, tugboats, cargo vessel, etc;
2. describe marine structures including quay, port;
3. identify the different properties of the ocean;
4. Explain marine systems;
5. list marine renewable sources and their benefits; and
6. possess the skills to classify the ecology of the tropical and temperate and marine waters.

Course Contents
Essential elementary knowledge of marine crafts and marine structures. Marine systems and ocean renewable resources. Ocean technology.Ocean properties. Marine ecology of the tropical, polar, and temperate regions and deep sea. Maritime zones as well as some other marine environmental concerns. Have practical and field experiences with visit to the seaport and appreciate the different marine structures.

MTS 102: Introduction to Oceanography (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. label ocean structures;
2. list the functions of marine system;
3. explain the properties of sea water;
4. discuss the influence of the environment on the characteristics of the ocean;
5. measure the oceanic parameters using oceanographic instruments; and
6. link up human activities to climate change and interpret how they affect the ocean.

Course Contents
The global ocean based on the latest in marine science and technology. Fundamental principles in geological, physical, chemical and biological oceanography. Anthropogenic activities and their impacts on the marine environment. This course will delve into the formation of the ocean basins, the properties of seawater, surface and deep global ocean circulation, marine ecology, causes and effects of climate change. Have practical experiences on measurement of density, salinity, pressure, temperature of seawater.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa, and the rest of the world; and

8. state the basic principles of e-commerce.

Course Contents
Concept of entrepreneurship (entrepreneurship, entrepreneurship/corporate entrepreneurship,). Theories, rationale, and relevance of entrepreneurship (Schumpeterian and other perspectives. Risk-taking, necessity and opportunity-based entrepreneurship and creative destruction. Characteristics of entrepreneurs (opportunity seeker, risk taker, natural and nurtured, problem solver and change agent, innovator, and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking, and creative thinking). Innovation (concept of innovation, dimensions of innovation, change and innovation, knowledge, and innovation). Enterprise formation, partnership, and networking (basics of business plan, forms of business ownership, business registration and forming alliances and join ventures). Contemporary entrepreneurship issues (knowledge, skills and technology, intellectual property, virtual office, networking). Entrepreneurship in Nigeria (Biography of inspirational entrepreneurs, youth and women) entrepreneurship. Entrepreneurship support institutions. Youth enterprise networks and environmental and cultural barriers to entrepreneurship. Basic principles of e-commerce.

MTS 201 Introduction to Navigation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. practice using the navigation instruments;
2. itemise the fundamentals of navigation;
3. describe the fundamentals of navigation;
4. calculate position of ship from chart;
5. estimate position of ship from chart; and
6. interpret charts.

Course Contents
Introduction to marine navigation. Basic definitions and concepts of navigation. Theory of nautical chart projection. Nautical publications and charts. Uses of the magnetic and gyro compasses.Variation and deviation and the computation of compass course and true course. Chart work – fixing ship's position. Finding course and distance to designated position. Running fix. Horizontal angles. Current and leeway. Dipping and rising bearings of lights.The sailings- parallel sailing, plane sailing, mercator sailing.

MTS 202: Introduction to Nautical Astronomy (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. determine the position of the ship in the sea using the stars at night and the sun in the day;
2. manipulate astronomical instruments like Sextant;
3. identify the benefits of celestial navigation;
4. detect defects of indication instruments
5. rectify any defects in course indication instruments and
6. measure the altitude of stars and sun over the visible sea horizon.

Course Contents
Methods of determining the position of a ship at sea using celestial bodies. The basic concepts and principles of navigational astronomy. Different celestial objects used in navigation. Importance of celestial navigation. Correction for course indication instruments. Measurement of altitude of stars and sun over the visible sea horizon. Plane of artificial horizon created in the ship. Instrumental correction. Index correction. Dip visible horizon. Refraction, half diameter and parallax of the celestial body.

MTS 223: Introduction to Meteorology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. measure meteorological parameters with appropriate instruments;
2. read, assess, and interpret weather charts;
3. forecast future weather events;
4. categorize the weather conditions;
5. perform optimum ship routing under specific weather condition; and
6. report and record weather conditions.

Course Contents
Basic principles of meteorology and its application to shipboard operations. Meteorological instruments and their application. Characteristics of various weather systems. Reporting procedures and recording systems. Application of meteorological information available. Practical assessment of reading and interpreting weather charts. Boundary layer. Heat budget, temperature, salinity and density, ocean circulation, waves, sea, and swell, tides, and tidal ecosystems, seiches, storm surges, internal waves. Solar radiation and earth atmospheres systems, weather element, atmospheric thermodynamics, wind systems, latitude cyclones, violent local storms, tropical cyclonic storms, the synoptic weather map, weather forecasting, lightning and thunderstorms, ocean waves, ocean circulation, temperature/salinity curves, sea ice, ice accretion and optimum ship routing.

MTS 232: Marine Operations & ISM Code (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. captain a ship;
2. steer the ship under different oceanographic conditions;
3. acquire the skills to respond to emergency situations while onboard a vessel;
4. explain the various rules and regulations in the Nigerian shipping operations; and
5. report on international standards in marine safety management.

Course Contents
Marine carrier operations: onshore and their interrelationship between the cargo vessel and the shore side operations. Principles of material handling and their application to the movement of all types of cargoes carried at sea. Safe cargo operations – stowage and security of cargoes. care of cargo – ventilation and ventilation systems, fumigation, principles of loading of vessels, break bulk, dry bulk, containers refrigerated, dangerous and special cargoes, utilized cargo and RO – RO operations, principles of stowage – mathematical calculations of safe and efficient cargo

stowage and cargo plans, certification of cargo gear and stress calculations. Principles of rudder, propeller and their effect on ship maneuvering. Ship handling. Effect of wind and current on ship handling. Interaction between vessels. Squat, shallow water and similar effects. Contingency plans for response to emergencies. Ensuring the safety of passengers and/or crew. The ship and the protection of the marine environment. Actions following collision or grounding. Man-over-board procedures. Precautions when beaching a vessel. Fire and explosion on board. Management of ship in heavy weather. Requirements of the international safety management code. Deck officers, engineering officers and office staff will benefit from a solid understanding of this international standard.

MTS 235 Marine Techniques (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. perform routine operation of the seaport;
2. plan voyage and adopt the relevant port strategy;
3. develop plan for quay construction;
4. conduct ships on arrival to the port; and
5. draw budget for any voyage.

Course Contents
Introduction to marine operation, ship chandelling. Cargo inspection. Assessment report. Quay development. Port strategy. Marine activities and integral concept. Voyage budget. Conferring, marine logistics, information technology and vessel sail procedures. Ships arrival and conductivity. Channels demarcations procedures.

MTS 242: Field and Professional Skills (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. acquire and apply information technology skills;
2. function very well in their professions as maritime scientists;
3. justify their actions in relating with others, either in workplace or elsewhere;
4. manage workload;
5. acquire communication skills; and
6. acquire team work skills.

Course Contents
Information technology. Professional skills in entrepreneurship or scientific writing, how to describe and develop professional skills, examples of professional skills. The best course in IT field. How to acquire professional skills in career goals. Learning new technological skills such as whiteboards or course management. A professional skill competence and point of view. Transferable social work skills. Workload management. Interview skills. Learning skills. Communication skills. Teamwork skills. Self-awareness skills. Emotional intelligence skills. Problem solving skills. Organizational skills. Relationship building skills. Technology skills. Leadership and management skills.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict, and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media, and traditional institutions in peace building.

Course Contents
Concepts of Peace, conflict and security in a multi-ethnic nation. Types and theories of conflicts: ethnic, religious, economic, geo-political conflicts. Structural conflict theory, realist theory of conflict, frustration-aggression conflict theory. Root causes of conflict and violence in Africa: Indigene and settlers Phenomenon. Boundaries/boarder disputes. Political disputes. Ethnic disputes and rivalries. Economic inequalities. Social disputes. Nationalist movements and agitations. Selected conflict case studies – Tiv-Junkun, Zango Kartaf, chieftaincy and land disputes. Peace building. Management of conflicts and security. Peace& human development. Approaches to peace & conflict Management --- (Religious, government, community leaders etc.). Elements of peace studies and conflict resolution. Conflict dynamics assessment scales. Constructive& destructive.justice and legal framework. Concepts of social justice. The Nigeria legal system. Insurgency and terrorism, peace mediation and peace keeping. Peace & security council (international, national and local levels). Agents of conflict resolution – conventions, treaties community Policing. Evolution and imperatives. Alternative dispute resolution (ADR).a). Dialogue b).Arbitration, c).Negotiation d).Collaboration etc.Roles of international organizations in conflict resolution. (a). The United Nations, UN, and its conflict resolution organs. (b). The African union & peace security council (c). ECOWAS in Peace Keeping.Media and traditional institutions in peace building. Managing post-conflict situations/crisis. Refugees, internally displaced persons, IDPs.The role of NGOs in Post-conflict situations/crisis.

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents
Opportunity identification (sources of business opportunities in Nigeria, environmental scanning, demand and supply gap/unmet needs/market gaps/market research, unutilised resources, social and climate conditions and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (venture capital, equity finance, Micro finance, Personal savings, small business investment organizations and business plan competition). Entrepreneurial marketing and e-commerce (principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first mover advantage, E-commerce business models and successful E-commerce companies,). Small business management/family business. Leadership & management, basic book keeping, nature of family business and family business growth model. Negotiation and business communication (Strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, Idea pitching); technological solutions (the concept of market/customer solution, customer solution and emerging technologies, business applications of new technologies - Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), blockchain, cloud computing, renewable energy etc. Digital Business and E-commerce strategies).

MTS 315: Navigation Aids and Equipment (2 Units C: LH15; PH 45)

Learning Outcomes
At the end of the course, the students will be able to:
1. execute the movement of ship from one point to the another;
2. explain how to design and develop instruments that acts as aid in Navigation, e.g., Buoys. Fog signal, Light houses;
3. classify navigation types;
4. identify the various navigation instruments; and
5. project and interpret navigation chart.

Course Contents
The arts and science of navigation, computation of solutions for various navigational problems, design and development of instruments. methods, tables and almanacs intended to facilitate the work of the navigator, the principal classification of navigation includes piloting, dead reckoning, electronic navigation, celestial navigation. Early history of navigation. The earth and its coordinates. Chart projections and chart interpretation. Sailings. Aids to navigation – light houses, light ships, buoys, day beacons, fog signals. Electronic aids to navigation – omega, loran, consol, etc. Practical will include actual participation in navigation by the students onboard. Students will be adequately exposed to the practical aspect of navigation.

MTS 321: Radar/Electronic Navigation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, the students will be able to:
1. recognize basic signalling and electronic communications;
2. appreciate the danger of exclusive reliance on information gained from instruments;
3. attain ability to pick up a line of sounding;
4. explain passage planning;

5. describe tide and tidal currents;
6. list effects of tide and tidal currents; and
7. explain the meaning of great circle sailing.

Course Contents
basic signaling and radiotelephone communications. Morse code. Flashing light, international code of signals. Distress, urgent, safety, and navigational messages. Basic theory of electronic navigational aids and instruments, such as GPS, AIS, SARIS, NAVTEX, EPIRB. Fathometers, lifeboat, radios, and speed logs. Continuation of chart work. Running fix wish current. Three-point bearings. Picking up a line of soundings. Position lines by astronomical observations. Passage planning. Great circle sailing. Composite great circle sailing. Tides and tidal current and their effects.

MTS 361: Containerization and Modern Cargo Storage (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. supervise the preparation of holds;
2. operate a ship's cargo gear;
3. proper handling of cargo against damage;
4. identify dangerous goods; and
5. know the ballast water system and the ecological implications of such.

Course Contents
Central to maritime industry is shipment of cargoes, this requires special skills, consequently, this course will expose the students to the following: preparation of holds,operation of ships' cargo gears, securing cargo aboard break- bulk, container and other types of dry cargo vessels. Underway replenishment operations. Handling of dangerous goods. IMDG code. Hazards in bulk cargoes. Water ballast and hatch cover systems. Ecological implication of water ballast.Cargo claim prevention principle.

MTS 371: Research and Technical Report Writing (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. demonstrate good writing and reporting skills in their areas of specialization;
2. write reports related to their fields;
3. write memos and other official means of communications;
4. acquire skills in instructions delivery; and
5. prepare documents in electronic and hard copies.

Course Contents
Technical writing is designed for students preparing for careers in the sciences and applied sciences, particularly engineering. The writing course familiarizes students with the conventions and design strategies practiced in their disciplinary and institutional communities and introduces them to basic disciplinary formats, including memos, formal reports and presentations Gantt charts, instructions, letters, resumes, and visual documents-for both electronic and hard copy.

MTS 372: Students Industrial Work Experience Scheme (3 Units C: PH 135)

Learning Outcomes
At the end of the course, the students should be able to:
1. explain to sea service environment;
2. demonstrate industrial work skills;
3. apply relevant professional skills;
4. attain acceptable level of proficiency in each area of required competence; and
5. write and present project reports.

Course Contents
Students industrial work experience scheme (SIWES) provides an opportunity for the cadets to obtain sea service as an officer in charge of navigational watch in a structured shipboard training programme. The training uses a building block approach, bringing the cadets up to an acceptable level of proficiency in each area of required competence. The cadets or the students at the end of the SIWES undertake individual projects involving study. Research, design or manufacturing on a suitable topic in the chosen option areas according to their individual work experience, interest, future employment or current problem. A project report is expected to be submitted. Time devoted to performing the project and report is 135 hours which will earn 3 units.

400 Level

MTS 401: Mariculture Entrepreneurship (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. construct cage for marine aquaculture;
2. raise fish in cages- a very productive enterprise;
3. identify the conditions needed for successful cage culture;
4. predict the oceanographic condition for fish health; and
5. dispose mariculture products to consumers.

Course Contents
This entrepreneurial course will introduce the students to practical marine aquaculture. The course will include components of cage culture, marine cage culture, cage construction and cage culture species.

MTS 411: Advanced Navigation Safety (2 Units C: LH 15; PH 45)
Learning Outcomes
At the end of the course, the students should be able to:
1. operate radars to ensure safety during navigation;
2. list the general principles of marine radar systems;
3. manipulate marine radar systems;
4. observe radar and report the events in the system; and
5. describe the working of radar reflectors and transponders.

Course Contents
General principles and applications of marine radar systems. Functional system specifications design and operator maintenance procedures. Theory and practice of radar navigation and collision avoidance techniques. Radar observation and reporting. Radar simulation. Doppler, continuous wave and secondary radars. Radar reflectors and transponders.

MTS 412: Coastal and Deep-Sea Navigation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. carry out the routine of navigational watch keeping;
2. read and interpret different navigational instruments and charts;
3. use various electronic navigation system necessary for deep sea navigation;
4. compare and criticize magnetic of different types of compasses; and
5. present information needed by desk officers.

Course Contents
Introduction to the knowledge and practices necessary to carry out the routine, day-to-day navigational watch keeping duties in a proper and safe manner. Information chart, fixing ship's position in coastal and deep waters, earth's magnetism, buoyage systems. magnetic and gyro compasses. Obtaining and applying compass error, basic concepts of electronic navigational aids, global positioning system and radar. Class work is supplemented by practical chart plot exercise in the weekly labs. The free gyro, the controlled gyro, the gyro compass, survey of various gyro compasses, the magnetic compass, errors, and compensation methods. The diascope, the fluxgate compass, the gyro magnetic compass, the directional gyro, inertial platforms, strap down systems, laser gyro. Speed and distance logs, Navistar GPS, Autopilot, Facsimile integrated, Navigation systems. To present information needed by the Deck Officer or member of the bridge team to use and understand various hand-based and space-based electronic navigation system including depth indicators, global positioning system (GPS), differential global system, electronic chart display information (ECDIS), raster chart display information system (RCDS), and the integrated bridge system. Fundamental collision avoidance in compliance with the rules of the road, using radar transfer plotting sheets and radar scope plotting is also covered. Electronic navigation information.

MTS 431: Marine Environmental Problems (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the students should be able to:
1. highlight needs for environmental protection and management;
2. appreciate the impacts of human activities on the marine environment;
3. seek for better ways of protection of the environment;
4. provide advice on health issues in the port; and
5. list causes of plastic pollution.

Course Contents
In-depth study on the current and pressing global issues in environmental science, marine protection and management, plastic pollution, deforestation of the riparian vegetation and the attendant consequences, as it affects the abiotic and biotic aspect of the marine environment.

Health and safety in the workplace. Some topics will be revisited in greater detail during subsequent courses in the MSSEP curriculum.

MTS 414: Rules of the Nautical Roads (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the students should be able to:
1. explain the various rules governing the use of nautical roads;
2. use of navigation lights at various times under different visibilities;
3. identify when to apply the rules of navigation to avoid collisions at sea;
4. appraise the international regulations for preventing collisions; and
5. explain the rules governing overtaking and crossing power vessels.

Course Contents
The international regulations for preventing collision at sea (1960) apply to all international waters and all inland waterways of Nigeria. The rules allow the use of navigation lights during daylight hours in restricted visibility. This course covers: running and anchor lights, towing lights, special lights, day lights, sound signals for approaching power vessels, rules for meeting power vessels, overtaking power vessels, crossing power vessels, rules of fog, principles of marine collision law, lawful lights, head and head. This course is also designed to meet all rules of the road knowledge-based assessments and the three performance-based assessments, each of which forms part of the requirements for officer in charge of a navigation watch (STCW 2010). The objective of this rigorous program of study is to provide the student with a thorough knowledge of the content, application, and intent of the International Regulations for Preventing Collisions at Sea (COLREGS) and the unified inland navigational rules and regulations (INLAND RULES).

MTS 421 Vessel Chattering and Brokerage (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the students should be able to:
1. critique the legal conditions for chattering a ship;
2. itemize the responsibilities of each party in ship brokerage and charter;
3. explain the fundamental trade practice;
4. analyse documentation and cargo brokerage;
5. describe the arts of crewing of ship;
6. determine the number of crewmen according to the nature of voyage and the capacity of the ship.

Course Contents
Operational and legal environment of ship brokerage and chartering, charter parties, responsibilities of owner and charterer under various charter forms. Rules and regulations concerning loading and discharging. Introduction to fundamental trade practice. Types of cargoes, cargo freight market, types of voyages, chartering markets, documentation, lay time calculations, cargo brokerage, ship brokerage and cargo deliveries. Multimodal operators, ship sale, maritime arbitration, ship agent, ship owner, ship purchase and ship acquisition. UNCTAD code of liner shipping. Nonconference operators, crewing of ships, classification of ships and registration.

MTS 434: Ship Stability and Trim (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the students should be able to:
1. describe the principle and causes of instability in ship;
2. explain what causes instability in ship;
3. assess any damaged stability;
4. proffer solutions in the events of loss of intact buoyancy;
5. compute longitudinal and transverse stability; and
6. take appropriate action in the events of partial loss of stability.

Course Contents
This course is designed to meet all stability knowledge requirements officer in charge of a Navigation Watch defined by STCW regulation II/1. Building on the principles of stability, the student will use tables and diagrams of stability and trim data to calculate initial stability, drafts, and trim for any given configuration of loading. The student will compute both longitudinal and transverse stability for any condition during the load-out or discharge using both the traditional stability information and identify factors adversely affecting stability. Finally, the student will become familiar with damage stability assessment and fundamental actions to be taken in the event of partial loss of intact buoyancy.

MTS 432: Port Health and Safety (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. acquire adequate knowledge in monitoring, investigating, and addressing current hazards relating to health and safety in and around the seaport;
2. identify pathogen carrying organisms around the seaport;
3. develop methods of controlling disease vectors;
4. describe the life history of diseases causing organism around the seaport; and
5. list the various port diseases and their causative agents.

Course Contents
This course is aimed at training to support the role of the public health officials in and around the seaport. It addresses issues concerning activities such as monitoring, investigating, and addressing current as well as potential hazards relating to food borne diseases and human contamination. The course also addresses ports emergency preparedness, bio-safety, bio-security and response for outbreaks of dangerous and emerging pathogens outbreaks (examples: SARS, Covid-19, Viral hemorrhagic fevers etc.). Vector Surveillance and control- a comprehensive program for systemic monitoring of diseases vectors and integrated vector control at seaport in compliance with the core capacity requirements of the International Health Regulations (IHR 2005) as well as the World Health Organization (WHO) are examined.

Minimum Academic Standards

Equipment

1. Barometer
2. Hydrometer,
3. Salinometer/refractometer.
4. Air-water thermometer.
5. Echo sounder,
6. Current meter.
7. Sextant.
8. Chronometer.
9. Sight reduction worksheet.
10. Tables.
11. The Sun Almanac.
12. Scientific calculator.
13. Plotting sheet.
14. Parallel ruler.
15. Navistar global positioning System.
16. Thermometer
17. Anemometer.
18. Hygrometer.
19. Rain gauge.
20. Computer and appropriate weather forecasting software.
21. Gyro compass
22. Radar system
23. Compasses

Workshop: There should be a swimming pool facility for training students on the personal survival techniques (PST) using totally enclosed motor propelled survival crafts (TEMPSC) on outrigger davits fitted on a purpose-built steel structure and also a freefall lifeboat. These crafts are used for approved Training for the offshore oil and gas industry
There should be a fast rescue boat located on the pool side area for proficiency in fast rescue boat (FBR) initial courses and refresher training. Also, a number of 'in water 'skills are taught before practical training is undertaken using a variety of life rafts and survival equipment.

Lab: Full mission ship handling simulator: This Lab provides full mission real- time computer-based simulation facility capable of supporting advanced training in navigation, seamanship, manoeuvring and operation of vessels under normal and potentially hazardous conditions.

Tugboat simulator: The system provides for a better insight into capabilities and limitations of powerful and manoeuvrable tugs. It's improving the practical knowledge of handling modern steering devices, various types of programmes and towing operations best practice, the system provides training on conventional tugs, azimuth stern drive tug. (ASD).

Staffing
Student ratio for science is 1:20 and the minimum number of academic staff is 6 in the ratio of 1:2:3 for Professors, Senior lecturers, and Lecturers I and below. PhD degree holder should account for 70 % of the academic staff.

Academic staff – Minimum of 6 (at least one must be of professorial cadre)
Non-academic staff - Qualified technical staff in the various cadres listed below, with a minimum of school certificate and National Diploma in Laboratory Technology or its equivalent:

1. Chief technologist;
2. Assistant chief technologist;
3. Senior technologist;
4. Technologist I;
5. Technologist II;
6. Laboratory assistants with a minimum of school certificate;
7. Secretary;
8. Higher executive officer; and
9. Messenger

Library and Information Resources

1. The university should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition, well stock and current hardcopies of reference and other textual materials should be provided centrally at the level of the faculty. A well network digital library should serve the entire university community. Availability of wireless facilities (Wi-Fi) with adequate bandwidth should enhance access to these electronic resources relevant to Maritime Science.
2. In any case, there should be internet ready workstations available in the library for least 25% of the total student enrolled in maritime Science programme. The funding of the library should be in line with NUC guidelines.

Classrooms, Laboratories, Workshops and Office Space
The NUC recommends the following physical space requirements:

Description		**Size m²**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

Laboratories
There should be standard scientific laboratories for students at all levels (which may be more than one per level depending on the number of students).

Lecture Theatres/Rooms
There should be at least one large lecture theatre (that can take not less than 250 students) for large classes and several lecture rooms to accommodate students adequately at each level from 200 to 400 level.

Seminar room
There should be a seminar room that can occupy up to 100 participants.

Store
There should be a store for storage of chemicals equipment.

Offices
Each lecturer should have an individual office.
Adequate space should be provided for the departments. Effort must be made to provide the department with at least:

1. four (4) large laboratories calculated according to specifications of 7.5 m^2 per FTE; a minimum of four (4) preparatory rooms for each laboratory at the NUC specifications of 7 m^2 each;
2. at least two lecture rooms capable of sitting at least sixty students at the specification of 1 m^2 per FTE;
3. a departmental conference room;
4. a staff common room; and
5. technologists should have offices preferably attached to their laboratories.

B.Sc. Mathematics

Overview
Mathematics programme develops in students' self-confidence in handling problems with minimal or no supervision. Graduates of the programme will acquire sufficient knowledge to develop confidence in appreciating and solving problems in general.

Philosophy
The philosophy of the mathematics programme is to train students to acquire academic excellence and competence in Mathematical reasoning and problem–solving through the use of logic and computational skills with main purpose of meeting our national needs in the area of technological advancement which is currently a global trend.

Objectives
1. To instil in students a sense of enthusiasm for mathematics, an appreciation of its application in different areas and to involve them in an intellectually stimulating and satisfying experience of learning and studying.
2. To provide students a broad and balanced foundation in mathematics knowledge and practical skills in statistics and computer science.
3. To develop in students the ability to apply their mathematics knowledge and skills to the solution of theoretical and practical problems in mathematics.
4. To develop in students, through an education in mathematics, a range of transferable skills of value in mathematical related and non-mathematical related employment.
5. To provide students with knowledge and skills base from which they can proceed to further studies in specialised areas of mathematics or multi-disciplinary areas involving mathematics.
6. To generate in students an appreciation of the importance of mathematics in an industrial, economic, environmental and social context.

Employability Skills
Mathematics is embodiment of employability skills and the graduates will be equipped with skills that include the following:
1. Learning and innovation skills
2. Life and career skills
3. Information, media and technology skills
4. quantitative reasoning;
5. ability to manipulate precise and intricate ideas;
6. numeracy.

21st Century Skills
1. creative and critical thinking;
2. problem solving;
3. analytical thinking;
4. logical thinking;
5. communication;
6. time management;
7. teamwork;
8. independence;

Unique Features of the Programme

The unique features of the programme include

1. graduates will certainly possess the needed skills to bring to bear the applications of mathematics to address industrial and societal problems towards improvement of quality of life in both the developed and developing worlds taking advantage of current innovations in technology;
2. they will be well equipped to pursue careers in several other emerging areas that encompasses all the mathematics disciplines as well as many other areas of science, social science, business, etc. Examples include finance and cryptography, artificial intelligence, machine learning, actuarial science, climate change, energy and sustainable development, mathematical modelling, biomathematics; and
3. graduates will be equipped to demonstrate anywhere they find themselves that mathematical skills propel a better world and enable one to excel in every other field

Admission and Graduation Requirements

Admission Requirements

The entry requirements shall be at least credit level passes in five subjects including English Language, Mathematics, and Physics to form the core subjects with credit in any other two relevant science subjects at the Senior Secondary Certificate (SSC) or its equivalent. In addition, an acceptable pass in the Unified Tertiary Matriculation Examination (UTME), with appropriate subject combination is required for admission into 100 Level.

Candidates with two A level passes (graded A-E) at the GCE/IJMB Advanced Level in relevant subjects (Mathematics, Further Mathematics, Physics and Chemistry) may be admitted into 200-level.

Graduation Requirements

Students are required to pass a minimum of 120 credits and 90 credits for UTME and Direct entry students respectively.

Global Course Structure

100 Level

Course Code	Course Title	Units	Status	LH	PH
GST 111	Communication in English I	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
CSC 101	Introduction to Computer Science	3	C	30	45
MTH 103	Elementary Mathematics III	2	C	30	-
STA 112	Probability I	3	C	45	-
	Total	**16**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	30	-
COS 201	Computer Programming I	3	C	30	45
MTH 201	Mathematical Methods I	2	C	30	-
MTH 202	Elementary Differential Equations	2	C	30	-
MTH 203	Sets Logic and Algebra I	2	C	30	-
MTH 204	Linear Algebra I	2	C	30	-
MTH 205	Linear Algebra II	1	C	15	-
MTH 207	Real Analysis I	2	C	30	-
MTH 209	Introduction to Numerical Analysis	2	C	30	
MTH 210	Vector Analysis	1	C	15	-
	Total	**21**			

300 Level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace and Conflicts Resolutions	2	C	30	-
ENT 311	Enterprise Appreciation	2	C	30	-
MTH 300	Abstract Algebra I	2	C	30	-
MTH 301	Metric Space Topology	2	C	30	-
MTH 302	Ordinary Differential Equations	2	C	30	-
MTH 303	Vector and Tensor Analysis	2	C	30	-
MTH 304	Complex Analysis I	2	C	30	-
MTH 305	Complex Analysis II	2	C	30	-
MTH 306	Abstract Algebra II	2	C	30	-
MTH 307	Real Analysis II	2	C	30	-
MTH 308	Introduction to Mathematical Modelling	2	C	30	-
MTH 310	Mathematical Methods II	2	C	30	-
MTH 399	Industrial Attachment II (12 Weeks)	3	C		-
	Total	**27**			

400 Level

Course Code	Course Title	Units	Status	LH	PH
MTH 401	Theory of Ordinary Differential Equations	2	C	30	45
MTH 402	Theory Of Partial Differential Equations	2	C	30	-
MTH 403	Functional Analysis	2	C	30	-
MTH 404	Project	6	C	-	-
MTH 405	General Topology	2	C	15	45
MTH 406	Lebesgue Measure and Integrals	2	C	30	-
MTH 407	Mathematical Methods	2	C	30	-
MTH 408	Entrepreneurship in Mathematics	2	C	30	-
	Total	**20**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 30; PH 45)

Learning Outcomes
At the end of this course, students should be able to
1. identify possible sound patterns in English language;
2. list notable Language skills; classify word formation processes; construct simple and fairly complex sentences in English;
3. apply logical and critical reasoning skills for meaningful presentations;
4. demonstrate an appreciable level of the art of public speaking and listening; and
5. write simple and technical reports.

Course Contents
Sound patterns in English language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and Deductive Argument and Reasoning Methods, Analogy, Generalisation and Explanations). Ethical considerations, Copyright Rules and Infringements. Writing Activities: (pre-writing, writing, post writing, editing and proofreading; brainstorming, outlining, paragraphing, types of writing, summary, essays, letter, curriculum vitae, report writing, note making etc. mechanics of writing). Comprehension Strategies: (reading and types of reading, comprehension skills, 3RsQ). Information and communication technology in modern language learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of trade, economic and self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building analyse the role of the Judiciary in upholding people's fundamental rights identify acceptable norms and values of the major ethnic groups in Nigeria;
   and
6. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents
Nigerian history; culture and art up to 1800 (yoruba, hausa and igbo peoples and culture, peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria, colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914, formation of political parties in Nigeria. Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics, Nigerian Civil War). concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification). Judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values. Patterns of citizenship acquisition. Citizenship and civic responsibilities. Indigenous languages, usage and development. Negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – reconstruction, rehabilitation and re-orientation). Re-orientation strategies. Operation feed the nation (OFN). Green revolution and austerity measures. War against indiscipline (WAI). War against indiscipline and corruption (WAIC). Mass mobilization for self-reliance, social justice and economic recovery (MAMSER). National orientation agency (NOA). Current socio-political and cultural developments in Nigeria.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing

computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic definition of set, subsets, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers, integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers, algebra of complex numbers, the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative as limit of rate of change. Techniques of differentiation. Extreme curve sketching. Integration as an inverse of differentiation. Methods of integration. Definite integrals. Application to areas, volumes.

MTH 103: Elementary Mathematics III (Vectors, Geometry and Dynamics)
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. solve some vectors in addition and multiplication;
2. calculate force and momentum; and
3. solve differentiation and integration of vectors.

Course Contents
Geometric representation of vectors in 1-3 dimensions, components, direction cosines. Addition, scalar, multiplication of vectors, linear independence. Scalar and vector products of two vectors. Differentiation and integration of vectors with respect to a scalar variable. Two-dimensional co-ordinate geometry. Straight lines, circles, parabola, ellipse, hyperbola. Tangents, normals. Kinematics of a particle. Components of velocity and acceleration of a particle moving in a plane. Force, momentum, laws of motion under gravity, projectiles and resisted vertical motion. Elastic string and simple pendulum. Impulse, impact of two smooth spheres and a sphere on a smooth surface.

STA 112: Probability I (3 Units C: LH 45)

Learning Outcomes
At the end of the course students should be able to
1. explain the differences between permutation and combination;
2. explain the concept of random variables and relate it to probability and distribution functions;
3. describe the basic distribution functions; and
4. explain the concept of exploratory data analysis.

Course Contents
Permutation and combination. Concepts and principles of probability. Random variables. Probability and distribution functions. Basic distributions: Binomial, geometric, Poisson, normal and sampling distributions; exploratory data analysis.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and

8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk-taking state the characteristics of an entrepreneur
2. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence engage in entrepreneurial thinking;
3. identify key elements in innovation; describe stages in enterprise formation, partnership and networking including business planning;
4. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
5. state the basic principles of e-commerce.

Course Contents
Concept of entrepreneurship (entrepreneurship, intrapreneurship/corporate entrepreneurship,). Theories, rationale and relevance of entrepreneurship (Schumpeterian and other perspectives, risk-taking, necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of entrepreneurs (opportunity seeker, risk taker, natural and nurtured, problem solver and change agent, innovator and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking, and creative thinking). innovation (concept of innovation, dimensions of innovation, change and innovation, knowledge and innovation); enterprise formation, partnership and networking (basics of business plan, forms of business ownership, business registration and forming alliances and join ventures). Contemporary entrepreneurship Issues (knowledge, skills and technology, intellectual property, virtual office, networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, youth and women entrepreneurship, entrepreneurship support institutions, youth enterprise networks and environmental and cultural barriers to entrepreneurship); basic principles of e-commerce.

COS 201: Computer Programming I (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. Explain the principles of good programming and structured programming concepts;
2. Explain the programming constructs, syntax and semantics of a higher-level language;
3. Describe the chosen programming language variables, types, expressions, statements and assignment; simple input and output;

4. Describe the programme control structures, functions and parameter passing, and structured decomposition; and
5. Develop simple programmes in the taught programming language as well as debug and test them.

Course Contents
Introduction to computer programming. Functional programming; Declarative programming; Logic programming; Scripting languages. Introduction to object-orientation as a technique for modelling computation. structured, and even some level of functional programming principles; Introduction of a typical object-oriented language, such as Java; Basic data types, variables, expressions, assignment statements and operators; Basic object-oriented concepts: abstraction; objects; classes; methods; parameter passing; encapsulation. Class hierarchies and programme organisation using packages/namespaces; Use of API – use of iterators/enumerators, List, Stack, Queue from API; Searching; sorting; Recursive algorithms; Event-driven programming: event-handling methods; event propagation; exception handling. Introduction to Strings and string processing; Simple I/O; control structures; Arrays; Simple recursive algorithms; inheritance; polymorphism.

Lab work: Programming assignments; design and implementation of simple algorithms, e.g., average, standard deviation, searching and sorting; Developing and tracing simple recursive algorithms. Inheritance and polymorphism.

MTH 201: Mathematical Methods 1 (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain real-valued functions of a real variable;
2. solve some problems using mean value theorem and Taylor series expansion; and
3. evaluate line integral, surface integral and volume integrals.

Course Contents
Real-valued functions of a real variable. Review of differentiation and integration and their applications. Mean value theorem. Taylor series. Real-valued functions of two and three variables. Partial derivatives chain rule, extrema, lagrangian multipliers. Increments, differentials and linear approximations. Evaluation of line integrals. Multiple integrals.

MTH 202: Elementary Differential Equations (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. define the following: order and degree of a differential equation;
2. describe some techniques for solving first and second order linear and non-linear equations; and
3. solve some problems related to geometry and physics.

Course Contents
Derivation of differential equations from primitive geometry, physics etc. Order and degree of differential equation. Techniques for solving first and second order linear and non-linear

equations. Solutions of systems of first order linear equations. Finite linear differential equations. Application to geometry and physics.

MTH 203: Sets, Logic and Algebra I (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. solve various problems using the concept of set theory;
2. recognise Algebraic structures; and
3. describe the meaning of logic in Mathematics.

Course Contents
Introduction to the language and concepts of modern mathematics. Topics include: basic set theory: mappings, relations, equivalence and other relations, Cartesian products, binary logic, methods of proof, binary operations. Algebraic structures, semi-groups, rings, integral domains, fields. Homeomorphics. Number systems; properties of integers, rationals, real and complex numbers.

MTH 204: Linear Algebra I (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain vector space;
2. describe linear transformations and their representation by matrices; and
3. calculate algebra of various matrices.

Course Contents
Vector space over the real field. Sub-spaces, linear independence, basis and dimension. Linear transformations and their representation by matrices – rings, null space, rank. Singular and non-singular transformation and matrices. Algebra of matrices.

MTH 205: Linear Algebra II (1 Unit C: LH 15)

Learning Outcomes
At the end of the course, students should be able to:
1. recognise systems of linear equations.
2. calculate the Eigen values and Eigen vectors.
3. describe the Cayley-Hamilton theorem and its uses.

Course Contents
Systems of linear equation, change of basis, equivalence and similarity. Eigen values and Eigen vectors. Minimum and characteristic polynomials of a linear transformation (matrix). Cayley-Hamilton theorem. Bi-linear and quadratic forms, orthogonal diagonalisation. Canonical forms.

MTH 207: Real Analysis I **(2 Units C: LH 30)**

Learning Outcomes
At the end of the course, students should be able to:
1. describe convergence of sequence of numbers;
2. discuss the monotone, cauchy sequences;
3. test for convergence of series; and
4. state roles and mean value theorem.

Course Contents
Bounds of real numbers, convergence of sequence of numbers. Monotone sequences, the theorem of nested intervals. Cauchy sequences, tests for convergence of series. Absolute and conditional convergence of series and re-arrangements. Completeness of reals and incompleteness of rationale. Continuity/and differentiability of functions. Rolles' mean and value theorems for differentiable functions, Taylor series.

MTH 209: Introduction to Numerical Analysis **(2 Units C: LH 30)**

Learning Outcomes
At the end of the course, students should be able to:
1. solve some numerical solution of algebraic and transcendental equations;
2. describe curve fitting;
3. discuss error analysis;
4. calculate interpolation and approximation;
5. solve some numerical differentiation and numerical integration problems; and
6. solve some numerical problems in ordinary Differential equations with initial value problems;

Course Contents
Solution of algebraic and transcendental equations. Curve fitting. Error analysis. Interpolation and approximation. Zeros of non-linear equations 'in one variable'. Systems of linear equations. Numerical differentiation and integration. Initial value problems in ordinary differential equation.

MTH 210: Vector Analysis **(1 Unit C: LH 15)**

Learning Outcomes
At the end of the course, students should be able to:
1. describe vector algebra;
2. explain geometrical equation of lines and planes; and
3. outline problems in gradients, divergent and curl.

Course Contents
Elementary vector algebra, vector and vector triple, vector products (more application solution of vector equation, plain curves and space curves. Geometrical equation of lines and planes. Linear independence of vectors; components of vectors, direction cosines; position vector and scaler products; Frenet-Serret formulas; differential definition ofgradients, divergent and simple multiplication)

300 Level

GST 312: Peace and Conflict Resolution (2 Unit C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents

Concepts of peace, conflict and security in a multi-ethnic nation. Types and theories of conflicts: ethnic, religious, economic, geo-political conflicts; structural conflict theory, realist theory of conflict, frustration-aggression conflict theory. Root causes of conflict and violence in Africa: indigene and settlers phenomenon; boundaries/boarder disputes; political disputes; ethnic disputes and rivalries; economic inequalities; social disputes; nationalist movements and agitations; selected conflict case studies – Tiv-Junkun; Zangon Kataf, chieftaincy and land disputes, etc. Peace building, management of conflicts and security: peace & human development. Approaches to peace & conflict management (religious, government, community leaders, etc.). Elements of peace studies and conflict resolution: conflict dynamics assessment. Scales: constructive & destructive. Justice and Legal framework: concepts of social justice; the Nigeria legal system. Insurgency and terrorism. Peace mediation and peace keeping. Peace & security council (international, national and local levels). Agents of Conflict resolution – conventions, treaties, community policing. Evolution and imperatives. Alternative Dispute Resolution, ADR. a). dialogue b). arbitration, c). negotiation d). collaboration, etc. Roles of International Organizations in Conflict Resolution. a). The United Nations, UN and its conflict resolution organs. b). The African Union & peace security council c). ECOWAS in peace keeping. Media and traditional institutions in peace building. Managing post-conflict situations/crisis: refugees. Internally Displaced Persons, IDPs. The role of NGOs in post-conflict situations/crisis.

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students, through case study and practical approaches, would be able to:

1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce; apply a wide variety of emerging technological solutions to entrepreneurship; and

8. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/Market Research, Unutilised resources, Social and climate conditions and technology adoption gap). New business development (business planning, market research). Entrepreneurial Finance (Venture capital, Equity finance, Micro finance, Personal savings, small business investment organisations and Business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, First mover advantage, E-commerce business models and successful E-Commerce Companies,). Small business management/family business: Leadership & management, Basic book keeping, Nature of family business and family business growth model. Negotiation and business communication (Strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological solutions (The concept of market/customer solution, customer solution and emerging technologies, business applications of new technologies - Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud computing, Renewable energy etc. Digital business and E-Commerce strategies).

MTH 300: Abstract Algebra I (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. state various groups, sub-groups, ring, field and Integral domain; and
2. calculate the H.C.F and L.C.M of Polynomials.

Course Contents
Group definition, examples including permutation groups. Sub-groups, Cosets. Lagrange's theorem and applications. Cyclic groups. Rings: definition and examples including Z, Zn, rings of polynomials and matrices. Integral domains, fields. Polynomial rings, factorisation. Euclidean algorithm for polynomials, H.C.F. and L.C.M. of polynomials.

MTH 301: Metric Space Topology (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the following: set, metric, open sphere, open set, closed sets, interior, exterior, neighbourhood, connectedness and compactness; and
2. discuss convergence in metric space.

Course Contents
Sets, metrics, and examples. Open spheres (or balls). Open sets and neighbourhoods. Closed sets. Interior, exterior, frontier, limit points and closure of a set. Dense sub-sets and separable

space. Convergence in metric space homeomorphisms. Continuity and compactness, connectedness.

MTH 302: Ordinary Differential Equations (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. describe line dependence, Wronskian, reduction order, variation of parameters, series solution about ordinary and regular points; and
2. discuss orthogonal polynomials.

Course Contents
Ordinary differential equations: linear dependence, Wronskian, reduction order, variation of parameters, series solution about ordinary and regular points. Special functions: Gamma, Beta, Bessel, Legendre's theorem, hyper geometric. Laplace transform and applications to initial value problems

MTH 303: Vector and Tensor Analysis (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. discuss vector differentiation and vector integration;
2. describe gradient, divergence and curl;
3. discuss Green's, Stoke's and divergence theorems;
4. solve some problems involving applications of vector differentiation and vector integration; and
5. Discuss tensor and Cartesian tensor.

Course Contents
Vector differentiation and applications. Gradient, divergence and curl. Vector integration, line, surface and volume integrals, Greens, Stoke's and divergence theorems. Tensor products of vector spaces. Tensor algebra. Symmetry. Cartesian tensors.

MTH 304: Complex Analysis (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. define functions of complex variable;
2. derive Cauchy-Riemann equations;
3. discuss conformal mapping;
4. solve some problems involving contour integrals, Power and Taylor series of function of a complex variable.

Course Contents
Functions of a complex variable. Limits and continuity of functions of a complex variable. Derivating the Cauchy-Riemann equations. Analytic functions. Bi-linear transformations, conformal mapping, contour integrals. Cauchy's theorems and its main consequences,

convergence of sequences and series of functions of a complex variable. Power series. Taylor series.

MTH 305: Complex Analysis II (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. discuss Laurent expansion, Isolated singularities and Residues; and
2. define Residue theorem and Rouche's theorem

Course Contents
Laurent expansions. Isolated singularities and residues. Residue theorem. Calculus of residue, and application to evaluation of integrals and to summation of series. Maximum modulus principle. Argument principle. Rouche's theorem. The fundamental theorem of algebra. Principle of analytic continuation. Multiple valued functions and Riemann surfaces.

MTH 306: Abstract Algebra II (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. define normal subgroups and quotient groups;
2. state isomorphism theorem and Cayley's theorems;
3. discuss Sylow theorems; and
4. describe algebraic and transcendental extensions.

Course Contents
Normal subgroups and quotient groups. Monomorphism, isomorphism theorems. Cayley's theorems. Direct products. Groups of small order. Group acting on sets. Sylow theorems. Ideal and quotient rings. P.I.D. &, U.F.D's Euclides rings. Irreducibility; Field extensions, degree of an extension, and minimum polynomial. Algebraic and transcendental extensions. Straight edged and compass constructions.

MTH 307: Real Analysis II (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. discuss Riemann integral of several functions;
2. define Riemann Stieltjes integral; and
3. describe continuous differentiable functions.

Course Contents
Riemann integral of functions $R^n \rightarrow R$, continuous monopositive functions. Functions of bounded variation. The Riemann Stieltjes integral. Pointwise and uniform convergence of sequences and series of functions $R^n \rightarrow R$. Effects on limits (sums) when the functions are continuous differentiable or Riemann integrable. Power series.

MTH 308: Introduction to Mathematical Modelling (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. develop some mathematical models in Biology, Physics, Chemistry, and Social Science;
2. describe flow Diagrams;
3. discuss method of Analysis of models formulated; and
4. describe the method of solutions to the models formulated.

Course Contents
Methodology of model building; identification, formulation and solution of problems, cause-effect diagrams. Equation types: algebraic, ordinary differential, partial differential, difference, integral and functional equations. Applications of mathematical models to physical, biological, social and behavioural sciences.

MTH 310: Mathematical Methods II (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. describe Sturm-Liouville problems.
2. discuss orthogonal polynomials and functions.
3. solve some problems using first and second order differential equations

Course Contents
Sturm – Liouville problems. Orthogonal polynomials and functions. Fourier series and integrals. Partial differential equations: general and particular solutions. Linear equations with constant coefficients, first and second order equations, solutions of the heat, wave and Laplace equations by the method of separation of variables. Eigen function expansions. Methods of variation of parameters. Fourier transforms.

MTH 399: Industrial Attachment II (12 Weeks) (3 Units C: PH 135)

Students should be attached to some industrial organizations for additional 12 weeks at their 300 Level preferably during the long vacation for more industrial experience. Students to be assessed based on seminar presentation, their reports and assessment by supervisors.

400 Level

MTH 401: Theory of Ordinary Differential Equations (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. define existence and uniqueness theorems;
2. describe Volterra and Fredholm types; and
3. solve some problems of reduction of ordinary differential equations to integral equations.

Course Contents
Existence and uniqueness theorems, dependence of solutions on initial data and parameters. Properties of solutions. Sturm comparison and Sonin-Polya theorems. Linear and non-linear

systems. Floquet's theory and stability theory. Integral equations: classification, Volterra and Fredholm types, Neumann series. Fredholm alternative for degenerate Hilbert – Schmidt kernels. Reduction of ordinary differential equations to integral equations. Symmetric kernels, eigenfunction expansion with application.

MTH 402: Theory of Partial Differential Equations (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. define first and second order linear equations;
2. describe Cauchy problems; and
3. solve some problems in parabolic, hyperbolic and elliptic equations.

Course Contents

Theory and solutions of first-order and second order linear equations. Classification, characteristics and canonical forms. Cauchy problems. Elliptic equations: Laplace's and Poisson's formulas, properties of harmonic functions. Hyperbolic equations; wave equations, retarded potential: transmission line equation, Riemann method. Parabolic equation: diffusion equation, singularity function, boundary and initial – value problems.

MTH 403: Function Analysis (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. define Hilbert spaces, Banach spaces and vector spaces;
2. describe Banach algebra.

Course Contents

Hilbert Spaces bounded linear functionals, operators on Banach spaces, topological vector spaces, Banach algebra.

MTH 404: Project: (6 Units C: PH 270)

A research project and dissertation to be undertaken on any topic of mathematical interest.

MTH 405: General Topology (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. define the following: topological spaces, continuous functions and topological invariants;
2. describe pointwise and uniform convergence.

Course Contents

Topological spaces, definition, open and closed sets neighbourhoods. Coarser, and finer topologies. Basis and sub- basis. Separation axioms, compactness, local compactness, connectedness. Construction of new topological spaces from given ones. Sub-spaces and quotient spaces. Continuous functions, homeomorphisms and topological invariants. Spaces of continuous functions: Pointwise and uniform convergence.

MTH 406: Lebesgue Measure and Integrals (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. define Lesbesgue measure; and
2. describe Measurable functions and Integral convergence theorems.

Course Contents
Lebesgue measure; measurable and non-measurable sets. Measurable functions. Lebesgue integral: Integration of non-negative functions, the general integral convergence theorems.

MTH 407: Mathematical Methods (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. define calculus of variation;
2. describe isoperimetric problems; and
3. solve some problems using integral transforms like: Laplace, Fourier, Hankel, Mellin, Z, Hilbert transforms.

Course Contents
Calculus of variation. Lagrange's functional and associated density. Necessary condition for a weak relative extremum. Hamilton's principles. Lagrange's equations and geodesic problems. The Du Bois-Raymond equation and corner conditions. Variable end-points and related theorems. Sufficient conditions for a minimum. Isoperimetric problems. Variational integral transforms. Laplace, Fourier and Hankel transforms. Complex variable methods, convolution theorems. Application to solution of differential equations.

MTH 408: Entrepreneurship in Mathematics (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. read, write, execute, run and analyse prevailing programming languages
2. prepare documents using LaTeX
3. engage in web designing, printing technology and other related assignments

Course Contents
Student should be exposed to programming languages and how to write projects using latex, web designing, printing technology and mathematics improvement projects.

Minimum Academic Standards

Staffing

Academic Staff
The guidelines on academic staff/student ratio of 1:20 for science programmes shall apply.
To start any programme in science, there should be a minimum of six academic staff. There is need to have a reasonable number of staff with PhD degrees accounting for at least 70% of the total number and having adequate teaching experience for every programme in the discipline.

Administrative support staff
The services of the administrative support staff are indispensable in the proper administration of departments and faculty offices. It is important to recruit very competent, computer literate senior staff.

Technical support personnel
The services of technical support staff, which are indispensable in the proper running of laboratories and workshops, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training developments in equipment operation and maintenance.

Classrooms, Laboratories, Workshops and Office Space
The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

Adequate space should be provided for all departments in the sciences. Effort must be made to provide each department with at least:
1. Four (4) large laboratories calculated according to specifications of 7.5 m^2 per FTE; a minimum of four (4) preparatory rooms for each laboratory at the NUC specifications of 7 m^2 each.
2. At least two lecture rooms capable of sitting at least sixty students at the specification of 1 m^2 per FTE.
3. A departmental conference room.
4. A staff common room.

Library and Information Resources
Universities should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition, well stock and current hardcopies of reference and other textual materials should be provided centrally at the level of the faculty.

A well network digital library should serve the entire university community. Availability of wireless facilities (Wifi) with adequate bandwidth should enhance access to these electronic resources. In any case, there should be internet-ready workstations available in the library for at least 25% of the total students enrolled in each academic programme. The funding of the library should be in line with NUC guidelines.

Equipment

S/N	Description	Quantity Required
1	Computers	60
2	Computer software	6
3	Flash drives	10
4	Printers	10
5	Projectors	10
6	Smart board	5
7	Smart TV	5
8	Video machine	5
9	Screen board	10
10	Pen drive	10
11	Loud speaker with microphones	5

B. Sc. Medical Physics

Overview
Bachelor of Science (Honours) in Physics (Medical Physics) is designed to bridge the gap between pure and applied physics and is offered as an interfaculty programme of the Faculties of Science and Health Sciences. This curriculum is prepared to offer bachelor's degree in physics with a concentration in medical physics. Coursework for the programme is founded on mathematics and physics at the 100 level through 400 level with more concentrated specialised courses at the 500 level.

Philosophy
The philosophy of the programme is to provide supportive learning environment for the training of students in both theoretical knowledge and experimental skills in Physics, Medical Physics, Radiation Protection ready and capable for further academic pursuit, research, or work in all relevant fields for human development.

Objectives
The objective of this curriculum is to produce graduates who will be able to:
1. explain and critically discuss the fundamental concepts, of physics, their interrelationship and the wide-ranging applicability to healthcare;
2. explain and critically discuss the basic concepts of medical imaging and relevant fields;
3. formulate physical laws in mathematical language and construct mathematical models of medical phenomena;
4. interpret and use equations to represent physical laws and processes and their medical application;
5. apply the solution of complex equations describing medical processes;
6. assess measurement uncertainty in medical measurements and computational models;
7. exploit connections between physics, mathematics, biology and medicine;
8. formulate and solve physical problems based on mathematical and computational models; and
9. manage tasks independently, using own initiative and plan and execute a project.

Employability Skills
1. graduates can carry out research in Physics, Medical Physics, Radiation Protection in the Medical Device industry;
2. they would be equipped to fit in Research & Development laboratories in industry, government, public sectors;
3. appreciation of medical physics application in different other related fields; and
4. they can be self-employed by establishing relevant small and medium scale enterprises.

21st century Skills
1. Creativity
2. Communication
3. Team work
4. Critical thinking
5. Innovation
6. Technology literacy

7. Flexibility

Unique Features of the Programme

The unique features of the programme include:

1. Qualification for certification by international professional organisations;
2. Further professional development leading to recognition as medical physicist;
3. Ability to ensure high standard of patient care;
4. Qualification to undergo further clinical training at postgraduate level;
5. Prepares graduates for study in medical school or advanced degree in any major aspect of health sciences; and
6. Recognition for engagement by bodies like the International Atomic Energy Agency (IAEA), International Organisation for Medical Physics (IOMP), Federation of African Medical Physics Organisation (FAMPO) and Nigerian Association of Medical Physicists (NAMP).

Admission and Graduation Requirements

Admission Requirements

Indirect-Entry

Admission through the indirect-entry shall take the student to 100 level. To be eligible for admission, a candidate must have a minimum of credit pass in five subjects at not more than two sittings in Senior Secondary Certificate (SSC) or its equivalent. The credit passes are required in English language, Mathematics, Chemistry, Physics and Biology. The UTME subjects are: English Language, Physics, Biology and Chemistry. Candidates are also expected to pass the UTME with a reasonable score.

Direct Entry

Admission by direct entry is into second year (200 level) of the programme. Eligible students should possess good passes at GCE (advanced level) at one sitting in at least two of the following subjects: Physics, Mathematics, Biology and Chemistry or National Diploma (ND) at a minimum of Upper Credit level in Physics Electronics, Physics Computer, Computer Science, Computer Engineering, and any other related course from any recognised institution.

Graduation Requirements

To be eligible for the award of a bachelor's degree in Medical Physics, a student must pass a minimum 150 units for those admitted through UTME and 120 units for Direct Entry including all the compulsory courses provided their CGPA is not below 1.0.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication In English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
PHY 101	General Physics I	2	C	30	-

Course Code	Course Title	Unit(s)	Status	LH	PH
PHY 102	General Physics II	2	C	30	-
PHY 103	General Physics III	2	C	30	-
PHY 104	General Physics IV	2	C	30	-
PHY 107	General Physics Practical I	1	C	-	45
PHY 108	General Physics Practical II	1	C	-	45
BIO 101	General Biology I	2	C	30	-
BIO 102	General Biology II	2	C	30	-
	Total	**25**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	**2**	**C**	**30**	**-**
ENT 211	Entrepreneurship and Innovation	2	C	15	45
COS 201	Computer Programming I	3	C	30	45
MTH 202	Elementary Different Equations	2	C	30	-
ANA 211	Systemic and Functional Anatomy	2	C	15	45
PHY 201	General Physics V (Elementary Modern Physics)	2	C	30	-
PHY 206	General Physics VII (Energy and Environment)	2	C	30	-
PHY 207	Experimental Physics III	1	C	-	45
PHY 208	Experimental Physics IV	1	C	-	45
PHY 211	Workshop Practice	2	C	15	45
PHY 213	Classical Physics I	2	C	30	-
PHY 214	Classical Physics II (Electrodynamics)	2	C	30	-
	Total	**23**			

300 Level

Course Code	Course title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
PHY 301	Analytical Mechanics I	2	C	30	-
PHY 303	Electromagnetism	3	C	45	-
PHY 304	Electro-magnetic Waves & Optics	3	C	45	-
PHY 305	Quantum Physics	3	C	45	-
PHY 306	Statistical and Thermal Physics	3	C	45	-
PHY 325	Introduction to Special Theory of Relativity	3	C	45	-
MPH 323	Medical Physics Practical	1	C	-	45
MPH 326	Medical Imaging	2	C	30	-
ANA 301	Neuroanatomy	2	C	15	45
	Total	**26**			

400 Level

Course Code	Course Title	Units	Status	LH	PH
PHY 401	Quantum Mechanics I	3	C	45	-
PHY 403	Mathematical Methods in Physics I	3	C	45	-
PHY499	Students Industrial Work Experience	6	C	-	24 weeks
	Total	**12**			

500 Level

Course Code	Course Title	Units	Status	LH	PH
PHY 510	Nuclear and Particle Physics I	2	C	30	-
PHY 514	Biophysics I	2	C	30	-
PHY 518	Atomic and Molecular Spectroscopy	3	C	45	-
PHY 530	Medical Nuclear Physics	2	C	30	-
MPH 525	Applications Software and Programming for Medical Physics	2	C	30	-
MPH 529	Radiation Biology	2	C	30	-
MPH 555	Research Project	6	C		270
	Total	**19**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. identify possible sound patterns in English Language;
2. list notable language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English Language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and Deductive Argument and Reasoning Methods, Analogy, Generalisation and Explanations). Ethical considerations, Copyright Rules and Infringements. Writing Activities: (Pre-writing , Writing, Post writing, Editing and Proofreading; Brainstorming, outlining, Paragraphing, Types of writing: Summary, Essays,

Letter, Curriculum Vitae, Report writing, Note making etc. Mechanics of writing). Comprehension Strategies: (Reading and types of Reading, Comprehension Skills, 3RsQ). Information and Communication Technology in modern language learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of trade, economic and self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian state towards nation building;
6. analyse the role of the judiciary in upholding people's fundamental rights;
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; Nationalist movements and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian civil war). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigerian people; trade, skill acquisition and self-reliance). Social justice and national development (law definition and classification. Judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation; Re-orientation strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption(WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;

3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic definitions of Set, subset, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify various types of numbers; and
5. solve some problems using Binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers; integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers; algebra of complex numbers; the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of Function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative, as limit of rate of change. Techniques of differentiation. Extreme curve sketching; Integration as an inverse of differentiation. Methods of integration, Definite integrals. Application to areas, volumes.

BIO 101: General Biology I (2 Units C: LH 30)

Learning Outcomes
At the end of lectures, students should be able to:
1. explain cell structure and organisations;
2. summarize functions of cellular organelles;
3. characterize living organisms and state their general reproduction;
4. describe the interrelationship that exists between organisms;
5. discuss the concept of heredity and evolution; and
6. enumerate habitat types and their characteristics.

Course Contents
Cell structure and organisation, functions of cellular organelles, characteristics and classification of living things, chromosomes, genes their relationships and importance. General reproduction, interrelationships of organisms (competitions, parasitism, predation, symbiosis, commensalisms, mutualism, saprophytism). Heredity and evolution (introduction to Darwinism and Lamarkism, Mendelian laws, explanation of key genetic terms), elements of ecology and types of habitat.

BIO 102: General Biology II (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures, students should be able to:
1. List the characteristics, methods of identification and classification of Viruses, bacteria and fungi;
2. state the unique characteristics of plant and animal kingdoms;
3. describe ecological adaptations in the plant and animal kingdoms;
4. explain nutrition, respiration, excretion and reproduction in plants and animals; and
5. describe growth and development in plants and animals.

Course Contents
Basic characteristics, identification and classification of viruses, bacteria and fungi. A generalized survey of the plant and animal kingdoms based mainly on the study of similarities and differences in the external features. Ecological adaptations. Briefs on physiology to include nutrition, respiration, circulatory systems, excretion, reproduction, growth and development.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes
Upon the completion of course, the student should be able to:
1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;

5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents

space and time. units and dimension. vectors and scalars. differentiation of vectors: displacement, velocity and acceleration. Kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). relative motion. Application of Newtonian mechanics. equations of motion. conservation principles in physics, conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass. Rotational motion. torque, vector product, moment, rotation of coordinate axes and angular momentum, polar coordinates. conservation of angular momentum; Circular motion. Moments of inertia, gyroscopes and precession. gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General Physics II (2 Units C: LH 30)

Learning Outcomes

On completion, the student should be able to:
1. describe the electric field and potential, and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law, and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savartand Ampere's law;
5. describe electromagnetic induction and related concepts and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters; and
8. determine the characteristics of AC voltages and currents in resistors, capacitors, and inductors.

Course Contents

Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and resistance. Ohm's law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.
bubbles.

PHY 103: General Physics III **(2 Units C: LH 30)**

Learning Outcomes
At the end of the course, students should be able to:
1. explain the concepts of heat and temperature and relate the temperature scales;
2. define, derive, and apply the fundamental thermodynamic relations to thermal systems;
3. describe and explain the first and second laws of thermodynamics, and the concept of entropy;
4. state the assumptions of the kinetic theory and apply techniques of describing macroscopic behaviour;
5. deduce the formalism of thermodynamics and apply it to simple systems in thermal equilibrium; and
6. describe and determine the effect of forces and deformation of materials and surfaces.

Course Contents
Heat and temperature (temperature scales). Gas laws. General gas equation. Thermal conductivity. First Law of thermodynamics (heat, work and internal energy, reversibility). Thermodynamic processes (adiabatic, isothermal, isobaric). Second law of thermodynamics (heat engines and entropy). Zero's law of thermodynamics. Kinetic theory of gases. Molecular collisions and mean free path. Elasticity (Hooke's law, Young's, shear and bulk moduli). Hydrostatics (Pressure, buoyancy, Archimedes' principles). Bernoulli's equation and incompressible fluid flow. Surface tension (adhesion, cohesion, viscosity, capillarity, drops and bubbles).

PHY 104: General Physics IV **(2 Units C: LH 30)**

Learning Outcomes
On completion, the students should be able to:
1. describe and quantitatively analyse the behaviour of vibrating systems and wave energy;
2. explain the propagation and properties of waves in sound and light;
3. identify and apply the wave equations;
4. explain geometrical optics and principles of optical instruments.

Course Contents
Simple harmonic motion (SHM): energy in a vibrating system, Damped SHM, Q values and power response curves, forced SHM, resonance and transients, coupled SHM. Normal modes. Waves: types and properties of waves as applied to sound; Transverse and Longitudinal waves; Superposition, interference, diffraction, dispersion, polarisation. Waves at interfaces, Energy and power of waves, the 1-D wave equation, 2-D and 3-D wave equations, wave energy and power, phase and group velocities, echo, beats, the doppler effect, propagation of sound in gases, solids and liquids and their properties. Optics: Nature and propagation of light; reflection, refraction, and internal reflection, dispersion, scattering of light, reflection and refraction at plane and spherical surfaces, thin lenses and optical instruments, wave nature of light; Huygens's principle, interference and diffraction.

PHY 107: General Practical Physics I (1 Unit C: PH 45)

Learning Outcomes
On completion, the students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasizes quantitative measurements, the treatment of measurement errors, and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc., covered in PHY 101. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

PHY 108: General Practical Physics II (1 Unit C: PH 45)

Learning Outcomes
On completion, the students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasizes quantitative measurements, the treatment of measurement errors, and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc., covered in PHY 102. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;

6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents

Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students should be able to:

1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;
2. state the characteristics of an entrepreneur;
3. analyze the importance of micro and small businesses in wealth creation, employment, and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents

Concept of entrepreneurship (entrepreneurship, intrapreneurship/corporate entrepreneurship,). Theories, rationale and relevance of entrepreneurship (Schumpeterian and other perspectives, Risk-taking, necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of entrepreneurs (opportunity seeker, Risk taker, natural and nurtured, problem solver and change agent, innovator and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking, and creative thinking). Innovation (concept of innovation, dimensions of innovation, change and innovation, knowledge and innovation). enterprise formation, partnership and networking (basics of business plan, forms of business ownership, business registration and forming alliances and joint ventures). Contemporary entrepreneurship issues (knowledge, skills and technology, intellectual property, virtual office, networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, youth and women entrepreneurship, Entrepreneurship support institutions, Youth enterprise networks and environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

COS 201: Computer Programming I **(3 Units C: LH 30; PH 45)**

Learning Outcomes
At the end of this course, students should be able to:
1. explain the principles of good programming and structured programming concepts;
2. explain the programming constructs, syntax and semantics of a higher-level language;
3. describe the chosen programming language variables, types, expressions, statements and assignment; simple input and output;
4. describe the programme control structures, functions and parameter passing, and structured decomposition; and
5. develop simple programmes in the taught programming language as well as debug and test them.

Course Contents
Introduction to computer programming. Functional programming; Declarative programming; Logic programming; Scripting languages. Introduction to object-orientation as a technique for modelling computation. structured, and even some level of functional programming principles; Introduction of a typical object-oriented language, such as Java; Basic data types, variables, expressions, assignment statements and operators; Basic object-oriented concepts: abstraction; objects; classes; methods; parameter passing; encapsulation. Class hierarchies and programme organisation using packages/namespaces; Use of API – use of iterators/enumerators, List, Stack, Queue from API; Searching; sorting; Recursive algorithms; Event-driven programming: event-handling methods; event propagation; exception handling. Introduction to Strings and string processing; Simple I/O; control structures; Arrays; Simple recursive algorithms; inheritance; polymorphism.

Lab work: Programming assignments; design and implementation of simple algorithms, e.g., average, standard deviation, searching and sorting; Developing and tracing simple recursive algorithms. Inheritance and polymorphism.

ANA 211: Systemic and Functional Anatomy **(2 Units C: LH 15; PH 45)**

Learning Outcomes
At the end of this course, students will be able to:
1. demonstrate morphological knowledge needed to construct spatial perception of anatomical systems; and
2. describe precisely the organ localisation, its tri-dimensional configuration as well as its form-function relationship.

Course Contents
The fundamental anatomical concepts/the general description of the systems (spatial references, nomenclature rules, regions and systems, anatomical landmarks). The human body studied on a system basis, with particular emphasis on the form-function relationship and on the topographic-functional organ interactions. The Course contents include general concepts - osteo-articular system, muscles and locomotion function - nervous system, sensory organs and sensorimotor function - heart, vessels and the circulation - thoracic and abdominal viscera, respiratory tract, digestive and urogenital functions.

PHY 201 General Physics V **(2 Units C: LH 30)**

Learning Outcomes

On completion, the students should be able to:

1. explain the notion of an inertial frame and the concept of an observe;
2. relate the limitations imposed by and consequences of motion of bodies at the speed of light;
3. state the principles of Special Relativity and use them to derive relations for time dilation and length contraction;
4. perform calculations using the Lorentz transformation formulae;
5. derive relativistic energy and momentum, and use these to solve problems in mechanics;
6. apply the mathematical treatment of the wave function and Schrodinger's equation;
7. relate the atomic structure and energy associated with the particles of the atom;
8. apply the ideas of a wave-particle duality and the uncertainty principle to solve problems in quantum mechanics;
9. apply the Bohr formula to calculate energies and wavelengths in the context of atomic hydrogen; and
10. explain the interaction of photons and electrons with matter.

Course Contents

Defects in Newtonian mechanics, Galilean relativity, the speed of light, inertial frames and the concept of an observer. The principles of Einstein's special theory of relativity, the speed of light. Lorentz transformation: time dilation and length, contraction, transformation of velocities and the doppler effect. Relativistic energy and momentum. Basic properties of atoms and molecules, experimental basis of quantum theory, electrons and quanta. Bohr's theory of atomic structure, electrons and quanta. Energy levels and spectra. De Broglie hypothesis, the uncertainty principle, Black body radiation. The momentum operator and the time-independent Schrödinger equation, the infinite square well, simple applications in particle and nuclear physics. Compton effect, thermionic emission, radioactivity measurement and detection of charged particles (including the treatment of detectors), x-rays.

PHY 206: General Physics VI **(2 Unit C: LH 30)**

Learning Outcomes

On completion, the students should be able to:

1. explain the origin and sources of energy and power;
2. describe the inter relation and transformation of energy sources and types;
3. illustrate and explain the principles of generation of power;
4. outline the concept of energy demand and supply;
5. explain the economics, politics and problems associated with energy demand and supply;
6. identify and assess categories of environmental pollutants;
7. describe the effects of carbon emission on global warming;
8. describe the environmental effect of energy generation, supply, and consumption; and
9. Identify and evaluate the merits and demerits of power generation from different sources.

Course Contents
Energy requirements and climate impacts: Energy processing and conversion, Energy units and pricing. The greenhouse effect. Energy requirements and consumption. Biological forms of energy**,** Fossil fuels, Biofuels. Energy transformation – Power plant. Basic Nuclear Physics: The atom, Radioactivity and decay laws, Interaction of radiation with matter. Nuclear Fission**:** Principles of nuclear fission, Chain reaction dynamics, Reactor types and control. Current status of nuclear fission as a power source. Nuclear Fusion: Principle and energetics of nuclear fusion (in stars and on earth). Thermonuclear fusion, fuels, ignition and the Lawson criterion. Magnetic and inertial confinement, Current status of nuclear fusion as a power source. Stellar fusion, proton-proton chain and CNO cycle. Solar Power: Solar thermal, Solar photovoltaic. Wind, waves, tides: Power from fluids. Nature of wind, wind power, Wind turbines, Betz criterion, Principles of water waves, energy and power. Wave power extraction, Origin and properties of tides. Tidal stream power and tidal range power. Hydro power; Energy transportation and storage. Thermal pollution; Costs, capacity, reserves, efficiency, new environmental effects.

PHY 207 & 208 Experimental Physics I & II (2 Units C: PH 90)

Learning Outcomes
Upon completion of the course, the students should be able to:
1. identify the two physical quantities to be measured as independent and dependent variables;
2. determine the relationship between the two variables in form of graph;
3. determine some physical constants such as acceleration due to gravity, force constant of a spring, refractive index of a prism and focal length of converging and diverging lenses using different methods;
4. determine momentum of inertia of a fly wheel and determine coefficient of static and dynamic friction for wood.

Course Contents
The laboratory courses consist of a group of experiments drawn from diverse areas of Physics (optics, electromagnetism, mechanics, modern physics, etc.). It is accompanied by seminar studies of standard experimental techniques and challenging experiments.

PHY 211 Workshop Practice (2 Units C: LH 15; PH 45)

Learning Outcomes
On completion, the students should be able to:
1. identify safety signs for various workshop types and abide by the underlining regulations while working in the workshop;
2. handle workshop tools and machineries;
3. illustrate simple metal processing methods;
4. describe the criteria for selection of construction materials;
5. identify electrical and electronic devices and explain some instrumentation techniques for measuring parameters; and
6. explain types and methods of wood and plastic processing.

Workshop layout and safety. Basic hand tools and bench work practices. Measurement and gauging. Sheet metal operations: Casting, cutting, drilling, turning, milling, metal joining devices and adhesives in common use. Soldering techniques and wrap joints. Plain and cylindrical generation of smooth surface using power operated machines. Criteria for selection of materials used for construction – metallic and non-metallic. Instrumentation and measuring techniques. Multi-meters and oscilloscopes. Extension of instrument range. A survey of the use of electronic circuit devices e.g., diodes, transistors including FET, integrated circuits, photocells. Basic circuit development and analysis. Wood logging. Wood types and processing. Plastic types and working, plastic moulding, bending, and encapsulation.

PHY 213: Classical Physics I (2 Units C: LH 30)

Learning Outcomes

On completion, the students should be able to:

1. relate the concepts of space coordinates, time and linear motion;
2. describe particle dynamics, equilibrium and conservative forces;
3. solve problems on central forces, energy and angular momentum;
4. explain the dynamics of rotational motion;
5. discuss and apply the potential theory;
6. explain the dynamics of rigid bodies;
7. apply Newton's theory of gravitation to problems of planetary motion and space travel;
8. use inertial forces to explain motion from the viewpoint of rotating frames of reference; and
9. Derive the general relation between the angular velocity and angular momentum of a rigid body and use this to solve problems in rotational dynamics.

Course Contents

Introduction to classical mechanics, space and time, straight line kinematics. Linear and angular momentum, force and torque. Motion in a plane. Newtonian gravity. The two-body systems, forces and equilibrium, particle dynamics, force fields and potentials, collisions, conservative forces, inertial frames and non-inertial frames. Motion in rotating frames. Centrifugal force. Central force motions. Kepler's motion in a central force field. Particle orbits as conic sections and Kepler's laws. Rigid body motion and rotational dynamics. Moment of inertia. Free rotation and stability. Gyroscopes.

PHY 214 Classical Physics II (Electrodynamics) (2 Units C: LH 30)

Learning Outcomes

On completion, the students should be able to:

1. use scalar and vector potentials and explain the concept of gauge invariance;
2. demonstrate the compatibility of electrodynamics and special relativity;
3. use Lorentz covariant formalism in the context of electrodynamics and special relativity;
4. solve Poisson's equation and the inhomogeneous wave equation;
5. distinguish between radiation fields and other electromagnetic fields; and
6. calculate the radiated power produced by accelerating charges.

Course Contents
Maxwell's equations and wave solutions. Definition of scalar and vector potentials. Electrostatics and magnetostatics and Poisson's equation. Electrodynamics in Lorentz Gauge. the inhomogeneous wave equation and the retarded time. Relativistic dynamics. Electromagnetic field tensor. Power radiated from an arbitrary moving charge. Multiple radiation, electric and magnetic dipole radiation; slow-down of pulsars. Rayleigh and Thomson scattering.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building

Course Contents
Concepts of Peace, Conflict and Security in a multi-ethnic nation. Types and Theories of Conflicts: Ethnic, Religious, Economic, Geo-political Conflicts; Structural Conflict Theory, Realist Theory of Conflict, Frustration-Aggression Conflict Theory. Root causes of Conflict and Violence in Africa: Indigene and settlers Phenomenon; Boundaries/boarder disputes; Political disputes; Ethnic disputes and rivalries; Economic Inequalities; Social disputes; Nationalist Movements and Agitations; Selected Conflict Case Studies – Tiv-Junkun; Zango Kataf, Chieftaincy and Land disputes etc. Peace Building, Management of Conflicts and Security: Peace & Human Development. Approaches to Peace & Conflict Management --- (Religious, Government, Community Leaders etc.). Elements of Peace Studies and Conflict Resolution: Conflict dynamics assessment Scales: Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice; The Nigeria Legal System. Insurgency and Terrorism. Peace Mediation and Peace Keeping. Peace & Security Council (International, National and Local levels) Agents of Conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of International Organizations in Conflict Resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping. Media and Traditional Institutions in Peace Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis.

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students, through case study and practical approaches, would be able to:
1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical

location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce; apply a wide variety of emerging technological solutions to entrepreneurship; and
8. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/Market Research, Unutilised resources, Social and climate conditions and technology adoption gap). New business development (business planning, market research). Entrepreneurial Finance (Venture capital, Equity finance, Micro finance, Personal savings, small business investment organisations and Business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, First mover advantage, E-commerce business models and successful E-Commerce Companies,). Small business management/family business: Leadership & management, Basic book keeping, Nature of family business and family business growth mode Negotiation and business communication (Strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological solutions (The concept of market/customer solution, customer solution and emerging technologies, business applications of new technologies - Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud computing, Renewable energy etc. Digital business and E-Commerce strategies).

PHY 303: Electromagnetism (3 Units C: LH 45)

Learning Outcomes

On completion, the students should be able to:
1. derive Maxwell's equation set from the empirical laws of electromagnetism;
2. apply the fundamental laws of electromagnetism to solve simple problems of electrostatics, magnetostatics and electromagnetic induction in a vacuum;
3. modify Maxwell's laws to apply in the presence of materials and solve problems involving them;
4. derive the electromagnetic boundary conditions which apply at the interface between two simple media, and to use them to solve problems involving two or more materials;
5. explain the properties of plane electromagnetic waves in a vacuum and in simple media
6. and to be able to derive these properties from Maxwell's equations; and
7. apply the special theory of relativity to problems in electromagnetism

Course Contents

Review of vector calculus. Electrostatics and magnetostatics. Magnetization and magnetic susceptibility. Laplace's equation and boundary value problems. Multiple expansions. EM waves in dielectric and magnetic materials. Polarization of EM waves. Electromagnetic induction.

Faraday's and Lenz's laws. A.C. circuits. Maxwell's equations. Lorentz covariance and special relativity. Gauss theorem in dielectrics. Poisson's equations. Uniquenes's theorem, magnetron, magnetic properties, motors, generators and Poynting vectors.

PHY 304: Electromagnetic Waves and Optics (3 Units C: LH 45)

Learning Outcomes

On completion, the students should be able to:

1. explain plane electromagnetic waves and waves propagation;
2. derive the wave equation;
3. describe the transport of electromagnetic energy;
4. explain scattering, interference, diffraction, reflection, polarisation, and refraction of electromagnetic waves;
5. use complex notation competently for wave phenomena;
6. solve problems which require the use of wave representations of electric and magnetic fields in propagating electromagnetic waves;
7. analyse simple examples of interference and diffraction phenomena;
8. explain the principles of operation of, a range of equipment used in modern optics, notably the Michelson interferometer and Fabry-Perot etalon; and
9. explain the physics of the laser and processes involved in producing laser radiation to solve simple problems.

Course Contents

Review of Maxwell's equations and wave equation in a dielectric. Electromagnetic potentials. Propagation of plane and spherical waves. Huygen's wavelets and Fermat's principle. Recap of polarisation states, Interference, Michelson interferometer and Fabry-Perot etalon. Fourier Transform spectroscopy. Young's slits. Lloyd's mirror. Multiple slits. Fraunhofer diffraction. Resolution of optical instrument. Reflection and refraction. Transmission lines, wave guides and optical cavities. Lasers, Rate equation, Steady state operation, threshold and efficiency.

PHY 306: Statistical and Thermal Physics I (3 Units C: LH 45)

Learning Outcomes

On completion, the students should be able to;

1. describe an ideal gas on the basis of classical statistics;
2. explain the basic concepts of statistical mechanics, including entropy, its statistical interpretation and relation to disorder, and the statistical origin of the second law of thermodynamics;
3. illustrate the canonical and grand-canonical partition functions for systems in thermal equilibrium, and use them to obtain thermodynamic quantities of interest;
4. describe the implications of the indistinguishability of particles for systems of non-interacting quantum particles;
5. deduce the Bose-Einstein and Fermi-Dirac distribution functions, and apply them to calculate the properties of Bose and Fermi gases, for example in the context of White Dwarf stars and black-body radiation; and
6. explain the physical origin of Bose-Einstein condensation, to characterise it quantitatively, and to explain the experiments confirming Bose-Einstein condensation

Course Contents
Basic theory of thermodynamics. Basic probability theory, microstates and macrostates. The concept of ensembles, Statistical interpretation of entropy and temperature. Isolated systems and the microcanonical ensemble. Statistical physics of non-isolated systems. Derivation of the Boltzmann distribution and canonical ensemble. The partition function in thermodynamics. Non-interacting systems. Equipartition theorem. Density of states. Grand canonical ensemble. Fermi-Dirac and Bose-Einstein distributions, The ideal Fermi gas, Fermi energy. Electronic heat capacity. The ideal Bose gas. Black body radiation. Bose-Einstein condensation.

PHY 325: Introduction to Special Theory of Relativity (3 Units C: LH 45)

Learning Outcomes
On completion, the students should be able to:
1. describe Galilean transformations and limitation of Newtonian mechanics, constancy of speed of light. Michelson-Morley experiment. Lorentz-Einstein transformations;
2. analyse simple examples of interference and diffraction phenomena;
3. explain the simultaneity of events, relativistic addition of events;
4. explain the relativistic kinematics and dynamics, MATs-energy equivalence;
5. describe Proper distance and length contraction. Simultaneity of events, relativistic addition of events. Doppler Effect; and
6. identify and explain four vectors, space-time and energy-momentum, invariants, relativity and electric and magnetic fields. Invariance of Maxwell equation.

Course Contents
Galilean transformations and limitation of Newtonian mechanics, constancy of speed of light. Michelson-Morley experiment. Lorentz-Einstein transformations. Space-time diagram, event and world lines. Proper time and time dilation. Proper distance and length contraction. Simultaneity of events, relativistic addition of events. Doppler Effect. Relativistic kinematics and dynamics, MATs-energy equivalence, four vectors, Space-time and energy-momentum, invariants relativity and electric and magnetic fields. Invariance of Maxwell equation.

MPH 323: Medical Physics Practical (1 Unit C: PH 45)

Learning Outcomes
By the end of this course, the students will be able to:
1. explain the basic radiographic techniques, imaging techniques, such as Magnetic Resonance Imaging (MRI), ultrasound, Instrumentation in respect of imaging, diagnostic and therapeutics machines;
2. describe the component of imaging equipment and how they are operated;
3. pull the equipment apart and rearrange them and study, repair them. This includes their power supplies and procedure for calibration; and
4. articulate the fundamental principles of radiation measurement procedures and equipment

Course Contents
The laboratory course consists of a group of experiments drawn from diverse area of Physics related to modern and medical technology. The course addresses Radiographic Techniques, imaging techniques, Magnetic Resonance Imaging (MRI), ultrasound. Instrumentation in respect of imaging, diagnostic and therapeutics machines will be treated. Students examine old equipment (study the component and how they are operated), they are expected to pull the equipment apart and rearrange them and study repairs of equipment, power supplies. Procedure for calibration of basic equipment are treated, radiation measurement procedures and equipment are also treated etc. (Physics student are expected to join Radiography and Radiation students during their clinical session on radiation techniques as listed above).

MPH 326: Medical Imaging (2 Units C: LH 30)

Learning Outcomes
By the end of the course, the students will be able to:
1. explain the basic electric diagnostic radiology with X-rays, X-ray transmission and computed tomography;
2. describe the physics of radioisotope imaging and emission computed tomography;
3. explain the clinical applications and biological aspects of diagnostic ultrasound nuclear magnetic resonance pulse sequences and relaxation processes and their measurement;
4. articulate the fundamental principles of image acquisition and reconstruction and the mathematics of image formation and image processing, imaging and target volume; and
5. explain imaging modalities, procedures and technology, disease oriented imaging, image handling in radiotherapy, target volume determination in clinical practice.

Course Contents
Diagnostic radiology with X-rays, X-ray transmission and computed tomography. The physics of radioisotope imaging, emission and computed tomography, clinical applications of radioisotope imaging. Diagnostic ultrasound, clinical applications and biological aspects of diagnostic ultrasound. Nuclear magnetic resonance, nuclear magnetic resonance pulse sequences and relaxation processes and their measurement, image acquisition and reconstruction. The mathematics of image formation and image processing. Imaging and target volume, imaging modalities, procedures and technology, Disease oriented imaging, image handling in radiotherapy, target volume determination in clinical practice.

ANA 301: Neuroanatomy (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students would be able to:
1. describe the anatomy of the central and peripheral nervous systems;
2. explain the topography and structural organisation of the brain and spinal cord.
3. describe the basic features of development of the nervous system and to understand how and why common malformations occur in the nervous system;
4. describe the ultrastructure of neurons and glia and the major cytoarchitectural features of the brain and spinal cord; and
5. discuss the blood supply and venous drainage of the nervous system.

Course Contents
Neuroembryology. Introduction to the central nervous system, Spinal cord morphology, Spinal cord-tracts, Lower medulla-pyramids. Decussation, tubercles; Upper medulla-olive, Pons-basis pontis and middle cerebellar penduncle. Pons tegmentum, Midbrain-tectum, Midbrain-tegmentum, Cerebellum; Diencephalon-thalamus, Diencephalon-hyphothalamus. Epithalamus, subthalamus, ascending pathways and descending pathways, Ventricles, Pyramidal system, cerebral hemispheres, sulci and gyri, internal structure of cerebrum. Basal ganglia. Cortex-cytoarchitectonics. Brodman areas, Limbic system, blood supply to the brain and spinal cord. Applied Anatomy.

400 Level

PHY 401: Quantum Mechanics I (3 Units C: LH 45)

Learning Outcomes
On completion, the student should be able to:
1. state the postulates of quantum mechanics;
2. explain the basics of vectors and tensor operators;
3. solve a variety of physical problems using the Schrodinger equation;
4. work with angular momentum operators and their eigenvalues both qualitatively and quantitatively;
5. explain electron spin and the Pauli principle; and
6. apply perturbation theory and other methods to find approximate solutions to problems in quantum mechanics, including the fine-structure of energy levels of hydrogen.

Course Contents
The formulation of quantum mechanics in terms of state vectors and linear operators. Time evolution of the Schrodinger equation. The theory of angular momentum and spin. Electron spin and the Stern-Gerlach experiment. Identical particles and the Pauli exclusion principle. Multi-electron atoms, Approximation methods, Variational methods and WKB approximation for bound states and tunnelling. Time-independent Perturbation theory. The fine structure of hydrogen, Harmonic oscillator, Creation and annihilation operators, External fields. Zeeman and Stark effects in hydrogen.

PHY 403: Mathematical Methods for Physics I (3 Units C: LH 45)

Learning Outcomes
On completion, the students should be able to:
1. explain the concepts of scalar and vector fields;
2. describe the properties of div, grad and curl and be able to calculate the divergence and
3. curl of vector fields in various coordinate systems;
4. calculate surface and volume integrals in various coordinate systems;
5. calculate flux integrals and relate them to divergence and the Divergence Theorem;
6. calculate line integrals and relate them to the curl and to Stokes' Theorem;
7. apply the methods of vector calculus to physical problems; and
8. calculate the Fourier series associated with simple functions and apply them to selected physical problems.

Course Contents
Vector and scalar fields, Vector operators, div, grad, and curl. Divergence theorem. Stoke's theorem. Linear Algebra and Functional Analysis. Transformations in linear vector spaces and matrix theory. Hilbert space and complete sets of orthogonal functions. Special functions of Mathematical Physics. The gamma function. hypergeometric functions. Legendre functions. Bessel functions. Hermite and Laguerre function. The Dirac Delta function. Integral Transforms and Fourier Series. Fourier series and Fourier transforms. The Dirichlet conditions. Orthogonality of functions. Fourier coefficients. Complex representation of Fourier series. Laplace transform. Applications of transform methods to the solution of elementary differential equations of interest in physics and engineering.

PHY 499: Student Industrial Work Experience Scheme (24 weeks)
(6 Units C: PH 270)

Learning Outcomes
By the end of the SIWES, the students will be able to:
1. explain the main ethical theories and moral principles;
2. recognize the various issues and dilemmas which present themselves in various health care settings;
3. engage critically in debates on current and topical ethical dilemmas; address ethical issues in a professional way;
4. reflect on their own moral dilemmas in their own field of practice;
   demonstrate an ability to identify ethical issues in a particular scenario; and
5. demonstrate an ability to think and write critically.

Course Contents
This course is the Student Work Experience Scheme. This consists of a six month industrial work (400 Level second semester and the long vacation). Students are expected to be supervised by an individual (experienced staff) in the establishment such as hospitals, biomedical engineering firms, radiotherapy department, nuclear engineering facilities, nuclear power station etc ((where students can obtain hand on job experience)) within and outside Nigeria. Supervisor is expected to assign job on daily/weekly basis to student towards achieving a learning experience on the job. He/she can be attached to a specialist who trains him/her for the period of industrial experience. Student would be visited by a university staff and the logbook examined and signed. University supervisor could interact with the industrial supervisor during the visit. Student writes report and presents a seminar in the department based on the work experience.

500 Level

PHY 510: Modern Optics (2 Units C: LH 30)

Learning Outcomes
On completion, the students should be able to:
1. explain the concepts of coherence, interference and diffraction of light waves;
2. state the principles of light spectroscopy;
3. explain the principle of laser;
4. illustrate and describe the interaction of light with solids;

5. identify optical properties of metals and non-metals;
6. describe application of optical phenomena; and
7. describe the principle and applications of the laser.

Course Contents
Coherence and interference. Michelson and Fabry-Perot interference filters. Fourier interference spectroscopy. Fraunhofer and Fresnel diffraction, diffraction gratings, Principles and physics of Laser. Spontaneous and stimulated emissions, absorption, Rate equations, population inversion and optical gain. Steady state operation. Holography. Optics of solids. Propagation of light in anisotropic solids, the index ellipsoid, double refraction, electro-optic effects. Introduction to non-linear optics.

PHY 514: Biophysics I (2 Units C: LH 30)

Learning Outcomes
On completion, the students should be able to:
1. describe the processes and effect of interactions of radiation with matter;
2. explain the concept of electricity and magnetism at the cellular levels;
3. illustrate and explain the effect of impulse in nerves and muscles; and
4. explain solute transport in membranes.

Course Contents
Molecules and Cells, Mesoscopic forces, Phase transitions, Motility, Aggregating self assembly, Surface phenomena. Biomacromolecules, Charged ions and Polymers. Membranes, Rheology, Motors. Chemical kinetics, Enzyme kinetics, System biology, Spikes. Physiology of cells and organisms. Biological sensors. Ionization of biomolecules, thermodynamic principles. Energy transfer in living systems. Bioelectricity – ion channels, action potentials nerve impulse transmission.

PHY 518: Atomic and Molecular Spectroscopy (3 Units C: LH 45)

Learning Outcomes
On completion, the students should be able to:
1. explain the atomic structure and apply the solution of the Schrodinger equation for the hydrogen atom;
2. describe the Zeeman effect and electron spin;
3. analyse electron interaction in many electron atoms;
4. explain the principle of X-ray diffraction;
5. describe molecular spectra and vibrational wave functions;
6. explain the interaction of light with atoms and the laser principle; and
7. illustrate and explain the mechanisms of dipole rotation and ionic conduction.

Course Contents
The hydrogen atom, relativistic effects and spin. Energy bands and energy levels. Band structure. Identical particles and symmetry. Many electron atoms. Coupling schemes and vector model. Zeeman effect. Hyperfine structure. The diatomic molecule, the Kronig-Penny model and the tight binding method. X-ray diffraction and interpretation. Microwave methods. Resonance phenomena; ESR, NMR, optical pumping and Mossbauer scattering.

PHY 530: Medical Nuclear Physics (2 Units C: LH 30)

Learning Outcomes
On completion, the students should be able to:
1. describe the characteristics of radioactive substances;
2. explain the processes and effects of radiation interaction with matter;
3. state the principles of generation of alpha particles, beta particles, positrons and gamma rays;
4. explain the physics of nuclear magnetic imaging, and X-ray generation;
5. describe the preparation of radionuclides, radiopharmaceuticals, tracers and their applications; and
6. describe principles of radiation monitoring and protection as well as instrumentation.

Course Contents
Production of isotopes, nuclear scanning and tracers, nuclear magnetic resonance. Interaction of radiation with matter, (X-ray and gamma rays). Thomson scattering, Compton scattering, photoelectric effect, pair production, neutron diffusion theory, nuclear reactors, types of reactors and their start-up operation. Effects of radiation on living cells, somatic and genetic damage, acute whole-body syndromes, uses of radiation (industrial and medical uses). Principles and methods of radiation protection. Personnel monitoring using TLD and film.

MPH 525: Applications Software and Programming for Medical Physics (2 Units C: LH 30)

Learning Outcomes
By the end of the course, the students will be able to:
1. explain the importance of the various software applications frequently used in Medical Physics and Radiation Protection practice;
2. describe the use of common software applications such as ImageJ, PCXMC, TPS (commercial TPS or PRISM or PLanUNC), 3DSlicer;
3. explain the basics of the MATLAB programming language;
4. explain basic functions of the MATLAB Image Processing and Optimization toolboxes;
5. employ basic functions of diagnostic radiology, nuclear medicine, radiation oncology and radiation protection software e.g., ImageJ, PCXCM, TPS (commercial or PRISM or PLanUNC), 3DSlicer to address simple Medical Physics and Radiation Protection tasks;
6. write MATLAB scripts at the basic programming level; and
7. employ basic functions of the MATLAB Image Processing and Optimization toolboxes to address simple Medical Physics and Radiation Protection tasks.

Course Contents
This study-unit will help students familiarise themselves with the basics of software commonly used in Medical Physics and Radiation Protection such as ImageJ, PCXMC, TPS software (commercial TPS software or PRISM or PLanUNC) and 3DSlicer (The range of software used in these professions is increasing continuously and it is important for young Medical Physicists and Radiation Protection Expert professionals to become familiar with existing packages as early as possible). The unit also includes the basics of programming using MATLAB and the use of MATLAB's image processing and optimization toolboxes including practical hands-on experience. Application of the knowledge and skills to biomedical signal and image processing required for

medical diagnosis. Applying the signal and image processing techniques to the processing of clinical biomedical diagnostic signals and images.

MPH 529: Radiation Biology (2 Units C: LH 30)

Learning Outcomes

On completion, the students should be able to:

1. explain basic physics and chemistry of radiation interactions, free radicals, oxidation and reduction;
2. explain sub cellular and cellular effects: killing, repair, sensitization and protection;
3. describe thermal dissymmetry, Biology of Thermal Potentiation of Radiotherapy, High temperature thermal therapy, Interaction of radiation at the molecular level, Radiation absorption;
4. explain DNA damage and repair, Chromosomal aberrations, mechanisms of cell death, Cell survival curves, Models of cell killing, Radio sensitivity; and
5. explain effects of oxygen, sensitizers and protectors, Signal transduction, normal tissue systems, proliferative and cellular organisation, response to irradiation, and volume effects.

Course Contents

Introduction to basic physics and chemistry of radiation interactions, free radicals, oxidation and reduction. Subcellular and cellular effects, killing, repair, sensitisation and protection. Measurement methods. Survival curves and their significance. Modification of the radiation response. Tissue effects, genetic and carcinogenic effects, mutations, hazards. Effects of heat on tissue. Thermal dosimetry. Biology of Thermal Potentiation of Radiotherapy. High temperature thermal therapy. Interaction of radiation at the molecular level. Radiation absorption. DNA damage and repair, Chromosomal aberrations, mechanisms of cell death. Cell survival curves, Models of cell killing, Radio sensitivity. Effects of oxygen, sensitizers and protectors. Signal transduction, Normal tissue systems, Proliferative and cellular organisation, Response to irradiation, volume effects.

MPH 555: Research Project (6 Units C: PH 270)

Learning Outcomes

On completion, the students should be able to:

1. design and or conduct a research work on the basis of some physical laws or principles;
2. write scientific reports; and
3. Present and defend a scientific research work.

Course Contents

The course offers students the opportunity to do research in contemporary physics under the supervision of a staff. A detailed report on the research is to be presented and defended by the student when the project is completed.

Minimum Academic Standards

Staffing

Academic Staff

The guidelines on academic staff/student ratio of 1:20 for Science Programmes shall apply.
To start any programme in Science, there should be a minimum of six academic staff. There is need to have a reasonable number of staff with PhD degrees accounting for at least 70% of the total number and having adequate teaching experience for every programme in the discipline.

Administrative Support Staff

The services of the administrative support staff are indispensable in the proper administration of departments and faculty offices. It is important to recruit very competent, computer literate senior staff.

Technical Support Personnel

The services of technical support staff, which are indispensable in the proper running of laboratories and workshops, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

Classrooms, Laboratories, Workshops and Office Space

The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

Adequate space should be provided for all departments in the Sciences. Effort must be made to provide each department with at least:

i) Four (4) large laboratories calculated according to specifications of 7.5 m^2 per FTE; a minimum of four (4) preparatory rooms for each laboratory at the NUC specifications of 7 m^2 each.
ii) At least two lecture rooms capable of sitting at least sixty students at the specification of 1 m^2 per FTE.
iii) A departmental conference room.
iv) A staff common room.

Library and Information Resources

Universities should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition, well stocked and current hardcopies of reference and other textual materials should be provided centrally at the level of the faculty. A well network digital library should serve the entire university community. Availability of wireless facilities (Wifi) with adequate bandwidth should enhance access to these electronic resources.

In any case, there should be internet-ready workstations available in the library for at least 25% of the total students enrolled in each academic programme. The funding of the library should be in line with NUC guidelines.

Equipment

Medical physics equipment as described in PHY 323 (Medical Physics Practical) and PHY 326 (Medical Imaging) are available in the School (Faculty) of Medical Sciences. Therefore, learning will have strong roots in the teaching hospitals, where the relevant departments can provide day-to-day clinical services. Most of the laboratories/workshop/clinic/studio equipment that will be required for training the Medical Physics students are available in the teaching hospitals across the country. The following equipment are required in the department of Physics.

S/N	Description
1.	Measuring Cylinder 250 ml (glass + plastic)
2.	Measuring Cylinder 50ml
3.	Measuring Cylinder 25ml
4.	Measuring Cylinder glass (0 – 1000 ml)
5.	Harris ripple tank
6.	Beaker (50ml, 250 cc)
7.	Glass Beaker (4,000ml)
8.	Flat Bottom Flask
9.	Stop watch
10.	Stop clock
11.	Weight (1Kg, 2Kg, 5Kg)
12.	Weight (500g, 200g, 100g, 50g, 20g, 10g, 5g)
13.	Weighing Balance Digital
14.	Weighing Balance Meter
16.	Air Blower
16.	Pulleys
17.	Calorimeter
18.	T Square
19.	Wet Cells
20.	Tripod Stand
21.	Hydrometer
22.	Spring Balance
23.	U Tube
24.	Glass Funnel

S/N	Description
25.	Conventional Air Apparatus
26.	Rectangular Glass Block
27.	Convex Lens
28.	Glass Prism
29.	Bar and Gauge
30.	Telescope
31.	Linear expansion apparatus
32.	Bulb Hide
33.	Mercury metal (800g)
34.	Resistor Box (100Ω, 1000Ω)
35.	Resistor (0.6Ω)
36.	Turning forks
37.	Standard Resistors (1, 2, 5, 10, 20, 50, 100 Ω etc.)
38.	Rheostat
39.	Decade Resistance Box
40.	Oscilloscope (Double beam)
41.	Signal Generator
42.	Spectrometer
43.	Transformer
44.	Sodium Lamp
45.	Mercury Lamp
46.	Extensometer
47.	Density Bottle
48.	Wooden Board
49.	Meter Bridge
50.	One Way Key
51.	Boyles Law Apparatus
52.	Voltmeter
53.	Ammeter
54.	Galvanometer
55.	Universal Indicator
56.	Relays
57.	Burette
58.	Meter Rule
59.	Table Lamp
60.	Optical Bench
61.	Micrometre Screw Gauge
62.	Vernier Caliper
63.	Filter Paper
64.	Litmus Paper
65.	Standing Fan
66.	Thermometer (Mercury in glass, alcohol in glass)
67.	Slotted Masses (1, 2, 5, 10 Kg)
68.	Slotted Masses (5, 10, 20, 100, 200, 500g)
69.	Micro amplifier

S/N	Description
70.	Pyrometer
71.	Micrometer Screw Gauge
72.	Decade Capacitor
73.	Standard capacitors
74.	Long Glass Tubes
75.	High Current DC Power Supply
76.	Turning forks
77.	Plastic tubes
78.	Aluminum Sheets
79.	Terrameter
80.	Connecting Cable
81.	Metal Electrode
82.	Interface Cable
83.	Metallic-Bucket
84.	Drawing Board
85.	Force Board
86.	Young Modulus Apparatus
87.	Meter Rule
88.	Optical Bench (Wooden)
89.	Ray Box
90.	Avometer (Analogue)
91.	Copper sheets
92.	Discharge Lamp
93.	Meldes Apparatus
94.	Soldering wire
95.	Baterry Charger
96.	Burette (50cc)
97.	Lens Holder (Wooden)
98.	Spiral Spring
99.	Plane Mirror
100.	Microscope Slide
101.	Sonometer
102.	Soldering iron
103.	Simple Microscope
104.	Travelling microscope
105.	Specific gravity bottle
106.	Barometer
107.	Hydrometer
108.	Diffraction Grating
109.	Sodium Lamp
110.	Table Lamp
111.	AC Ammeter /Voltmeter
112.	Ammeter (Double Range)
113.	Milliammeter (Double Range)
114.	Beaker (Pyrex 500cc)

S/N	Description
115.	Retort Stand (Complete)
116.	Millivolt meter
117.	Chemical Balance
118.	Galvanometer
119.	One-Way-Key
120.	Jockey
121.	Wheatstone Bridge
122.	Electrolyte Capacitor
123.	P – N Junction Diode
124.	Standard Electrodes
125.	Bar Magnet
126.	Decade Capacitance Box
127.	High Vacuum Intonation (Edwards)
128.	Projector
129.	Science Workshop 750 Interface (USB)
130.	Model CI 75gg with accessories
131.	Vacuum Pump
132.	Spectrum Analyzer
133.	Model 80 801OB
134.	Hydro - electrical Power Station Apparatus
135.	Volume determination of a solid Kit No.042
136.	Air as a thermal insulator Kit No.045
137.	Steam Canon KL No. 017
138.	Osmotic pressure Kit No. 084
139.	Conductivity of Solution with Kit No.006
140.	Conductivity of Solid Kit No.005
141.	Visualizing Hydrostatic pressure Kit No.063
142.	Marioff's column and flow rate devices Kit No.064
143.	Liquid at different sensitivities Kit No.048
144.	Conductivity in Liquids Kit Nos. 036 & 037
145.	Porocity of Bricks Kit No. 072
146.	Chemical activation of an electric motor Kit No. 032
147.	Floating Bodies in Liquids of different densities Kit No.049
148.	Thermal expansion of a bimetallic strip Kit No. 040
149.	Prism Kit 075+076+077
150.	Experiments in electromagnetism Kit Nos. 003 & 007
151.	Electric Generator Kit No.018
152.	Steady hand Kit No. 038
153.	The cave of Dogs Kit No.079
154.	Two –ball pendulum Kit No.030
155.	Melting a metal in Hot Water Bismuth Alloy Kit No.046
156.	Flow rate of Liquids with different viscosities Kit No.055
157.	Maxwell's Pendulum Kit No.031
158.	Air Occupies Space Kit No.041
159.	Intermolecular Spaces in Liquids Kit No.069

S/N	Description
160.	Inter atomic forces in metals Kit No. 068
161.	Conductivity of Solutions and Solids Kit No.004
162.	Heating Water with a Concave Mirror Kit No.078
163.	Electromagnetism Oested's effect Kit
164.	Double Slit
165.	Grating
166.	Convex Mirror
167.	Plane Mirror
168.	Electric field meter
169.	Altitude meter
170.	Hot Plate
171.	Digital Stop Clock
172.	Compound Pendulum
173.	Optical Bench (Metallic Screen& Lens Holder)
174.	Avometer (Analogue)
175.	Avometer (Digital)
176.	Mercury Lamp
177.	Box of Aluminium Foil
178.	Handling Tong
179.	Radioactive Sources
180.	Radioactive Cabinet
181.	EMS Radiation Meter
182.	Heat Index Meter
183.	New Temperature Coefficient Apparatus
184.	Distiller
185.	Ammeter (Variable range AC/DC or DC))
186.	Angle Table Lamp
187.	Abingdon Sound Wave Kit
188.	Air Cell
189.	Adaptor WPA (Shunts)
190.	A/C Potentiometer (Wide Range)
191.	Terrameter SAS 1000
192.	Adaptor WPA (Shunts)
193.	A/C Potentiometer (Wide Range)
194.	Audio Amplifier
195.	A/C – DC Lamp (S N)
196.	AC/DC Converter Trainer (AD 4101)
197.	AC/DC Power Supply Baku (BK 1502 DD)
198.	Analogue dial (Various turns)
199.	Aluminium Solder (16 SWG)
200.	AM/DSB Transmeter (KL 93061)
201.	AM Radio Transmitter
202.	Battery Charger
203.	Basic Spark Source
204.	Bunsen Burner

S/N	Description
205.	Bi-convex Lens (Various focal length)
206.	Bi-concave Lens (Various focal length)
207.	Beaker Pyrex (Various ml)
208.	Beaker Plastic (250 ml)
209.	Beaker CSN (Various ml)
210.	Bar Magnet
211.	Blade Connector
212.	Battery Clips
213.	Cathode ray tube (Unilab)
214.	Ballistic Module 099624
215.	Bench Power Supply (Philip Harris G85458)
216.	Copper Wire
217.	Constantan Wire
218.	Constantan Alloy
219.	Camera Lens
220.	Camera (Simple type)
221.	Camera (For Oscilloscope)
222.	Capacitance Box (Type C500)
223.	Capacitance substitution box 012308
224.	Cathode ray Oscilloscope 099622
225.	Convex Mirror (Various Focal Length)
226.	Concave Mirror (Various Focal Length)
227.	Coiled Core
228.	Cable (3 Core)
229.	Cable, (Individually screened 4 core)
230.	" (Screened, twin)
231.	" (Low noise)
232.	" (Air spaced coax)
233.	" (300 Ohms twin feeder)
234.	Capacitor, electrolyte (Various values)
235.	Cable Polystyrene (Various values)
236.	" Silvered mica (Various values)
237.	" Ceramic (Various values)
238.	" Paper (Various values)
239.	" M D C (Various values)
240.	" Trummers Compression
241.	" Trimmers
242.	Circuit Breaker (Various amps)
243.	Capacitor Suppression
244.	Choke Suppression (Various values)
245.	CMOS Logic checker
246.	Crystal Sockets
247.	Crimp connectors (Various types and sizes)
248.	Communing block
249.	Communing connectors

S/N	Description
250.	Clock timer IC
251.	Condenser microphone
252.	Dart Board Set
253.	Discharge lamp holder
254.	Discharge lamp transformer
255.	Discharge lamp, sodium
256.	Discharge lamp, cadmium
257.	Discharge lamp, mercury
258.	Discharge lamp, Helium
259.	Discharge lamp, Neon
260.	Digital multimeter
261.	Diode (Various types)
262.	Digital dial (10 turns)
263.	Differential amplifier 1445
264.	Diffraction Grating
265.	Digital Clock module
266.	D to A converter IC ZN 425 E
267.	Darlington drivers
268.	4-Decade counter driver
269.	Dual pin recorder
270.	D C Power Supply (ST 4078)
271.	Electric timer 6 – 12V AC
272.	Etch resist ink pen
273.	Electro conductive paint
274.	Electronic alternator IC
275.	Electricity LAB (NV6000)
276.	Electronics Kit (Basic Elect. Expt PK101)
277.	e/m Apparatus (SE 9638)
278.	Frequency counter
279.	Fuses (Various values and sizes)
280.	Fresnel Biprism
281.	Ferrite beads
282.	F E T input OP amp DIL
283.	" (Various types)
284.	Function Generator
285.	Fibre Optic Kit (Fok 721)
286.	FM Transmeter (KL 93063)
287.	Geissher's tube Helium
288.	" " Argon
289.	" " Hydrogen
290.	" " Nitrogen
291.	" " Mercury
292.	" " Oxygen
293.	" " Neon
294.	" " Unknown

S/N	Description
295.	" " Carbon Dioxide
296.	" " Holden
297.	Galvanometer
298.	" Electronic
299.	Manganin wire
300.	Mobile Phone Trainer
301.	Nanovolt pre-amplifier
302.	Neon indicator 250V (Various colors)
303.	Nichrome wire
304.	Solar Cells
305.	LED Lights
306.	Waveform generator
307.	Holography set
308.	Interferometer
309.	Physical optics kit
310.	Leak rate meter
311.	Photocell
312.	Photodiode
313.	Rectifier unit
314.	T S Module 401.1 Diode characteristics
315.	T S Module 401.2 DC power supply unit
316.	Transmission Line Trainer (ST 2261)
317.	Junction transistor common base connection
318.	Junction transistor common emitter
319.	Transistor Tester
320.	Unijunction transistor (U J T)
321.	Constant Current Source
322.	Emitter Follower voltage stabilizer
323.	Free-running multivibrator
324.	Silicon controlled rectifier
325.	Travelling microscope
326.	Multivibrator
327.	555 Timer
328	Relay
329.	Sunshine Recorder with Accessories
330	Solar Power Meter
331.	Sound Level Meter
332.	Advanced Spectrometer
333.	Semiconductor Kit
334.	Modern Tech. & Electronic Trainer System
335.	Communication Training System
336.	Technology & The Computer Training System
337.	Analog Communication Training System
338.	Digital Communication Training System
339.	Optical Communication Trainer

S/N	Description
340.	Analog-Digital Signal Conversion Trainer
341.	Electricity & Semiconductors Training System
342.	Analog Electronics Training System

Workshop Equipment & Tools

S/N	Description
1.	Lathe machine
2.	Drilling machines
3.	Milling machines
4.	Gas welding equipment
5.	Work benches
6.	Metal cutting tools
7.	Cutting fluids
8.	Shaper
9.	Slotter
10.	Milling cutters
11.	Tool boxes
12.	Hand shears or snips
13.	Hammers (various types)
14.	Stake and stake holders
16.	Measuring tools
16.	Welding torch
17.	Spark lighter
18.	Gloves
19.	Goggles
20.	Filler rods
21.	First aid box
22.	Hand riddle
23.	Shovel
24.	Rammers
25.	Strike off bar
26.	Mallet
27.	Draw spike
28.	Vent rod
29.	Lifters
30.	Trowels
31.	Smoothers
32.	Slicks
33.	Clamps
34.	Cutters
35.	Wedges
36.	Metal sheets (various types and sizes)

S/N	Description
37.	Moulding boxes
38.	Crucible
39.	Oxy-Acy Gas
40.	Gas cylinders
41.	Hard and soft woods
42.	Timbers
43.	Plywood
44.	Screws
45.	Glue
46.	Paints
47.	Brushes
48.	Measuring tapes and rules
49.	Bevel gauge
50.	Combination set
51.	Carpenter vice
52.	Clamp
53.	Saws
54.	Planes
55.	Chisels
56.	Scraper
57.	Adze
58.	Boring tools
59.	Screw drivers

B. Sc. Medicinal Chemistry

Overview
Medicinal Chemistry is the science of drug discovery. Students in this programme will be trained as chemists but will additionally be provided with training that is appropriate for careers in the design, synthesis, and evaluation of potential drugs. There is therefore the need for proliferation in sound researches in the development and quality control of drugs and potential drug materials to meet the needs on global health challenges.

Philosophy
The bachelor's degree programme in Medicinal Chemistry is anchored on the philosophy of training students to have adequate capacity for deep inquiry, critical thinking and problem-solving skills. The philosophy of the programme is to produce skilled graduates with theoretical and practical knowledge in medicinal chemistry, including drug design, drug synthesis/preparation, drug formulation, drug development and metabolism, as well as acquiring sound knowledge in basic and core chemistry courses. These will ensure safe, effective and efficient utilisation of underutilised natural and synthetic materials in the production and formulation of drugs to meet the health challenge of the populace.

Objectives
The specific objectives of medicinal chemistry programs are to:
1. train students as chemists but to additionally provide them with training that is appropriate for careers in the design, synthesis, and evaluation of drugs and potential drug materials;
2. establish maintenance on assurance of drug quality and also incorporate relevant industrial training;
3. inculcate problem solving/ critical thinking/ creativity skills, develop ability to analyse facts and situations and apply creative thinking to develop appropriate solutions; and
4. develop entrepreneurial skills that will make students to be creative, productive and self-reliant.

Unique Features of the Programme
Medicinal Chemistry has evolved rapidly into a highly interdisciplinary field, enriched by the collaborative efforts of experts from a wide spectrum of specialist areas, from chemo-informatians and physical chemists to molecular biologists and pharmacologists.
The study of medicinal chemistry focuses on creating pharmacologically active molecules that ultimately become drugs. It involves the creation and refinement of molecules for the purpose of creating or improving drugs. It is grounded in synthetic organic chemistry, a discipline in which scientists combine small molecules to create new ones.

Employability Skills
As with graduates in other branches of chemistry, the skills acquired during this degree programme will make you highly attractive to employers in a wide variety of areas. In addition to pharmaceutical industry itself, business, finance, administration and teaching are all opportunities that are open to you as a Medicinal Chemistry graduate. Graduates of this course can work in national and multinational pharmaceutical companies.

Earning a degree in Medicinal Chemistry positions the graduate for a job as a **synthetic or medicinal chemist**. In these roles, he/she will study, research, and develop molecules that will later be tested for their efficacy as drugs. Though these roles have various titles in the industry, from "synthetic chemist" to simply "scientist," each focuses on the creation of molecules. In addition to experimental and developmental work, other job duties may include:

1. Maintaining records of work
2. Collaborating with project leads and other scientists
3. Conducting research activity
4. Presenting your findings to stakeholders within the company

Scientists interested in furthering their careers can earn Masters and PhD in a related field and progress to supervisory positions. Instead of creating molecules, the majority of their time in a role like this would be spent managing various experiments and processes within the lab. Job titles in this area include project leader or lead research investigator.

21st Century Skills

1. Innovation
2. Critical Thinking
3. Competency
4. Technology literacy
5. Creativity
6. Collaboration

Admission and Graduation Requirements

Admission Requirements

Indirect entry (100 Level) - minimum of five credits at Senior Secondary Certificate (SSC) or its equivalent in the following subjects: Chemistry, Biology, Physics, Mathematics and English Language and appropriate score in UTME.
Direct Entry (DE) (200 Level) – Five SSC (or equivalent) credit passes in relevant subjects, two of which are at Advanced level. Advanced level Subjects should include Chemistry, Biology and Physics.

Graduation Requirements
For a student to be deemed fit to graduate, he/she must have passed a minimum of 120 Units for UTME entrants and 90 Units for Direct Entry students, including all Compulsory courses as well as a CGPA of not less than 1.00.

Global Course Structure

100 Level

Course code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
MTH 101	Elementary Mathematics. 1	2	C	30	-

Course code	Course Title	Unit(s)	Status	LH	PH
MTH 102	Elementary Mathematics II	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
PHY 101	General Physics 1	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 107	General Physics Practical 1	1	C	-	45
PHY 108	General Practical Physics II	1	C	-	45
CHM 101	General Chemistry 1	2	C	30	-
CHM 102	General Chemistry II	2	C	30	-
CHM 107	General Chemistry Practical 1	1	C	-	45
CHM 108	General Chemistry Practical II	1	C	-	45
BIO 101	General Biology 1	2	C	15	45
BIO 102	General Biology II	2	C	30	-
BIO 107	General Biology Practical I	1	C	-	45
BIO 108	General Biology Practical II	1	C	-	45
	Total	**29**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
CHM 207	Experimental Organic & Inorganic Chemistry	1	C	-	45
CHM 210	Physical Chemistry 1	2	C	30	-
CHM 211	Organic Chemistry 1	2	C	30	-
CHM 212	Inorganic Chemistry 1	2	C	30	-
CHM 213	Analytical Chemistry 1	2	C	30	-
MCM 211	Fundamentals of Medicinal Chemistry	1	C	15	-
BCH 201	General Biochemistry 1	2	C	30	-
BCH 202	General Biochemistry 11	2	C	30	-
BCH 203	General Biochemistry Practical	1	C	-	45
PHS 211	Introduction and General Physiology	1	C	15	-
MTH 201	Mathematical Methods 1	2	C	30	-
	Total	**22**			

300 Level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
CHM 303	Organic Chemistry II	2	C	15	45
CHM 316	Applied Spectroscopy	2	C	30	-
CHM 327	Research Methodology	2	C	30	-

Course Code	Course Title	Units	Status	LH	PH
CHM 328	Experimental Organic Chemistry	1	C	-	45
MCM 311	The Medicinal Chemistry of Drug Development	2	C	30	
MCM 312	Medicinal Chemistry Practical	1	C	-	45
MCM 360	Industrial Training (SIWES)	3	C	-	12 Weeks
PHA 311	Pharmacology I	2	C	30	-
PHA 321	Pharmacology II	2	C	30	-
	Total	**21**			

400 Level

Course Code	Course Title	Units	Status	LH	PH
CHM 414	Natural Product Chemistry	2	C	30	-
CHM 419	Organic Synthesis	2	C	30	-
MCM 421	Antimicrobial Chemotherapy for Chemists	2	C	30	-
MCM 490	Seminar	2	C	30	-
MCM 499	Research Project	6	C	-	270
	Total	**14**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. identify possible sound patterns in English Language;
2. list notable language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English Language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and Deductive Argument

and Reasoning Methods, Analogy, Generalisation and Explanations). Ethical considerations, Copyright Rules and Infringements. Writing Activities: (Pre-writing , Writing, Post writing, Editing and Proofreading; Brainstorming, outlining, Paragraphing, Types of writing, Summary, Essays, Letter, Curriculum Vitae, Report writing, Note making etc. Mechanics of writing). Comprehension Strategies: (Reading and types of Reading, Comprehension Skills, 3RsQ). Information and Communication Technology in modern Language Learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of trade, economic and self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian state towards nation building
6. analyse the role of the judiciary in upholding people's fundamental rights
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; Nationalist movements and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian civil war). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justice and national development (law definition and classification. Judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation; Re-orientation strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption(WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic definition of set, subset, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify various types of numbers;
5. solve some problems using binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers; integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers; algebra of complex numbers; the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in Differentiation and Integration;
2. describe the meaning of Function of a real variable, graphs, limits and continuity;
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative, as limit of rate of change. Techniques of differentiation. Extreme curve sketching; Integration as an inverse of differentiation. Methods of integration, Definite integrals. Application to areas, volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its

applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

CHM 101: General Chemistry I (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

1. define atom, molecules and chemical reactions;
2. discuss the Modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. illustrate shapes of simple molecules and hybridized orbitals;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents

Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence Forces. Structure of solids. Chemical equations and stoichiometry; Chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry. Rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II (2 Unit C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reactions;

7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. describe basic properties of Transition metals.

Course Contents
Historical survey of the development and importance of Organic Chemistry. Fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures, nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The Chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify the differences between primary and secondary standards;
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents
Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify and carry out preliminary tests which includes ignition, boiling point, melting point, test on known and unknown organic compounds;
5. perform solubility tests on known and unknown organic compounds;
6. conduct elemental tests on known and unknown compounds; and
7. conduct functional group/confirmatory test on known and unknown compounds which could be acidic / basic / neutral organic compounds.

Course Contents
Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents
Space and time. Units and dimension. Vectors and scalars. Differentiation of vectors (displacement, velocity and acceleration). Kinematics. Newton laws of motion (Inertial frames, impulse, force and action at a distance, momentum conservation). Relative motion. Application of Newtonian mechanics. Equations of motion. Conservation principles in physics (conservative forces, conservation of linear momentum, kinetic energy and work, potential energy). System of particles. Centre of mass. Rotational motion (torque, vector product, moment, rotation of coordinate axes and angular momentum). Coordinate systems. Polar coordinates. Conservation of angular momentum. Circular motion. Moments of inertia (gyroscopes, and precession). Gravitation (Newton's Law of Gravitation, Kepler's laws of planetary motion, gravitational potential energy, escape velocity, satellites motion and orbits).

PHY 102: General Physics II (Electricity & Magnetism) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the electric field and potential, and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law, and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;
5. describe electromagnetic induction and related concepts and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters;
8. determine the characteristics of ac voltages and currents in resistors, capacitors, and Inductors.

Course Contents
Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and resistance. Ohm's law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

PHY 107: General Practical Physics I (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasizes quantitative measurements. Experimental techniques. The treatment of measurement errors. Graphical analysis. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc. (covered in PHY 101, 102, 103 and PHY 104). However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis, and deduction.

PHY 108: General Practical Physics II (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data; nd
6. prepare and present practical reports.

Course Contents
This practical course is a continuation of PHY 107 and is intended to be taught during the second semester of the 100 level to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements, the treatment of measurement errors, and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

BIO 101: General Biology I **(2 Units C: LH 30)**

Learning Outcomes
At the end of this course, students should be able to
1. explain cell structure and organizations;
2. summarize functions of cellular organelles;
3. characterize living organisms and state their general reproduction;
4. describe the interrelationship that exists between organisms;
5. discuss the concept of heredity and evolution; and
6. enumerate habitat types and their characteristics.

Course Contents
Cell structure and organisation, functions of cellular organelles. characteristics and classification of living things. chromosomes, genes; their relationships and importance. general reproduction. interrelationships of organisms (competitions, parasitism, predation, symbiosis, commensalisms, mutualism, saprophytism). heredity and evolution (introduction to Darwinism and Lamarkism, Mendelian laws, explanation of key genetic terms). elements of ecology and types of habitat.

BIO 102: General Biology II **(2 Units C: LH 30)**

Learning Outcomes
At the end of the lectures, students should be able to:
1. List the characteristics, methods of identification and classification of Viruses, bacteria and fungi;
2. state the unique characteristics of plant and animal kingdoms;
3. describe ecological adaptations in the plant and animal kingdoms;
4. explain nutrition, respiration, excretion and reproduction in plants and animals; and
5. describe growth and development in plants and animals.

Course Contents
Basic characteristics, identification and classification of viruses, bacteria and fungi. A generalized survey of the plant and animal kingdoms based mainly on the study of similarities and differences in the external features. Ecological adaptations. Briefs on physiology to include nutrition, respiration, circulatory systems, excretion, reproduction, growth and development.

BIO 107: General Biology Practical I **(1 Unit C: PH 45)**

Learning Outcomes
At the end of this course students should be able to:
1. outline common laboratory hazards;
2. provide precaution on laboratory hazards;
3. state the functions of the different parts of microscope;
4. use the microscope and describe its maintenance;
5. draw biological diagrams and illustrations; and
6. apply scaling and proportion to biological diagrams.

Course Contents
Common laboratory hazards. prevention and first aid. measurements in biology. uses and care of microscope. compound and dissecting microscope. Biological drawings and illustration, scaling, accuracy and proportion. use of common laboratory apparatus and laboratory experiments designed to illustrate the topics covered in **BIO 101.**

BIO 108: General Biology Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. describe the anatomy of flowering plants;
2. differentiate types of fruit and seeds;
3. state ways of handling and caring for biological wares;
4. describe the basic histology of animal tissues; and
5. identify various groups in the animal kingdom.

Course Contents
Anatomy of flowering plants, primary vegetative body. stem, leaf and root to show the mature tissues namely parenchyma, collenchyma, sclerenchyma, xylem and phloem. Types of fruits and seeds. Care and use of dissecting kits and other biological wares. Dissection and general histology of animal tissues based on vertebrate forms. Morphology and functions of epithelial, muscular, nervous and connective tissues. Examination of various groups of lower invertebrates under microscopes, identification of various groups of organisms in Animal Kingdom. Andany experiment designed to emphasize the practical aspects of topics in BIO 102.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and

human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211 – Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning outcomes
At the end of this course, students should be able to:
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking
2. state the characteristics of an entrepreneur;
3. analyze the importance of micro and small businesses in wealth creation, employment, and financial independence
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world;
8. state the basic principles of e-commerce.

Course Contents
Concept of Entrepreneurship (Entrepreneurship, Intrapreneurship/Corporate Entrepreneurship,). Theories, rationale and relevance of Entrepreneurship (Schumpeterian and other perspectives, Risk-taking, necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of entrepreneurs (opportunity seeker, risk taker, natural and nurtured, problem solver and change agent, Innovator and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking, and creative thinking). Innovation (concept of innovation, dimensions of innovation, Change and innovation, Knowledge and innovation). Enterprise formation, partnership and networking (basics of business plan, Forms of business ownership, Business registration and Forming alliances and joint ventures). Contemporary entrepreneurship issues (knowledge, skills and technology, Intellectual property, Virtual office, Networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, Youth and women entrepreneurship, Entrepreneurship support institutions, Youth enterprise networks and environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

CHM 207: General Chemistry Practical III (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students will be able to:
1. describe the measurement of pH;
2. determine the relative molar mass from the colligative properties;
3. demonstrate the partition coefficient of two immiscible solvents;
4. demonstrate temperature measurements and heat of dissolution, heat of neutralization and many others
5. determine the critical solution temperature of water-Phenol system; and
6. measure the molar volume of a gas and universal gas constant.

Course Contents
pH Measurement Determination of Relative Molar Mass from Colligative Properties. Demonstration of Partition Coefficient in two Immiscible Solvents. Temperature Measurement and Heat of Dissolution Heat of Neutralisation. Determination of Critical Solution Temperature of Water-Phenol System Ideal Gas Law: Measuring the Molar Volume of a Gas and the Universal Gas Constant.

CHM 210: Physical Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. state the kinetic theory of gases and solve problems related to ideal and real gases;
2. derive the formula for molecular velocity of gases and use the derived formula to solve problems;
3. describe and explain the fundamental concepts of physical chemistry including those of statistical mechanics, chemical Kinetics, quantum mechanics and spectroscopy;
4. apply simple models to predict properties of chemical systems;
5. define and state type of solutions; define different concentration terms which include molarity, normality etc. explain vapour pressure lowering of the solvent, boiling point elevation of solutions, freezing point depression of solution and measurement of osmotic pressure;
6. apply numerical or computational methods to calculate physical properties of Chemical systems and assess the appropriateness of different computational techniques and numerical approximations for solving chemistry problems;
7. design and plan an investigation by selecting and applying appropriate practical, theoretical, and/or computational techniques or tools; and
8. states Ohms law and describe the electrolytic conduction, states the Faraday's Law and Conductance Law of solution and calculation on electrical conductance on different electrolyte solution.

Course Content
Kinetic theory of gases. science of real gases. the laws of thermodynamics. entropy and free energy. reactions and phase equilibria. reaction rates. rate laws. mechanism and theories of elementary processes. photochemical reactions; basic electrochemistry.

CHM 211: Organic Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe and solve problems in chemistry of aromatic compounds;
2. describe the structures of simple sugars, starch and cellulose, peptides and proteins and show the difference in their conformation structure;
3. describe and solve problems in chemistry of bifunctional compounds;
4. explain he mechanisms of substitution, elimination, addition and rearrangement reactions;
5. describe stereochemistry and its application;
6. describe condition and pathways of the following organic reactions - Grignard reaction, Aldol and related reactions; and
7. describe simple alicyclic carbon compounds and their synthesis.

Course Contents
Chemistry of aromatic compounds. Structures of simple sugars, starch and cellulose, peptides, and proteins. Chemistry of bifunctional compounds. Energetics, kinetics, and the investigation of reaction mechanisms. Mechanisms of substitution, elimination, addition, and rearrangement reactions. Stereochemistry. Examples of various named organic reactions e.g., Grignard reaction, Aldol and related reactions. Simple alicyclic carbon compounds and their synthesis.

CHM 212: Inorganic Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. list the first-row transition elements and explain their characteristics and properties;
2. explain crystal field theory (CFT) and draw the diagram to illustrate with examples of coordination compounds;
3. state the advantages of CFT over other bonding theories;
4. discuss the comparative Chemistry of the following elements. (I) Ga, In, Tl (II). Ge, Sn, Pb (III). As, Sb, Bi (IV). Se, Te, Po;
5. define organometallic Chemistry;
6. give relevant examples with illustrations;
7. classify organometallic compounds with examples;
8. list the roles of metals in biochemical systems;
9. discuss the concepts of hard and soft acids and bases.
10. list examples of item 9 above;
11. explain oxidation and reduction reaction; and
12. illustrate the above (11) with appropriate reactions.

Course Contents
Chemistry of first row transition metals. Introduction to coordination chemistry including elementary treatment of crystal field theory. Comparative Chemistry of the following elements: (a) Ga, In, TI, (b) Ge, Sn, Pb, (c) As, Sb, Bi (d) Se, Te, Po.
Elementary introduction to organometallic chemistry. Role of metals in biochemical systems. Concepts of hard and soft acids and bases. Oxidation and reduction reactions.

CHM 213: Analytical Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:

1. explain analytical processes which include description of chemist as a problem solver;
2. describe and differentiate forms of error;
3. explain its implication on laboratory analysis;
4. state different statistical tool use in treatment of data;
5. solve practical problems using the statistical tools;
6. define sampling and give reasons for sampling in field work;
7. state and describe different sampling techniques;
8. state different forms of sample collection and processing;
9. describe volumetric method of analysis and solve some practical problems; and
10. describe gravimetric method of analysis and solve some practical problems.

Course Contents
Theory of errors; and statistical treatment of data: Theory of sampling. Chemical methods of analysis including volumetric, gravimetric, data analysis and presentation. Physicochemical methods. Optical methods of analysis; separation methods.

MCM 211: Fundamentals of Medicinal Chemistry (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the students should be able among others to:
1. appreciate the various classes of therapeutic agents and their synthesis;
2. explain their mechanisms of action; and
3. identify their metabolism.

Course Contents
Chemical components of cells structure. chemical bonding and interactions of a range of cellular macromolecules that allow natural cellular processes to occur. The key drug targets in medicinal chemistry, including enzymes, receptors and nucleic acids.

MCM 221: Introduction to Drug Design and Discovery (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the students should be able among others to:
1. describe how substituents affect the physicochemical properties of drugs,
2. explain the various concepts of drugs design.

Course Contents
The principle bonding interactions in drug receptor interactions. The basic concepts of structure activity relationships (SAR) and quantitative structure activity relationships (QSAR). The principles behind computer aided molecular design and 3-D QSAR. Peptide synthesis, protecting groups and combinatorial chemistry. optimal properties of small molecule leads: introduction to approaches to the design of high quality hits using parameters such as Ligand Efficiency, Lipophilic , Property Forecast Indexing. Basic carbohydrate chemistry and use these concepts and principles to solve simple problems in medicinal chemistry.

BCH 201: General Biochemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the structure of different macromolecules in biological system;
2. identify types of chemical reactions involving these macromolecules;
3. explain the various methods of isolation of these macromolecules;
4. estimate the effects of acids and alkalis on the macromolecules;
5. describe purification of macromolecules; and
6. discuss quantification of the various macromolecules.

Course Contents
Introductory chemistry of amino acids, their properties, reactions and biological functions. Classification of amino acids: neutral, basic and acidic; polar and non-polar; essential and non-

essential amino acids. Peptides. Introductory chemistry and classification of proteins. Biological functions of proteins. Methods of their isolation, purification and identification. Primary, secondary, tertiary and quaternary structures of proteins. Basic principles of tests for proteins and amino acids. Introductory chemistry of carbohydrates, lipids and nucleic acids. Nomenclature of nucleosides and nucleotides, effects of acid and alkali on hydrolysis of nucleic acids.

BCH 202: General Biochemistry II (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the structure of the cell including its components;
2. discuss the interrelationship between different organelles of the cell;
3. recognize the differences between plant and animal cells;
4. isolate the various organelles of both plant and animal cells; and
5. describe the influence of hydrogen ion concentration on cellular function.

Course Contents
The cell theory. Structures and functions of major cell components. Cell types, constancy and diversity. Cell organelles of prokaryotes and eukaryotes. Chemical composition of cells. Centrifugation and methods of cell fractionation. Structure, function and fractionation of extra-cellular organelles. Water, total body water and its distribution. Regulation of water and electrolyte balance. Disorder of water and electrolyte balance. Acidity and alkalinity, pH and pK values and their effects on cellular activities.

BCH 203: General Biochemistry Practical (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students will be able to understand the various laboratory procedures used in the study of various biochemical processes described in BCH 201 and 202.

Course Contents
Laboratory experiments designed to reflect the topics covered in BCH 201 and BCH 202. Introduction to laboratory methods and procedures employed in studying biochemical processes.

MTH 201: Mathematical Methods 1 (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain real-valued functions of a real variable;
2. solve some problems using mean value theorem and Taylor series expansion; and
3. evaluate line integral, surface integral and volume integrals.

Course Contents
Real-valued functions of a real variable. Review of differentiation and integration and their applications. Mean value theorem. Taylor series. Real-valued functions of two and three variables. Partial derivatives chain rule, extrema, lagrangian multipliers. Increments, differentials and linear approximations. Evaluation of line integrals. Multiple integrals.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents
Concepts of Peace, Conflict and Security in a multi-ethnic nation. Types and Theories of Conflicts: Ethnic, Religious, Economic, Geo-political Conflicts; Structural Conflict Theory, Realist Theory of Conflict, Frustration-Aggression Conflict Theory. Root causes of Conflict and Violence in Africa: Indigene and settlers Phenomenon; Boundaries/boarder disputes; Political disputes; Ethnic disputes and rivalries; Economic Inequalities; Social disputes; Nationalist Movements and Agitations; Selected Conflict Case Studies – Tiv-Junkun; Zango Kataf, Chieftaincy and Land disputes etc. Peace Building, Management of Conflicts and Security: Peace & Human Development. Approaches to Peace & Conflict Management --- (Religious, Government, Community Leaders etc.). Elements of Peace Studies and Conflict Resolution: Conflict dynamics assessment Scales: Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice; The Nigeria Legal System. Insurgency and Terrorism. Peace Mediation and Peace Keeping. Peace & Security Council (International, National and Local levels) Agents of Conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of International Organizations in Conflict Resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping. Media and Traditional Institutions in Peace Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students, through case study and practical approaches, should be able to:
1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and

9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity identification (Sources of business opportunities in Nigeria, Environmental scanning, demand and supply gap/unmet needs/market gaps/Market research, Unutilised resources, Social and climate conditions and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (Venture capital, Equity finance, Micro finance, Personal savings, small business investment organizations and business plan competition). Entrepreneurial marketing and e-commerce (principles of marketing, Customer acquisition & retention, B2B, C2C and B2C models of e-commerce, First Mover Advantage, E-commerce business models and successful E-Commerce companies,). Small business management/family business: Leadership & Management, Basic book keeping, Nature of family business and family business growth model. Negotiation and business communication (strategy and tactics of negotiation/bargaining, Traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, Business idea contest, Brainstorming sessions, Idea pitching). Technological solutions (the concept of market/customer solution, Customer solution and emerging technologies, Business applications of new technologies - Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud computing, Renewable energy etc. Digital business and E-Commerce strategies).

CHM 303: Organic Chemistry II (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

1. recognize and distinguish between aromatic and Alicyclic compounds by their structures;
2. identify the properties of aromatic and Alicyclic compounds, and the chemical consequences of aromaticity;
3. recognize and be able to write the mechanism of electrophilic aromatic and Alicyclic substitution;
4. outline the completed electrophilic aromatic substitution reactions of the following types: halogenation, nitration, sulfonation, and Friedel-Crafts acylation & alkylation;
5. explain the chemistry of heterocyclic Chemistry (3,4,5 and 6-membered ring of O, N, S heterocyclic compounds);
6. describe the Reactive intermediates – carbocations, carbanions, carbenes, nitrenes;
7. express the rearrangement reactions e.g., Beckmann, Baeyer-Villiger etc.
8. illustrate with various reaction mechanisms and types; and
9. organize Forensic analysis of biological samples, pharmaceutical samples, organic analytes and macromolecular samples.

Course Contents

Pre –requisite –CHM 211

Aromatic and Alicyclic chemistry. Survey of representative polycyclic compounds. Heterocyclic Chemistry (3,4,5 and 6-membered ring of O, N, S heterocyclic compounds). Reactive intermediates – carbocations, carbanions, carbenes, nitrenes etc. Selected rearrangement reactions such as, Beckmann, Baeyer-Villiger, and many others to illustrate various reaction mechanisms and types. Forensic analysis of biological samples, pharmaceutical samples, organic analytes and macromolecular samples. Forensic analysis of biological samples, pharmaceutical samples, organic analytes and macromolecular samples.

CHM 316: Applied Spectroscopy (2 Unit C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. study and characterize spectroscopically molecules and materials with the infrared; UV; NMR and mass spectrometry;
2. discuss the general principles of the analytical instruments listed above;
3. describe the applications of spectroscopy, such as the study of the atmosphere; cultural heritage, astrophysics, and materials;
4. describe the theoretical principle of GC-MS; LC-MS; LC-NMR;
5. study and characterise molecules and materials with the listed instruments in (4) above; and
6. list the application of these instruments in Industry and medicine.

Course Contents
Principles and applications of UV, IR, NMR and Mass spectroscopy in the determination and elucidation of structures of organic compounds. Brief mention of hyphenated systems: GC-MS, LC-MS and LC-NMR, and diagnostic use of NMR in medicine.

CHM 327: Research Methodology I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students will be able to:
1. learn how to carry out independent research;
2. learn how to search literature relevant to their interest; and
3. write scientific report.

Course Contents
This course is designed to introduce students to research methodology and research information useful in writing of their project/thesis /dissertation work. The student will be trained on online research journals related to the topic as well as to the different techniques of presentation of references. So also, the course should enable the student make scientific report both in writing and orally. To introduce the basic statistical methods used in scientific pharmaceutical practice and research.

CHM 328: Experimental Organic and Analytical Chemistry (1 Unit C: PH 45)
This will expose students to practical works based on topics taught under CHM 221 and CHM 222

MCM 311: The Medicinal Chemistry of Drug Development (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the student will be expected to appreciate
1. the various classes of therapeutic agents and their synthesis;
2. mechanism of actions; and
3. metabolism.

Course Contents
Role of computational chemistry in drug development. Structure and ligand-based drug design. Identification of active substances from traditional remedies of a natural origin. Instrumentation. Potentiometric and pH methods. Conducto-metric methods. Electroanalytical methods, Amperometric, Coulometric methods of analysis. Coupled, methods of analysis, GC-MS. Radio-chemical methods, Chromatography.

MCM 312: Medicinal Chemistry Practical I (1 Unit C: PH 45)
Laboratory practical to illustrate the analytical methods used in drug analysis. It will involve chromatographic and spectroscopic characterization of pharmaceuticals

MCM 360: Industrial Attachment 1 (SIWES) (12 weeks) (3 Units C: PH 135)
Contents: This is a supervised work-experience progress of approximately three months' duration, commencing with the long vacation (following the end of the 400 level second semester examinations) and ending on November 30, or an appropriate date stipulated by the Industrial Training Coordinator.

PHA 311: Pharmacology I (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the student will be expected to understand the behaviour of the drug from its administration until its removal from the body and introduce them to general and systemic Pharmacology and its application to therapy.

Course Contents
Introduction: History of Pharmacology and relationship of Pharmacology to other pharmaceutical and clinical subjects. Pharmacology Textbooks and journals. Definition and sources of Drugs. Routes of Drug Administration. Drug Absorption, Distribution, Elimination and factors affecting them. Enzyme induction and enzyme inhibition. Mechanisms of drug action – receptor and non-receptor theory. Drug dosage and dose response curves. Measurement of some pharmacological parameters.

Modern approaches to anti-infective drug design: The mechanism of action, design and synthesis of b-lactam antibiotics; Antiviral drug design; Antifungal drug design; The importance of protease enzymes as drug targets as illustrated by examples including the falcipain 2 inhibitors (cysteine proteases) and HIV protease inhibitors (aspartate proteases); advanced techniques in computational drug design. Introduction to the fundamental principles that underpin modern medicinal chemistry of anti-infective drugs; these will include qualitative and advanced quantitative SAR techniques, computer aided molecular design, further techniques in solid phase chemistry / combinatorial chemistry.

PHA 312: Pharmacology II (2 Units C: LH 30)

Learning Outcome
At the end of the course, the students will be expected to understand the behaviour of the drug from its administration until its removal from the body and introduce them to general and systemic Pharmacology and its application to therapy.

Course Contents
Quantitative aspects of drug action (on cellular receptors). relationship between drug efficacy and chemical structure. Introduction to the basic principles of pharmacokinetics: key pharmacokinetic concepts such as clearance, volume of distribution, half-life and steady state and solving problems involving these parameters. Role of drug concentrations in determining response to treatment. Biochemical events after drug administration: toxicological and biochemical significance. Principles of selective toxicity and their application to both self and non-self-targets.

400 Level

CHM 414: Natural Products Chemistry I (2 Units C: LH 30)

Learning Outcome
At the end of the course, the students will be expected to learn the source, physical and properties of drugs from natural sources.

Course Contents
Terpenoids, carotenoids, steroids, alkaloids and Lipids.

CHM 419: Organic Synthesis (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify reduction methods with boron, aluminum hydrides and their analogues,metals as well as selective reduction in polyfunctional groups;
2. describe oxidation methods including epoxidation,hydration and hydroxylation of alkenes as well as oxidative cleavage of glycol;
3. identify hydroboration and oxidation of ketones;
4. explain carboxylation reactions and protonolysis;
5. discuss phoshorus halides and their applications, enamies synthesis and application;
6. identify formation of polycyclic compounds, aldol type reactions and reaction of iminium salts with nucleophiles; and
7. explain synthesis of complex molecules and pericyclic reactions.

Course Contents
Reduction methods. Catalytic hydrogenation. Reduction with boron and aluminium hydrides and their analogues and derivatives. Metal reductions. Selective reduction in polyfunctional compounds. Oxidation methods. Epoxidation, hydration and hydroxylation of alkenes; oxidative cleavage of glycols. Survey of synthetic applications of organometallic compounds.. Hydroboration oxidation to ketones. Carboxylation reactions and protonolysis; phosphorus halides and their applications. Enamines: synthesis and applications. Formation of polycyclic compounds. Aldol type reactions and reaction of iminium salts with nucleophiles. Synthesis of complex molecules. Pericyclic reactions. Methodology for the construction of synthetic routes (disconnection approach) and applications for the synthesis of important and complex organic compounds. Molecular self assembly in synthesis.

MCM 421: Antimicrobial Chemotherapy for Chemists (2 Units C: LH 30)

Learning Outcome
At the end of the course, the student will be expected to know the various infectious pathogens and the classes of drugs used in the treatment of infectious and cancer diseases.

Course Contents
Principles of chemotherapy. Introduction to novel concepts in drug design (Nanomedicine) and treatment strategy (Pharmacogenomics) in the context of chemotherapy. Application of chemotherapy principles to diseases caused by viruses (e.g HIV/AIDS) and parasites (i.e malaria). Illustration of the importance of chemical structure and structure-based drug design in drug action. Evaluation of the application of the principles of selective toxicity to the chemotherapy of infectious diseases. Discussion of the clinical relevance of basic pharmacological principles of chemotherapy. Discussion of the importance of drug resistance in the treatment and prevention of disease. Evaluation of the importance of structure activity relationship (SAR) in modern drug design in the context of chemotherapy.

MCM 490: Seminar (2 Unit C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. demonstrate basic knowledge in report writings;
2. explain introduction, literature reviews, methodology/experimentation/materials and methods, results and discussion, conclusion, recommendations and referencing;
3. describe various types of referencing e.g. APA, Chicago, Harvard etc.;
4. explain spacing and paragraph used in presentation writings;
5. explain the use of multimedia in seminar presentations; and
6. describe assessment and grading of the written and oral presentation.

Course Contents
Student reports on an assigned or chosen current topic in chemistry. Review of literature on the assigned topic should be included. Assessment to be on written report and oral presentation.

MCM 499: Research Project (6 Units C: PH 270)

Learning Outcomes
At the end of this course, the students should be able to:
1. demonstrate basic knowledge of report writings;
2. choose a Chemistry related topic for the final year project;
3. explain introduction, literature reviews, methodology/experimentation/materials and methods, results and discussion, conclusion, recommendations and referencing;
4. describe various types of referencing e.g. APA, Chicago, Harvard etc.;
5. discuss spacing and paragraph used in presentation writings;
6. explain the use of multimedia in project seminar presentations; and
7. identify assessment and grading of the written and oral presentation.

Course Contents
Research projects into selected topics in chemistry. Students will be expected to carry out literature survey on chosen topics, perform experiments and produce reports. Students will be subjected to both seminar and oral examinations on their projects.

Minimum Academic Standards
Equipment

Item	**Quantity**
Calorimeter Model: C 200	1
Differential Scanning Calorimeter (DSC) Model: DSC 1| -150 … 700 °C	1
Digital Laboratory Hot Plate Magnetic Stirrer Model: RET basic IKAMAG®	10
Digital Refractometer Model: ATR-B TOUCH	1
Distillation Unit Apparatus Model: UDK 149 - Automatic steam distillation system	1
Drying Oven Model: Turbo-Fan Drying Oven 230V	10
Electronic Balance Model Number: JA103H	10
f2271 Ice-making machine	2
Fourier Transform Infrared (FTIR) Spectrometer	1
Freeze Dryer Model: Christ Beta 2-8 LD Freeze Dryer	3
Fume Chamber, Laboratory Fume Hood	1
Laboratory pH Meter -2 ... 20 pH, ± 2 000 mV | PP series	10
Melting Point Apparatus Model: VMP–PM	10
Multiskan™ GO Microplate Spectrophotometer with cuvette	1
Polarimeter Model: AUTOPOL VI	1
Rotary Evaporator Model: R-210/R-215	3
Soxhlet Extraction Apparatus with Energy Regulator	3
TLC Chromatographic Tanks	20

Staffing

Academic
Minimum Number of Academic Staff
1. Based on the NUC CCMAS, each department shall have minimum of six academic staff.
2. The staff mix shall be, Professors/Readers 20%; Senior Lecturer 35% and Lecturer I and below 45%
Competency: Academic staff should have a minimum of a PhD.

Technical
i. Technologists – Minimum of one Principal Technologist per laboratory
ii. Lab Assistant – Minimum of two Lab Assistants per laboratory
iii. Lab Attendant – One Laboratory Attendant per laboratory

Classrooms, Laboratories, Workshops and Office Space

The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

Laboratories

Preparation room, store and technologists' office to be provide in all conventional laboratories:

1. Instrumentation Laboratory - conventional laboratory with full complement of utilities and adequate work-stations to accommodate 30-50 persons
2. General Chemistry Laboratory - conventional bench laboratory with full complement of utilities and adequate work-stations to accommodate 100 persons
3. Physical Chemistry Laboratory - conventional bench laboratory with full complement of utilities and adequate work-stations to accommodate 50-100 persons.
4. Research Laboratory - conventional bench laboratory with full complement of utilities and adequate work-stations to accommodate 25-50 persons.

Library

The department shall maintain both physical and electronic libraries that shall comprise the following units:

1. Conventional
2. Circulation section
3. Reference/reserve section
4. Serial/journals
5. Electronic
6. Computers (DESK TOPS AND LAPTOPS.)
7. Internet connectivity (broad band),
8. Wide screen projection facilities.
9. Incinerator facility

Laboratory Equipment

Every university teaching laboratory should be equipped with a wide range of specialist facilities including:

1. State-of-the-art synthetic labs for project work.
2. Dedicated NMR spectrometer for exclusive use by undergraduates.
3. A suite of dedicated analytical instrumentations.

4. The undergraduate teaching labs should also have HPLC and HPLC-MS instruments to help in learning the fundamentals and applications of measurement and of separation science.
5. UV-Vis Spectrophotometer and a suite of infra-red spectrometers for measuring solids, liquids and gases.

Students should also have access to:

1. Open access research laboratories for Separations, EPR, NMR and Mass Spectrometry.
2. Cutting-edge X-ray diffractometers.
3. Research computing facility to support teaching & learning in computational and theoretical science.

Other teaching and learning/research facilities;
Animal House

(a) Colony holding Rooms viz:

1. Mice
2. Rats
3. Guinea pigs
4. Rabbits

(b) Experimental laboratory - conventional bench laboratory with full complement of utilities and adequate work-stations to accommodate 10 -15 persons

1. Quarantine room
2. Store

B.Sc. Meteorology

Overview

Meteorology programme covers the physics of the atmosphere and therefore students of meteorology will be exposed to various processes leading to different weather conditions and how the knowledge of weather and climate could be deployed in addressing life problems of man. This will be achieved through the rigorous training in various areas of meteorology such as agro-meteorology, aviation and marine meteorology, biometeorology, hydrometeorology, satellite meteorology, to mention but a few. The programme will also involve laboratory work in order to make students more conversant with analysis of imageries of synoptic features such as weather charts.

Philosophy

The philosophy of the B.Sc. Meteorology programme is to equip the students with theoretical and practical knowledge of weather and climate to understand the complex interactions between man and his environment. This will help in producing well-trained graduates to meet the ever-increasing demand of professional meteorologists who can proffer solutions to various meteorological disasters to our socio-economic sectors such as agriculture, transportation, health, power generation, housing, recreation, commerce etc. for Nigeria, Africa and the global community. The programme is also designed to produce graduates that are innovative and can be self-dependent with problem-solving orientation.

Objectives

Provide students with a broad and balanced foundation and practical skills in Meteorology and Climate Science.

1. Develop in students the ability to apply knowledge and skills to the solution of theoretical and practical problems in Meteorology and Climate Science.
2. Develop in students, a range of transferable skills and attitudes that are of value in Meteorological and non-Meteorological employment.
3. Provide students with a knowledge and skills base from which they can proceed to further studies in specialized areas of Meteorology or within multi-disciplinary areas involving Meteorology.
4. Produce well-equipped personnel in the areas in which the economy is highly dependent, especially agricultural meteorology; water resources management (hydro-meteorology); transport industry as well as other dependent services such as the Nigerian Meteorological Agency and the military (especially the Air Force and Navy).
5. Instill in the student the capability to carry out and disseminate application-oriented research in the areas (i) – (iii) above.

Unique Features of the Programme

1. The current CCMAS is more loaded with core courses that are very relevant to the B. Sc Meteorology programme.
2. The current CCMAS also has programme-specific entrepreneurship programme to further expose the graduates of meteorology on various areas and skills to make them independent professionals s after training.

3. The current CCMAS has a lot of practicals and laboratory work relevant to meteorology programme.

Employability Skills

A graduate of Meteorology at the bachelor's honor's level should have the following employability skills:

1. Mathematical competence and basic competences in science and technology;
2. digital competence in computer and GIS;
3. learning to analyze and understand the complex weather satellite imageries for weather forecasting purposes;
4. social and civic competences;
5. effective communication;
6. sense of initiative and entrepreneurship; and
7. cultural awareness and expression.

21st Century Skills

1. Communication
2. Collaboration
3. Critical Thinking
4. Creativity and Innovation
5. Technology Skills
6. Flexibility
7. Information and ICT Literacy
8. Leadership and Responsibility

Admission and Graduation Requirements

Admission Requirements

Admission into the meteorology programme may be through any of the following modes:

Indirect-Entry Admission

Candidates seeking admission into the five year degree programme in meteorology are expected to possess a Senior Secondary Certificate (SSC) or its equivalents with at least five credit passes, at not more than two sittings. The credit passes must include Mathematics, English Language and Physics and any two from Biology, Agricultural Science, Geography and Chemistry. In addition, candidates will normally have sat for and obtained satisfactory scores in the UTME exams with a minimum score of 200.

Direct Entry Admission

Direct Entry applicants for admission into the B.Sc. Meteorology degree programme shall possess at least five credits at the Senior Secondary Certificate (SSC) two of which must be at the Advanced level.

Graduation Requirements

To qualify for the award of the Bachelor of Science degree in meteorology of any Nigerian University, admitted students must attain:

1. pass the prescribed courses specified in the curriculum;

2. pass a minimum of 150 credits for UTME students and 120 credits for DE students.

Global Course Structure

100 Level

Course Code	Course title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
MTH 101	Elementary Mathematics 1	2	C	30	-
MTH 102	Elementary Mathematics 11	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
BIO 101	General Biology 1	2	C	30	-
BIO 102	General Biology 11	2	C	30	
BIO 107	General Biology Practical 1	1	C	-	45
BIO 108	General Biology Practical 11	1	C	-	45
CHM 101	General Chemistry 1	2	C	30	-
CHM 102	General Chemistry 11	2	C	30	
CHM 107	General Chemistry Practical 1	1	C	-	45
CHM 108	General Chemistry Practical 11	1	C	-	45
GEO 109	Introduction to Hydrology	2	C	30	-
MET 101	Introduction to Meteorology	2	C	30	-
PHY 101	General Physics 1	2	C	30	-
PHY 102	General Physics 11	2	C	30	
PHY 107	General Physics Practical 1	1	C	-	45
PHY 108	General Physics Practical 11	1	C		45
	Total	**33**			

200 Level

Course Code	Course Title	Units	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
AGR 201	General Agriculture I	2	C	30	-
CSC 201	Computer Programming I	3	C	30	45
GEO 205	Introduction to Climatology	2	C	30	-
MET 201	Codes, Observations & Plotting Practice	2	C	30	-
MTH 201	Mathematical Methods I	2	C	30	-
MTH 202	Elementary Differential Equations	2	C	30	-

Course Code	Course Title	Units	Status	LH	PH
MTH 209	Introduction to Numerical Analysis	2	C	30	-
PHY 204	General Physics IV (Waves & Optics)	2	C	30	-
PHY 209	Introduction to Space Science	2	C	30	-
	Total	**23**			

300 Level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace and Conflict Resolutions	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
MET 302	Dynamic Meteorology	2	C	30	-
MET 303	Atmospheric Physics Experiment	2	C		90
MET 304	Synoptic Analysis & Current Weather	2	C	30	-
MET 305	Atmospheric Thermodynamics	2	C	30	-
MET 308	Cloud Physics & Weather Modification	2	C	15	45
	Total	**14**			

400 Level

Course Code	Course Title	Units	Status	LH	PH
PHY 401	Meteorology and Physics of Lower Atmosphere	2	C	30	-
MET 403	Agro-Meteorology	2	C	15	45
MET 409	Radar and Satellite Meteorology	2	C	15	45
MET 415	Hydrometeorology	2	C	15	45
MET 411	Entrepreneurship in Meteorology	2	C	30	-
MET 499	Industrial Training (24 Weeks)	6	C	-	-
Total Units		**16**			

500 Level

Course Code	Course Title	Units	Status	LH	PH
MET 501	Research Project	6	C	-	-
MET 503	West African Meteorology	2	C	30	-

Course Code	Course Title	Units	Status	LH	PH
MET 505	Marine and Physical Oceanography	2	C	15	45
MET 507	Computer Application in Meteorology	3	C	30	45
MET 500	Case Study of Met. Phenomena (Seminar)	2	C	30	-
MET 504	Meso-Scale Weather Systems	2	C	30	-
MET 508	Advanced Dynamical Meteorology & Numerical Weather Prediction	2	C	30	-
	Total	**19**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to
1. identify possible sound patterns in English Language;
2. list notable Language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English Language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and Deductive Argument and Reasoning Methods, Analogy, Generalisation and Explanations). Ethical considerations, Copyright Rules and Infringements. Writing Activities: (Pre-writing , Writing, Post writing, Editing and Proofreading; Brainstorming, outlining, Paragraphing, Types of writing, Summary, Essays, Letter, Curriculum Vitae, Report writing, Note making etc. Mechanics of writing). Comprehension Strategies: (Reading and types of Reading, Comprehension Skills, 3RsQ). Information and Communication Technology in modern Language Learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of Trade, Economic and Self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building
6. analyse the role of the Judiciary in upholding people's fundamental rights
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification. Judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation; Re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption (WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. explain basic definition of set, subsets, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents

Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers, integers, rational and irrational numbers, mathematical induction, real sequences and series,

theory of quadratic equations, binomial theorem. Complex numbers, algebra of complex numbers, the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative as limit of rate of change. Techniques of differentiation. Extreme curve sketching. Integration as an inverse of differentiation. Methods of integration. Definite integrals. Application to areas, volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

BIO 101: General Biology I (2 Units C: LH 30)

Learning Outcomes
At the end of lectures, students should be able to:
1. explain cells structures and organisations;

2. summarize functions of cellular organelles;
3. characterize living organisms and state their general reproduction;
4. describe the interrelationship that exists between organisms;
5. discuss the concept of heredity and evolution; and
6. enumerate habitat types and their characteristics.

Course Contents
Cell structure and organisation, functions of cellular organelles. characteristics and classification of living things. chromosomes, genes; their relationships and importance. general reproduction. interrelationships of organisms (competitions, parasitism, predation, symbiosis, commensalisms, mutualism, saprophytism). heredity and evolution (introduction to Darwinism and Lamarkism, Mendelian laws, explanation of key genetic terms). elements of ecology and types of habitats.

BIO 102: General Biology II (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures, students should be able to:
1. List the characteristics, methods of identification and classification of Viruses, bacteria and fungi;
2. state the unique characteristics of plant and animal kingdoms;
3. describe ecological adaptations in the plant and animal kingdoms;
4. explain nutrition, respiration, excretion and reproduction in plants and animals; and
5. describe growth and development in plants and animals.

Course Contents
Basic characteristics, identification and classification of viruses, bacteria and fungi.
A generalized survey of the plant and animal kingdoms based mainly on the study of similarities and differences in the external features. Ecological adaptations. Briefs on physiology to include nutrition, respiration, circulatory systems, excretion, reproduction, growth and development.

BIO 107: General Biology Practical I (1Unit C: PH 45)

Learning Outcomes
At the end of this course students should be able to:
1. outline common laboratory hazards;
2. provide precaution on laboratory hazards;
3. state the functions of the different parts of microscope;
4. use the microscope and describe its maintenance;
5. draw biological diagrams and illustrations; and
6. apply scaling and proportion to biological diagrams.

Course Contents
Common laboratory hazards. prevention and first aid. measurements in biology. uses and care of microscope. compound and dissecting microscope. Biological drawings and illustration, scaling, accuracy and proportion. use of common laboratory apparatus and laboratory experiments designed to illustrate the topics covered in **BIO 101.**

BIO 108: General Biology Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. describe the anatomy of flowering plants;
2. differentiate types of fruit and seeds;
3. state ways of handling and caring for biological wares;
4. describe the basic histology of animal tissues; and
5. identify various groups in the animal kingdom.

Course Contents
Anatomy of flowering plants, primary vegetative body. stem, leaf and root to show the mature tissues namely parenchyma, collenchyma, sclerenchyma, xylem and phloem. Types of fruits and seeds. Care and use of dissecting kits and other biological wares. Dissection and general histology of animal tissues based on vertebrate forms. Morphology and functions of epithelial, muscular, nervous and connective tissues. Examination of various groups of lower invertebrates under microscopes, identification of various groups of organisms in Animal Kingdom. Andany experiment designed to emphasize the practical aspects of topics in BIO 102.

CHM 101: General Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. define atom, molecules and chemical reactions;
2. discuss the Modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. illustrate shapes of simple molecules and hybridized orbitals;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents
Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence Forces and structure of solids. Chemical equations and stoichiometry, chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry, rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reaction;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements and
9. describe basic properties of Transition metals.

Course Contents
Historical survey of the development and importance of organic chemistry, fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures and nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The Chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify the differences between primary and secondary standards;
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents
Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify the general laboratory rules and safety procedures;

2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify and carry out preliminary tests which includes ignition, boiling point, melting point, test on known and unknown organic compounds;
5. perform solubility tests on known and unknown organic compounds;
6. conduct elemental tests on known and unknown compounds; and
7. conduct functional group/confirmatory test on known and unknown compounds which could be acidic / basic / neutral organic compounds.

Course Contents
Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

MET 101: Introduction to Meteorology (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. discuss the structure and compositions of the earth's atmosphere.
2. explain the principles and practice of weather observation and measurements.

Course Contents
Structure and history of the earth and the solar system. Characteristics of the earth's atmosphere. Atmospheric variables and methods of measurement. Weather systems and forecasting. Climate and climatic change. Scientific concepts needed to understand climate and climate change. Principles of regional variations in climate. Understanding observed seasonal, decadal and millennial changes. Analysis of the Antarctic ozone hole, El Nino and human-induced global warming.

GEO 109: Introduction to Hydrology (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the problems of measurements of rainfall. Evaporation and evapotranspiration
2. discuss how both surface and groundwater could be effectively managed.
3. state the meteorological significance of evaporation

Course Contents
Scope, Significance and development of the science of hydrology. The hydrological cycle. Origin and measurement of precipitation. Evaporation and Evapotranspiration measurements. Interception, Infiltration and Soil moisture. Origin and occurrence of groundwater. Run off prediction and forecasting. The storm hydrograph. River basin studies and development. Water Resources Management. Man, and hydrological Cycle.

PHY 101: General Physics I (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity;
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents

Space and time. Units and dimension. Vectors and scalars. Differentiation of vectors (displacement, velocity and acceleration). Kinematics. Newton laws of motion (Inertial frames, impulse, force and action at a distance, momentum conservation). Relative motion. Application of Newtonian mechanics. Equations of motion. Conservation principles in physics (conservative forces, conservation of linear momentum, kinetic energy and work, potential energy). System of particles. Centre of mass. Rotational motion (torque, vector product, moment, rotation of coordinate axes and angular momentum). Coordinate systems. Polar coordinates. Conservation of angular momentum. Circular motion. Moments of inertia (gyroscopes, and precession). Gravitation (Newton's Law of Gravitation, Kepler's laws of planetary motion, gravitational potential energy, escape velocity, satellites motion and orbits).

PHY 102: General physics II (Electricity & magnetism) (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. describe the electric field and potential, and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law, and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;
5. describe electromagnetic induction and related concepts and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters;
8. determine the characteristics of ac voltages and currents in resistors, capacitors, and Inductors.

Course Contents

Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and

resistance. Ohm's law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

PHY 107: General Practical Physics I (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasizes quantitative measurements. Experimental techniques. The treatment of measurement errors. Graphical analysis. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc. (covered in PHY 101, 102, 103 and PHY 104). However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis, and deduction.

PHY 108: General Practical Physics II (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data;
6. prepare and present practical reports.

Course Contents
This practical course is a continuation of PHY 107 and is intended to be taught during the second semester of the 100 level to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements, the treatment of measurement errors, and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;

2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents

Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students should be able to:

1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa, and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents

Concept of entrepreneurship (entrepreneurship, intrapreneurship/corporate entrepreneurship). Theories, rationale and relevance of entrepreneurship (Schumpeterian and other perspectives, risk-taking, necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of entrepreneurs (opportunity seeker, rRisk taker, natural and nurtured, problem solver and change agent, innovator and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking and creative thinking). Innovation (concept of innovation, dimensions of innovation, change and innovation, knowledge and innovation). Enterprise formation, partnership and networking (basics of business plan, forms of business ownership, business registration and forming alliances and join ventures). Contemporary entrepreneurship issues (knowledge, skills and technology, intellectual property, virtual office, networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, youth and women

entrepreneurship, entrepreneurship support institutions, youth enterprise networks and environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

COS 201: Computer Programming I (3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of this course, students should be able to:

1. explain the principles of good programming and structured programming concepts;
2. explain the programming constructs, syntax and semantics of a higher-level language;
3. describe the chosen programming language variables, types, expressions, statements and assignment; simple input and output;
4. describe the programme control structures, functions and parameter passing, and structured decomposition; and
5. develop simple programmes in the taught programming language as well as debug and test them.

Course Contents

Introduction to computer programming. Functional programming; Declarative programming; Logic programming; Scripting languages. Introduction to object-orientation as a technique for modelling computation. structured, and even some level of functional programming principles; Introduction of a typical object-oriented language, such as Java; Basic data types, variables, expressions, assignment statements and operators; Basic object-oriented concepts: abstraction; objects; classes; methods; parameter passing; encapsulation. Class hierarchies and programme organisation using packages/namespaces; Use of API – use of iterators/enumerators, List, Stack, Queue from API; Searching; sorting; Recursive algorithms; Event-driven programming: event-handling methods; event propagation; exception handling. Introduction to Strings and string processing; Simple I/O; control structures; Arrays; Simple recursive algorithms; inheritance; polymorphism.

Lab work: Programming assignments; design and implementation of simple algorithms, e.g., average, standard deviation, searching and sorting; Developing and tracing simple recursive algorithms. Inheritance and polymorphism.

MTH 201: Mathematical Methods 1 (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. explain real-valued functions of a real variable;
2. solve some problems using mean value theorem and Taylor series expansion; and
3. evaluate line integral, surface integral and volume integrals.

Course Contents

Real-valued functions of a real variable. Review of differentiation and integration and their applications. Mean value theorem. Taylor series. Real-valued functions of two and three variables. Partial derivatives chain rule, extrema, lagrangian multipliers. Increments, differentials and linear approximations. Evaluation of line integrals. Multiple integrals.

MTH 202: Elementary Differential Equations (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. define the following: order and degree of a differential equation;
2. describe some techniques for solving first and second order linear and non-linear equations; and
3. solve some problems related to geometry and physics.

Course Contents
Derivation of differential equations from primitive geometry, physics etc. Order and degree of differential equation. Techniques for solving first and second order linear and non-linear equations. Solutions of systems of first order linear equations. Finite linear differential equations. Application to geometry and physics.

MTH 209: Introduction to Numerical Analysis (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. solve some numerical solution of algebraic and transcendental equations;
2. describe curve fitting;
3. discuss error analysis;
4. calculate interpolation and approximation;
5. solve some numerical differentiation and numerical integration problems; and
6. solve some numerical problems in ordinary Differential equations with initial value problems;

Course Contents
Solution of algebraic and transcendental equations. Curve fitting. Error analysis. Interpolation and approximation. Zeros of non-linear equations 'in one variable'. Systems of linear equations. Numerical differentiation and integration. Initial value problems in ordinary differential equation.

AGR 201: General Agriculture 1 (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. discuss the various systems of crop production in Nigeria;
2. identify various agro-ecological zones in Nigeria; and
3. explain the best way of managing forest resources for sustainable development.

Course Contents
Scope of Agriculture. Importance of Agriculture. Agriculture and natural Environment. Land tenure and Use systems. Agricultural Development in Nigeria. History of agriculture. Classes of Crops. Characteristics of Tropical Agriculture. Systems of Crop Production. Cultural Practice in Crop Production. Propagation of Crops. Climatic and Edaphic factors affecting crop production. Distribution of Crops in Nigeria. Economic Importance of Animal Husbandry. Classes of Farm animals. Fisheries and Fish production in Nigeria. Importance of Forest. Sustainable Forest Management. Silvicultural systems.

MET 201: Codes, Observations and Plotting Practice (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. master the principles and practice of weather observations and measurements; and
2. explain the techniques of plotting.

Course Contents
Basic meteorological variables (wind, visibility, weather, temperature etc.). Few derived variables (QFF, QNH, Dew point etc). Simple meteorological instruments (Thermometer, wind vane, sunshine recorder, hygrometer etc). Autographic Instruments: - Barograph, Thermograph, hygrograph, Pressure – dine anemograph etc. Simple care and maintenance of the instruments. Features of the Stevenson screen and meteorological enclosure (site, location, exposures of instruments e.g. rain gauge etc.). WMO approved International Codes (AAXX), (PPAA & PPBB) and ((TTAA), (TTBB)). Plotting of codes on meteorological weather charts. Ease of converting from plotting to codes to observation and vice versa.

MET 202: Instrumentation and Environmental Measurement
(2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. identify various instruments used in weather observations and measurements; and
2. read and interpret weather charts.

Course Contents
Fundamental principle of meteorological instrumentation. Basic requirements; sensitivity, errors, durability, ease of use, maintenance. Exposure problems. Spot and continuous measurements: General instrumentation to monitor precipitation, winds, evaporation, solar radiation, temperature, pressure, clouds, visibility and sea salinity. Upper air: radiosonde and radio-theodolite techniques. Use of radar and satellites: Infrared measurement and imagery. Instrumentation in micrometeorology: Soil temperature, moisture and heat flux. Leaf area index, leaf/canopy resistance, solar radiation, eddies. Pollen disposal. Hydrological measurements: water current and water table. Observation systems: Automatic stations, marine, aircraft and satellite observations.

PHY 204: General Physics V (Waves and Optics) (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the wave phenomena and explain the nature and properties of waves;
2. explain wave propagation in different media;
3. describe geometric optics and image formation;
4. analyse simple examples of interference and diffraction phenomena;
5. identify and explain functions of optical devices;
6. explain the principles of optical instruments and applications;
7. explain the principles of operation of the Michelson interferometer;
8. describe the polarization states of light.

Course Contents
Wave phenomena (types and properties of waves). SHM. Harmonic oscillator. Waves on a string. Energy in wave motion. Longitudinal waves. Standing waves. Acoustical waves. Group and phase velocities. Doppler effects. Physical Optics: Spherical waves. Interference. Superposition. Young's slits. Single and double slits. Multiple slits. The Michelson interferometer. Diffraction. The diffraction grating and spectrometers. Thin films. Dispersion and scattering. Echo and beats. Sound in gases, liquids, and solids. Geometrical optics (waves and rays). Reflection at plane and spherical surfaces. Refraction. Thin lenses. Prism. Optical lenses and optical instruments e.g., microscopes, telescopes, etc. Lens maker's formula. Polarization and polarization states. Unpolarised and partially polarized light. Brewster's angle. Polarizing beam splitters. Photometry and light spectrum analysis.

PHY 209: Introduction to Space Science (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. distinguish the astronomy from astrophysics; and
2. explain how space science is relevant to meteorology.

Course Contents
Introduction to Astronomy and Astrophysics. Satellite communication. Introduction to Atmospheric Science. Space Environment. Space craft systems and dynamics. Aero/astrodynamic engineering. Rocket Engineering. Cosmology; Origin of Universe and Life. Space Law and Business Development.

GEO 205: Introduction to Climatology (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. trace the historical development of modern climatology;
2. explain the formation and characteristics of tropical and extra-tropical weather systems; and
3. differentiate between the Koppen's and Strahler's climatic classification schemes.

Course Contents
Nature and scope of Climatology. Development of modern climatology. Radiation and Energy Balance. Evaporation and Evapotranspiration. General Circulation of the Atmosphere. Weather and Climate in tropical and extra-tropical areas. Meteorological Hazards. Classification of climates. Climate variations and changes. Mechanisms of Nigeria's climate.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;

4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building

Course Contents

Concepts of Peace. Conflict and Security in a multi-ethnic nation. Types and Theories of Conflicts: Ethnic, Religious, Economic, Geo-political Conflicts; Structural Conflict Theory, Realist Theory of Conflict, Frustration-Aggression Conflict Theory. Root causes of Conflict and Violence in Africa: Indigene and settlers Phenomenon; Boundaries/boarder disputes; Political disputes; Ethnic disputes and rivalries; Economic Inequalities; Social disputes; Nationalist Movements and Agitations; Selected Conflict Case Studies – Tiv-Junkun; Zango Kartaf, Chieftaincy and Land disputes etc. Peace Building, Management of Conflicts and Security: Peace & Human Development. Approaches to Peace & Conflict Management --- (Religious, Government, Community Leaders etc.). Elements of Peace Studies and Conflict Resolution: Conflict dynamics assessment Scales: Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice; The Nigeria Legal System. Insurgency and Terrorism. Peace Mediation and Peace Keeping. Peace & Security Council (International, National and Local levels) Agents of Conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of International Organizations in Conflict Resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping. Media and Traditional Institutions in Peace Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students, through case study and practical approaches, should be able to:

1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/Market Research, Unutilized resources, Social and climate conditions and Technology adoption gap). New business development (business planning, market research). Entrepreneurial Finance (Venture capital, Equity finance, Micro finance, Personal savings, small business investment organizations and Business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, Customer

Acquisition & Retention, B2B, C2C and B2C models of e-commerce, First Mover Advantage, E-commerce business models and Successful E-Commerce Companies,). Small Business Management/Family Business: Leadership & Management, Basic book keeping, Nature of family business and Family Business Growth Model. Negotiation and Business communication (Strategy and tactics of negotiation/bargaining, Traditional and modern business communication methods). Opportunity Discovery Demonstrations (Business idea generation presentations, Business idea Contest, Brainstorming sessions, Idea pitching). Technological Solutions (The Concept of Market/Customer Solution, Customer Solution and Emerging Technologies, Business Applications of New Technologies - Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy etc. Digital Business and E-Commerce Strategies).

MET 302: Dynamic Meteorology (3 Units C: LH 45)

Learning Outcomes

At the end of this course, students should be able to:

1. explain the physical laws governing the atmospheric motion;
2. explain the concepts of Barotrophic and Baroclinic atmospheres; and
3. differentiate between convergence and divergence within the context of atmospheric motion.

Course Contents

The physical laws governing atmospheric motion. Forces acting on a fluid element.
Equations of motion of a non-inertia (rotating) frame of reference. Effect of the shape of the earth on the equations. Scale analysis of the full equations leading to the hydrostatic, geostrophic approximations. The continuity equation. The thermal wind equations-Barotropic and Baroclinic atmospheres. Thermal wind and jet streams. Thermal wind and advection. Circulation and vorticity. Application to land and sea breezes. Divergence and convergence. Derivations and discussion of the vorticity equation; middle latitude and tropical cases. The equations of motion in other co-ordinates (e.g. pressure) and their advantages. The primitive equations. The pseudo vertical velocity (w) in pressure co-ordinates. The simple pressure tendency equation. Importance and application to development or otherwise of lows and highs. Instability mechanism: atmospheric disturbances as consequences of instability. Treatment of barotropic and baroclinic instabilities; convective instability and conditional instability of the second kind (CISK). Atmospheric wave motions.

MET 303: Atmospheric Physics Experiments I (2 Units C: PH 90)

Learning Outcomes

At the end of this course, students should be able to:

1. carry out basic experiments and field research in meteorology;
2. demonstrate the usage of weather recording instruments; and
3. explain the processes of real time data collection and analysis.

Course Contents

Basic techniques of laboratory and field research in Meteorology. Use and care of meteorological instruments. Experiments are designed to obtain instruments characteristics and errors such as in thermometers/thermistors, psychrometers and solarimeters. Pilot balloon observations including computations. Real-time data acquisition and analysis.

MET 304: Synoptic Analysis and Current Weather (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. define the concepts of divergence and vortices; and
2. analyse sequence of surface and upper air charts to illustrate different synoptic situations.

Course Contents
The concept of Divergence and Vortices. Scalar analysis of all meteorological variables (temperature, pressure, weather, visibility etc). The meaning of all isolines (isobar, isohyets etc). Streamline to isogons and isotach analysis. Limitations imposed by data sparse regions. Special problems of "Tropical Africa" analysis. Sequences of surface and upper air charts to illustrate different synoptic situations. Gridding Techniques. Evaluation of DIV, VORT, and Vertical motion (Kinematics' analyses).

MET 305: Atmospheric Thermodynamics (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. state the law of thermodynamics; and
2. differentiate between of thermodynamics of moist and dry processes.

Course Contents
Review of gas laws and moisture variables. Law of thermodynamics. Phase changes. Clausius-Clapeyron equations. Thermodynamics of moist and dry processes. Derivation of expressions for the adiabatic lapse rates. Parcel tracers; potential temperature: equivalent, saturated and wet-bulb potential temperature etc. Types of atmospheres. Atmospheric statics: stability criterion for both dry and moist ascent. Thermodynamic diagrams and their uses. Practical exercises with the T-Ø gram; CAPE and the determination of updraft velocities and precipitation rates.

MET 308: Cloud Physics and Weather Modification (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the physics of evaporation and condensation;
2. explain the meteorological significance of evaporation and condensation; and
3. state the importance of weather satellites and radar in meteorology.

Course Contents
Physics of evaporation and condensation. Super-saturation. Atmospheric aerosol – concentrations, size spectra, sources and sinks. The solute effect and cloud condensation nuclei. Micro-structure of warm (tropical) clouds. Equations for growth, terminal velocities and evaporation of falling drops. The micro-physics of cold clouds. Ice nuclei; growth equations. Formation of precipitation in cold clouds. Thunderstorms.
1-dimensional and multidimensional cloud models. Use of satellite and weather radar for monitoring cloud development and precipitation. Artificial modification of weather: warm and cold clouds; fogs, severe storms and precipitation. Socio-economics of weather modification, prospects for the future.

MET 320: Field Trip (During Long Vacation) (3 Units C: PH 135)

Learning Outcomes
At the end of this course, students should be able to:
1. explain various applications of meteorology for national development; and
2. describe challenges and prospects of the applications of meteorology in Nigeria

Course Contents
Field trip will expose students of meteorology to practical applications of meteorology in different areas such aviation, agriculture, transport, human health, environment etc. Students can be taken to relevant agencies such h as National Air Space Management Agency (NAMA), Federal Airports Authority of Nigeria (FAAN), agricultural research institutes etc so that most of what they were taught in class can be demonstrated physically.

MET 403: Agro-Meteorology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. discuss the principles and practice of weather observations and measurements for agricultural purposes;
2. explain the concept of agroclimatic zonation; and
3. demonstrate how the crop-climate models could be used for agroclimatic research.

Course Contents
Weather observations for Agriculture. the meteorological variables: winds, precipitation, evaporation, evapotranspiration (potential and actual) temperature, winds and humidity extremes. Suggestion of suitable regions for crop production (agroclimatic zoning). Local variations and crop/animal production. Investigation of atmospheric conditions within a crop. Electrical analogues. Farming systems: Cultural practices including land preparation timing and technique as functions of the climate. Soil erosion. Crop-weather modelling for yields and growths. Microclimate modification for crop/animal production; irrigation, mulching, frost protection, wind breaks, evaporative cooling, etc.

MET 409: Radar and Satellite Meteorology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. differentiate between radar and satellite;
2. explain the various areas in which radar and satellites could be used to enhance the profession of meteorology; and
3. discuss the problems associated with the interpretation of satellite data.

Course Contents
Satellite orbits. Types of satellites. Visible and infrared imagery. Radio Detection and Ranging (RADAR) and Radiometer Design consideration. Establishing climate data records from multispectral MODIS measurements. Next generation of satellites. Investigating Land, Ocean and Atmosphere with multispectral measurements. Using High Spectral Resolution Radiance measurements for Sounding the Atmosphere. Problems of interpretation of data and assignment

of levels to wind measurements. Effects of local influences (e.g. mountains). Uses of satellite information in weather forecasting, soil moisture monitoring, dust haze occurrence and movement, drought occurrence.

MET 411: Entrepreneurship in Meteorology (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. apply various skills acquired especially in the area of weather instrumentation, weather observation and weather forecasting; and
2. demonstrate special skills that could secure them employment in various agencies at local and international levels such as IFAD, UNDP, UNEP etc.

Course Contents
Applications of Meteorological services in hydro-geologic consultancy projects such as dam construction, road and houses construction, construction of air ports, recreational centres, power installation projects etc. Meteorological skills acquisition such as weather forecasting techniques etc.

MET 415: Hydrometeorology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the hydrological or water cycle;
2. explain the concepts of evaporation, infiltration and soil moisture and run off and their meteorological significance; and
3. Discuss the techniques of drought and flood prediction.

Course Contents
The hydrological cycle and major precipitation processes. Conversion of rainfall measured at a point to area estimate. Topographic influence. Evaporation processes. Measurement and estimation of evaporation by Penman's method. Water balance. Periods of surplus and deficit. Soil moisture infiltration. soil moisture storage and measurement of flow in natural channels and with structures. Factors affecting runoffs, storm run-off and the unit hydrograph. Effect of vegetation on water balance. River basin development in relation to river regimes. Droughts and its effects on ground water movement and table. Hydro-meteorological practice & forecasting; present techniques and trends in the tropics.

MET 499: Industrial Attachment (24 Weeks) (6 Units C: PH 270)

Learning Outcomes
At the end of this course, students should be able to:
1. demonstrate the knowledge and skills acquired in the class to practical terms; and
2. enhance their capacity to observe and measure weather elements.

Course Contents
Students are to be attached to relevant organisations for one semester (24 Weeks) for real-time practical experience in meteorology. Students are to be assessed based on written report, seminar presentation and assessments by supervisors.

PHY 401: Meteorology and Physics of Lower Atmosphere (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the structure and composition of the atmosphere;
2. discuss the dynamics of the atmosphere; and
3. state the importance of general circulation model in weather forecasting.

Course Contents
Composition and constitution of the atmosphere. Solar-Terrestrial interaction. Magnetic fields and storms. Meteorological parameters and their measurements: Rainfall, Temperature, Pressure, Wind, etc. Weather and Climate. Dynamics of the atmosphere. Motion of fluid elements and equation of continuity. Euler's equation of motion. Bernoulli's equation. Thermodynamics of the atmosphere: First Law of thermodynamics. Equation of state hydrostatic equation: altimetry, stability and instability of the atmosphere. Solar radiation, Solar constant and Solar induced motion of the atmosphere. Radioactive transfer processes. Particles in the atmosphere. Cloud physics. General Circulation and Weather Forecasting. The Nigerian Weather system.

MET 500: Seminar (2 Units C: LH 30)

MET 501: Research Project (6 Units C: PH 270)
Research by students into selected topics in Meteorology. Each student is expected to carry out literature survey on an assigned topic, perform experiments and produce a report. Students will be subjected to oral examination on their projects.

MET 503: West African Meteorology (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the dynamics of west African climate;
2. explain the role of the African Easterly Jet 9AEJ) amd tropical easterly jet (TEJ) in tropical weather systems; and
3. discuss the nature, causes, effects and management of pollutants within the lower atmosphere.

Course Contents
West African Climatology: the pressure, wind, temperature and moisture regimes. The Inter-tropical Discontinuity (ITD) and the Inter-Tropical Convergence Zone (ITCZ). The Afircan Easterly Jet (AEJ) and Tropical Easterly Jet (TEJ). Weather systems of West Africa: easterly waves, vortices, squall line, thunderstorms and the monsoon. Interdependence of the systems. The significance of the two jets (AEJ and TEJ) to the weather systems. Atmospheric pollutants in West Africa: Dust haze (tropical/extra-tropical interactions); fog: mechanisms for occurrence and

clearance prospects. Rainfall variability; the "little dry season" of West Africa. Rainfall prediction models: onset and cessation; the present and future trends.
East African Meteorology; the wind systems and peculiarities.

MET 504: Meso-Scale Weather Systems (2 Units; C) (LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the nature of tropical meso-scale systems;
2. discuss the formation and characteristics of thunderstorms, squall lines and the monsoon; and
3. discuss the theory of frontal development.

Course Contents
Review of atmospheric scales of motion. Scaling analysis – equations of motion applicable to meso-scale motions. Tropical meso-scale systems: vortices, shearlines. Thunderstorms/squall lines, cloud clusters, Hurricanes, typhoons. Cold and warm fronts. Baroclinic instability. Theory of frontal development. Energy source for meso-scale disturbances. The CISK and other mechanisms: Divergence and vorticity in tropical meso-scale disturbances. Difficulties in studies of meso-scale systems. Effects of orography. Convection (cumulonimbus) models. Lands and sea breezes and their dynamics. Economic aspects of meso-scale systems. Rainfall production by meso-scale disturbances.

MET 507: Computer Applications in Meteorology (3 Units: LH 30 PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. demonstrate the applications of computers in the capturing, storage, processing, analysis and presentation of meteorological data for research purposes; and
2. explain the application of FORTRAN language in the solution of differential equations.

Course Contents
Review of numerical methods relevant to Meteorological applications. Finite-differences and derivative expressions in terms of forwards, backward and centred differences. Implicit and semi-implicit formulations. Solution of differential equations with given boundary conditions using the FORTRAN language. Time series analysis and filtering techniques. Statistical analysis applied to Agro-meteorological, Hydro-meteorological and climatological problems (e.g. evaluation of linear and multiple correlation and regression analysis. Auto-correlation and simple power spectrum analysis.

MET 508: Advanced Dynamical Met. And Numerical Prediction
(2 Units: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. solve quasi-geostrophic system of equations; and
2. Demonstrate the applications of set of basic equations in numerical weather prediction.

Course Contents
Derivation and study of the quasi-geostrophic system of equations. Sutcliffe's development theorem. The basic equations of motion in the sigma-co-ordinates. The geopotential tendency and omega equations. Atmospheric energetics; available potential energy; energy conversions; Lorentz's and Pearce's formulations. Applications of energetic analysis to atmospheric motions on various scales. The set of basic equations used in numerical weather prediction. Stability and filtering of unwanted waves: "initialisation and adjustment procedures and schemes in numerical modelling". Prediction models: single, two – and multi-level models.

Minimum Academic Standards

Equipment
1. WMO standard meteorological Enclosure
2. US Class A Pan
3. Wind Vane
4. Ordinary Rainguage
5. Grass Thermometer
6. Stevenson Screen
7. Wet Bulb Thermometer
8. Dry Bulb Thermometer
9. Minimum Thermometer
10. Maximum Thermometer
11. Sunshine Recorder
12. Soil Thermometers
13. Gunn Belani Radiation Integrator
14. Cup Anemometer
15. Thermograph
16. Hygrograph
17. Barograph
18. Automated Weather Observatory System (AWOS)
19. Automated Rainguage
20. TAHMO 4 AWOS
21. Workstation with Computers
22. GIS Software (Arc GIS 10.9 and envi 5,7 saver or standalone
23. Projector
24. Interactive Screen
25. GNSS Rover System

Staffing
Academic Staff
The guidelines on academic staff/student ratio of 1:20 for Science Programmes shall apply. To start any programme in Science, there should be a minimum of six academic staff. There is need to have a reasonable number of staff with PhD degrees accounting for at least 70% of the total number and having adequate teaching experience for every programme in the Discipline.

Administrative Support Staff
The services of the administrative support staff are indispensable in the proper administration of departments and faculty offices. It is important to recruit very competent, computer literate senior staff.

Technical Support Personnel
The services of technical support staff, which are indispensable in the proper running of laboratories and workshops, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

There should be adequate number of qualified technical staff in the various cadres listed below, with a minimum of school certificate and National Diploma in Laboratory Technology or its equivalent:

Chief Technologist
Assistant Chief Technologist
Senior Technologist
Technologist I
Technologist II
There should also be adequate number of Laboratory Assistants with a minimum of school certificate

In addition, there should be supporting Office Staff: Secretary, Typist, Higher Executive Officer and Messenger.

Library
Universities should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition well stock and current hardcopies of reference and other textual materials should be provided centrally at the level of the Faculty. A well network digital library should serve the entire university community. Availability of wireless facilities (Wifi) with adequate bandwidth should enhance access to these electronic resources.

In any case, there should be internet ready workstations available in the library for least 25% of the total student enrolled in each academic programme. The funding of the Library should be in line with NUC guidelines.
Apart from the Faculty and Main University Library, a Department of Meteorology should be provided with fully equipped library and GIS Laboratory with computers and Internet connectivity and current reference books, periodicals, journals and audio-visual materials. The Department should ensure that updated literatures (soft and hard copies) in all fields of Meteorology and related disciplines are in the libraries (University and Faculty or Departmental Libraries).

Classrooms, Laboratories, Workshops and Office Space
The NUC recommends the following physical space requirements:

Description		**Size m²**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50

Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

Adequate space should be provided for all Departments in the Sciences. Effort must be made to provide each Department with at least:

i) Four (4) large laboratories calculated according to specifications of 7.5 m^2 per FTE; a minimum of four (4) preparatory rooms for each laboratory at the NUC specifications of 7 m^2 each.

ii) At least two lecture rooms capable of sitting at least sixty students at the specification of 1 m^2 per FTE.

iii) A Departmental conference room.

iv) A staff common room.

B.Sc. Microbiology

Overview
The programme has been designed to provide a sound understanding of the concepts of microbiology in relation to mankind and the environment. The programme will elaborate the importance of microorganisms and their products in industry (alcoholic beverages, petroleum and petrochemicals), health, food, agriculture, pharmacy and environmental sectors of the society. The Microbiology programmes will also emphasize the linkage between microbiology and biotechnology.

Philosophy
The philosophy is to train microbiology graduates who will apply microbiological procedures and techniques to solving developmental needs of the society.

Objectives
The objectives of the programme are to:
1. broadly train students for positions in the industry, health sector, research institutes;
2. prepare them for graduate and professional studies in applied areas of microbiology; and
3. develop their business skills in various aspects of Applied Microbiology.

Unique Features of the Programme
The programme includes a wider range and modern aspects (food, industrial, medical, systematics, pharmaceutical, environmental, petroleum, waste management, agricultural, biotechnology including genetic engineering and entrepreneurial) of microbiology.

Employability Skills
A graduate with degree in microbiology can provide opportunities in sectors such as private and government hospitals, technicians in private laboratories, forensic science laboratories, pharmaceutical industry, environmental management organisations, petroleum and petrochemical companies, agriculture, educational institutions, food processing industry, dairy industry, alcohol production, brewery industry, government regulatory agencies and non-governmental organisations (NGOs).
A degree in microbiology should equip the individual with technical, laboratory, scientific analytical and writing capacities with excellent interpersonal and communication skills. To ensure success the individual should have meticulous attention to detail and display a keen interest in treating and preventing diseases that are harmful to humans, proffer measures to monitor food quality, control food and material biodeterioration and enhance environmental quality.

21st Century Skills
1. critical thinking and problem solving
2. reasoning, analysis and interpretation
3. synthesising information
4. research skills and practices
5. problem solving,
6. interrogation and questioning.

Finally other skills emphasized are creativity, artistry, curiosity, imagination, innovation, personal expression perseverance, self-direction, planning, self-discipline, adaptability and initiative.

Admission and Graduation Requirements

Admission Requirements
Indirect entry
The entry requirements shall be at least credit level passes in five subjects including english language, mathematics, biology, chemistry, and physics at the senior secondary certificate (SSC) or its equivalent. In addition, an acceptable pass in the unified tertiary matriculation examination (UTME) is required for admission into 100-level.

Direct entry
Candidates with at least two A level passes GCE/IJMB/ JUPEB in two relevant subjects (biology, botany, chemistry, geography, mathematics and physics) may be admitted into 200-level, provided they satisfy the 'O' Level requirement.

Graduation Requirements
To be eligible for the award of a bachelor's degree in microbiology, a student must pass a minimum 120 units for those admitted through UTME and 90 units for direct entry.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication In English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
BIO 101	General Biology I	2	C	30	-
BIO 107	General Biology Practical I	1	C		45
CHM 101	General Chemistry I	2	C	30	-
CHM 107	General Chemistry Practical I	1	C		45
PHY 101	General Physics I	2	C	30	-
PHY 107	General Physics Practical I	1	C		45
BIO 102	General Biology II	2	C	30	-

Course Code	Course Title	Unit(s)	Status	LH	PH
BIO 108	General Biology Practical II	1	C		45
CHM 102	General Chemistry II	2	C	30	-
CHM 108	General Chemistry Practical II	1	C	-	45
PHY 102	General Physics II	2	C	30	-
PHY 108	General Physics Practical II	1	C	-	45
Total		**29**			

200 Level

Course Code	Course Title	Units	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	
ENT 211	Entrepreneurship and Innovation	2	C	15	45
MCB 221	General Microbiology	2	C	30	
MCB 231	Basic Techniques in Microbiology	2	C	30	
Total		**8**			

300 Level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace and Conflict Resolutions	2	C	30	
ENT 312	Venture Creation	2	C	30	
MCB 398	Entrepreneurship and Microbiology	1	C	15	
MCB 305	Fungi of Medical, Food and Industrial Importance	2	C	30	
MCB 307	Immunology	3	C	45	
MCB 399	Industrial Attachment II (12 Weeks)	3	C		
MCB 309	Food Microbiology	2	C	30	
MCB 322	Bacterial Diversity	3	C	45	
MCB 324	Microbial Ecology	3	C	45	
Total		**21**			

400 Level

Course Code	Course Title	Units	Status	LH	PH
MCB 405	Principles of Epidemiology and Public Health Management	2	C	30	
MCB 407	Pathogenic Microbiology	3	C	45	
MCB 431	Petroleum Microbiology	2	C	30	
MCB 412	Microbial Genetics	3	C	45	
MCB 423	Industrial Microbiology	3	C	30	45
MCB 424	Microbial Physiology & Metabolism	3	C	45	
MCB 425	Environmental Microbiology	3	C	30	45
MCB 482	Virology & Tissue Culture	2	C	30	
MCB 491	Research Project	6	C		270
Total		**27**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 30; PH 45)

Learning Outcomes
At the end of this course, students should be able to
1. identify possible sound patterns in English language;
2. list notable Language skills; classify word formation processes; construct simple and fairly complex sentences in English;
3. apply logical and critical reasoning skills for meaningful presentations;
4. demonstrate an appreciable level of the art of public speaking and listening; and
5. write simple and technical reports.

Course Contents
Sound patterns in English language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and Deductive Argument and Reasoning Methods, Analogy, Generalisation and Explanations). Ethical considerations, Copyright Rules and Infringements. Writing Activities: (pre-writing, writing, post writing, editing and proofreading; brainstorming, outlining, paragraphing, types of writing, summary, essays, letter, curriculum vitae, report writing, note making etc. mechanics of writing). Comprehension Strategies: (reading and types of reading, comprehension skills, 3RsQ). Information and communication technology in modern language learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigeria Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of trade, economic and self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building analyse the role of the Judiciary in upholding people's fundamental rights identify acceptable norms and values of the major ethnic groups in Nigeria; and
6. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history; culture and art up to 1800 (yoruba, hausa and igbo peoples and culture, peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria, colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914, formation of political parties in Nigeria. Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics, Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification). Judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values. Patterns of citizenship acquisition. Citizenship and civic responsibilities. Indigenous languages, usage and development. Negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – reconstruction, rehabilitation and re-orientation). Re-orientation strategies. Operation feed the nation (OFN). Green revolution and austerity measures. War against indiscipline (WAI). War against indiscipline and corruption (WAIC). Mass mobilization for self-reliance, social justice and economic recovery (MAMSER). National orientation agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. explain basic definition of set, subsets, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers, integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers, algebra of complex numbers, the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative as limit of rate of change. Techniques of differentiation. Extreme curve sketching. Integration as an inverse of differentiation. Methods of integration. Definite integrals. Application to areas, volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

BIO 101: General Biology I **(2 Units C: LH 30)**

Learning Outcomes
At the end of lectures, students should be able to:
1. explain cells structures and organisations;
2. summarize functions of cellular organelles;
3. characterize living organisms and state their general reproduction;
4. describe the interrelationship that exists between organisms;
5. discuss the concept of heredity and evolution; and
6. enumerate habitat types and their characteristics.

Course Contents
Cell structure and organisation, functions of cellular organelles. characteristics and classification of living things. chromosomes, genes; their relationships and importance. general reproduction. interrelationships of organisms (competitions, parasitism, predation, symbiosis, commensalisms, mutualism, saprophytism). heredity and evolution (introduction to Darwinism and Lamarkism, Mendelian laws, explanation of key genetic terms). elements of ecology and types of habitat.

BIO 102: General Biology II **(2 Units C: LH 30)**

Learning Outcomes
At the end of the lectures, students should be able to:
1. list the characteristics, methods of identification and classification of Viruses, bacteria and fungi;
2. state the unique characteristics of plant and animal kingdoms;
3. describe ecological adaptations in the plant and animal kingdoms;
4. explain nutrition, respiration, excretion and reproduction in plants and animals; and
5. describe growth and development in plants and animals.

Course Contents
Basic characteristics, identification and classification of viruses, bacteria and fungi.
A generalized survey of the plant and animal kingdoms based mainly on the study of similarities and differences in the external features. Ecological adaptations. Briefs on physiology to include nutrition, respiration, circulatory systems, excretion, reproduction, growth and development.

BIO 107: General biology Practical I **(1 Unit C: PH 45)**

Learning Outcomes
At the end of this course students should be able to:
1. outline common laboratory hazards;
2. provide precaution on laboratory hazards;
3. state the functions of the different parts of microscope;
4. use the microscope and describe its maintenance;
5. draw biological diagrams and illustrations; and
6. apply scaling and proportion to biological diagrams.

Course Contents
Common laboratory hazards. Prevention and first aid. Measurements in biology. Uses and care of microscope. Compound and dissecting microscope. Biological drawings and illustration, scaling, accuracy and proportion. Use of common laboratory apparatus and laboratory experiments designed to illustrate the topics covered in **BIO 101.**

BIO 108: General Biology Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. describe the anatomy of flowering plants;
2. differentiate types of fruit and seeds;
3. state ways of handling and caring for biological wares;
4. describe the basic histology of animal tissues; and
5. identify various groups in the animal kingdom.

Course Contents
Anatomy of flowering plants, primary vegetative body. Stem, leaf and root to show the mature tissues namely parenchyma, collenchyma, sclerenchyma, xylem and phloem. Types of fruits and seeds. Care and use of dissecting kits and other biological wares. Dissection and general histology of animal tissues based on vertebrate forms. Morphology and functions of epithelial, muscular, nervous and connective tissues. Examination of various groups of lower invertebrates under microscopes, identification of various groups of organisms in Animal Kingdom. And any experiment designed to emphasize the practical aspects of topics in BIO 102.

CHM 101: General Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. define atom, molecules and chemical reactions;
2. discuss the Modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. illustrate shapes of simple molecules and hybridized orbitals;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents
Atoms, molecules and chemical reactions. Modern electronic theory of atoms. Electronic configuration; periodicity and building up of the periodic table. Hybridisation and shapes of simple molecules. Valence Forces. Structure of solids. Chemical equations and stoichiometry. Chemical

bonding and intermolecular forces. Kinetic theory of matter. Elementary thermochemistry, rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to

1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reaction;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. describe basic properties of transition metals.

Course Contents

Historical survey of the development and importance of Organic Chemistry. Fullerenes as fourth allotrope of carbon, uses in nanotubules, nanostructures, nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The Chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements.

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes

At the end of this course, the students should be able to:

1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify the differences between primary and secondary standards;
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents

Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation

CHM 108: General Chemistry Practical II (1 Unit C: PH 45)

Learning Outcomes

At the end of this course, the students should be able to:

1. identify the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify and carry out preliminary tests which includes ignition, boiling point, melting point, test on known and unknown organic compounds;
5. perform solubility tests on known and unknown organic compounds;
6. conduct elemental tests on known and unknown compounds; and
7. conduct functional group/confirmatory test on known and unknown compounds which could be acidic / basic / neutral organic compounds.

Course Contents

Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum; describe the laws governing motion under gravity; and
7. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents

space and time. units and dimension. vectors and scalars. differentiation of vectors: displacement, velocity and acceleration. Kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). relative motion. Application of Newtonian mechanics. equations of motion. conservation principles in physics, conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass. Rotational motion. torque, vector product, moment, rotation of coordinate axes and angular momentum, polar coordinates. conservation of angular momentum; Circular motion. Moments of inertia, gyroscopes and precession. gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General Physics II (Electricity & Magnetism) (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. describe the electric field and potential, and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law, and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;
5. describe electromagnetic induction and related concepts and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters;
8. determine the characteristics of ac voltages and currents in resistors, capacitors, and Inductors.

Course Contents

Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and resistance. Ohm's law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

PHY 107: General Practical Physics (1 Unit C: PH 45)

Learning Outcomes

On completion of the course, the student should be able to:

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs**;** and
5. draw conclusions from numerical and graphical analysis of data

Course Contents

This introductory course emphasizes quantitative measurements, the treatment of measurement errors, and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc., covered in PHY 101. However, emphasis is placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

PHY 108: General Practical Physics (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data;
6. prepare and present practical reports.

Course Contents
This practical course is a continuation of PHY 107 and is intended to be taught during the second semester of the 100 level to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements, the treatment of measurement errors, and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH15; PH 45)

Learning Outcomes
At the end of this course, students should be able to

1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk-taking state the characteristics of an entrepreneur
2. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence engage in entrepreneurial thinking;
3. identify key elements in innovation; describe stages in enterprise formation, partnership and networking including business planning;
4. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
5. state the basic principles of e-commerce.

Course Contents

Concept of entrepreneurship (entrepreneurship, intrapreneurship/corporate entrepreneurship,). Theories, rationale and relevance of entrepreneurship (Schumpeterian and other perspectives, risk-taking, necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of entrepreneurs (opportunity seeker, risk taker, natural and nurtured, problem solver and change agent, innovator and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking, and creative thinking). Innovation (concept of innovation, dimensions of innovation, change and innovation, knowledge and innovation); enterprise formation, partnership and networking (basics of business plan, forms of business ownership, business registration and forming alliances and join ventures). Contemporary entrepreneurship Issues (knowledge, skills and technology, intellectual property, virtual office, networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, youth and women entrepreneurship, entrepreneurship support institutions, youth enterprise networks and environmental and cultural barriers to entrepreneurship); basic principles of e-commerce.

MCB 221: General Microbiology (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of the course, students will be able to:
1. explain the basic concepts and scope of microbiology;
2. describe the layout of a microbiology laboratory, equipment and reagents in a microbiology laboratory; and
3. discuss the theory behind basic protocols in a microbiology laboratory.

Course Contents

History of the Science of Microbiology. Classification of organisms into prokaryotes and eukaryotes. Classification of prokaryotes into archaea and eubacteria. Anatomy and cytochemistry of bacteria and fungi; shapes, groupings and colonial morphology of bacteria and fungi. Structure of viruses. Sterilization and disinfection. Structure, ecology and reproduction of representative microbial genera. Culture of micro-organisms. Isolation of micro-organisms. Isolation of bacteria, viruses fungi (yeasts and moulds, nutrition and biochemical activities of micro-organisms. Antigens and antibodies. Identification and economic importance of selected microbial groups. Microbial variation and heredity. Study of laboratory equipment. Introduction to microbiology of air food, milk, dairy products, water and soil. Staining techniques, antibiotic sensitivity tests, serological tests, antimicrobial agents.

MCB 231: Basic Techniques in Microbiology (2 Units C: PH 90)

Learning Outcomes
At the end of the course, students will be exposed to
1. the following techniques for the isolation of bacteria from soil, water, food and air;
2. process for obtaining pure cultures of bacteria and fungi;
3. techniques for the characterization and identification of bacterial isolates;
4. methods of bacteria enumeration; and
5. methods for the preservation of isolates and methods for culturing anaerobic bacteria

Course Contents
Culturing of micro-organisms. Preparation of media for microbial growth. Isolation of pure culture. Streaking, pour plates etc. Subculturing procedures. Staining techniques for differentiation of micro-organisms. Enumeration of micro-organisms, direct and indirect procedures. Identification of micro-organisms to include colonial and cellular morphology and biochemical procedures. Identification of bacteria should also include the use of serological techniques, antibiotic sensitivity discs and agar-in well methods. The use of anaerobic jar for growth of anaerobic organisms. Methods of preservation (agar slants, frequent subculturing, refrigeration and use of deep freezers, lyophilisation, storage in liquid nitrogen) of microbial cultures.

300 Level

GST 312: Peace and Conflict Resolution (2Units C: LH 30)
Learning Outcomes
At the end of the course, students should be able to
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents
Concepts of Peace, conflict and security in a multi-ethnic nation. Types and theories of Conflicts: ethnic, religious, economic, geo-political conflicts. Structural conflict theory, realist theory of conflict, frustration-aggression conflict theory. Root causes of conflict and violence in Africa: indigene and settlers' phenomenon. Boundaries/boarder disputes. Political disputes. Ethnic disputes and rivalries. Economic inequalities. Social disputes. Nationalist movements and agitations. Selected conflict case studies – Tiv-Junkun. Zango Kartaf. Chieftaincy and land disputes etc. Peace building, management of Conflicts and Security: Peace & human Development. Approaches to peace & conflict management --- (Religious, Government, Community Leaders etc.). Elements of peace studies and conflict resolution. Conflict dynamics assessment scales: constructive & destructive. Justice and legal framework. Concepts of social justice. The Nigeria legal system. Insurgency and terrorism. Peace mediation and peace keeping. Peace & security council (international, national and local levels) gents of conflict resolution – conventions, treaties Community Policing. Evolution and imperatives. Alternative Dispute

Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of international organizations in conflict resolution. (a). The United Nations, UN and its conflict resolution organs. (b). The African Union & peace security council (c). ECOWAS in peace keeping. Media and traditional institutions in peace building. Managing post-conflict situations/crisis: Refugees; internally displaced persons, IDPs. The role of NGOs in post-conflict situations/crisis.

ENT312: Venture Creation (2 Units C: LH 30; PH 45)

Learning Outcomes

At the end of this course, students, through case study and practical approaches, should be able to

1. describe the key steps in venture creation; spot opportunities in problems and in high potential sectors regardless of geographical location;
2. state how original products, ideas, and concepts are developed;
3. develop business concept for further incubation or pitching for funding;
4. identify key sources of entrepreneurial finance;
5. implement the requirements for establishing and managing micro and small enterprises;
6. conduct entrepreneurial marketing and e-commerce;
7. apply a wide variety of emerging technological solutions to entrepreneurship; and
8. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity identification (sources of business opportunities in Nigeria, environmental scanning, demand and supply gap/unmet needs/market gaps/market research, unutilised resources, social and climate conditions and technology adoption gap). New business development (business planning, market research); entrepreneurial finance (venture capital, equity finance, Micro finance, Personal savings, small business investment organizations and Business plan competition). Entrepreneurial marketing and e-commerce (principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first mover advantage, E-commerce business models and successful E-commerce companies,). Small business management/family business. Leadership & management. Basic book keeping. Nature of family business and family business growth model. Negotiation and business communication (Strategy and tactics of negotiation/bargaining. Traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological Solutions (the concept of market/customer solution, customer solution and emerging technologies. Business applications of new technologies - Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy etc. Digital Business and E-Commerce Strategies).

MCB 398 Entrepreneurship for Microbiology (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to

1. identify basic concepts of entrepreneurship in Microbiology;
2. demonstrate basic business skills;
3. identify areas in Microbiology that they can develop into small scale businesses; and

4. identify areas in microbiology for self-employment.

Course Contents
Identification of the basic concepts of entrepreneurship and Business skills. Scope of various aspects of Applied Microbiology- Medical Microbiology, Public health Microbiology, Immunology, Agricultural Microbiology, Food and Dairy Microbiology, Industrial Microbiology, Microbial Ecology, Petroleum Microbiology, Microbial Genetics and Molecular Biology, Genetic Engineering, Impact Assessment, Health Safety and Environment. Students will be exposed to employment opportunities in these aspects. Students will be introduced to various self – employment opportunities in these aspects of Microbiology. Students will be assisted in designing businesses of their choice within these aspects. The designed business may be validated by a professional entrepreneur educator and a professional in the field of study that relates to the business in question so as to assess the workability of the business as a small scale business, the financial cost of the business, market outlet of the business, economic gain of the business and its sustainability. Team (5 to 7 students) work will be encouraged so as to prevent repeated business design by single individuals, reduce financial cost of setting individual businesses and strengthen the manpower capacity of the business. Success stories of business entrepreneurs would be included in the curriculum especially in the student field of study so as to motivate the student to develop interest towards self – employment and self-productivity Students with best business design would be given recognition.

MCB 305: Fungi of Medical, Food and Industrial Importance
(2 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. discuss the structure, physiology and classification of fungi;
2. explain pathogenicity, immunity, epidemiology, treatment and incidence of fungi of medical importance; and
3. describe physiology and metabolites of fungi used in food and industrial microbiology.

Course Contents
Structure, life cycles, physiology and classification of fungi. Fungi of medical, food and industrial Importance, fungal pathogenicity, immunity epidemiology, incidence treatment-Superficial mycoses (ringworm, superficial candidosis, pityriasis), subcutaneous mycoses (Mycetoma, Histoplasmosis, Phaeohyphomycosis). Systemic mycoses coccidomycoses, blastomycose, Paracocidio-domycosis, aspergillosis, cryptococcosis). Fungi of food and industrial importance (*Aspergillus niger*, *Saccharomyces cerevisiae* importance. Metabolites of fungi, industrial uses of fungi. Fungi in medicine.

MCB 307: Immunology (3 Units: C LH 30; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the basic concepts of immunology and diagnostic immunology;
2. describe the types of immunity;
3. elucidate the structure of antibodies(immunoglobulins) and antigens,

4. explain the origin of the B and T cells;
5. discuss the role of immunity in protection against diseases;
6. describe the harmful effects of immunological responses;
7. identify the types of vaccines; and
8. describe animal and human vaccine production

Course Contents
Introduction; historical background. Innate and acquired immunity. Antigens, antibodies, cellular immunity. Immunological tolerance and suppression. Surgical grafting. Complement system. Hypersensitivity. Immunological anomalies. Diagnostic immunology. Vaccines, effect or systems of parasite killing and nature of resistance in plants. Animal and human vaccine production.

MCB 309: Food Microbiology (2 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. identify the factors responsible for food spoilage and food quality enhancement;
2. state the microorganisms involved in food spoilage;
3. explain the microbial indices of food quality; methods for food quality assessment;
4. describe the international microbiological standards for food quality assessment;
5. discuss the traditional and rapid methods for estimating microbial populations in foods quality; and
6. identify novel food production processes.

Course Contents
The distribution, role and significance of micro-organisms in food. Examples of international and national fermented foods. Intrinsic and extrinsic parameters of foods that affect microbial growth. Food spoilage and food borne diseases. Microbial indices of food sanitary quality international and national microbiology standards for food quality. Diseases of animal transmittable to man via food products. Rapid methods for assessing microbiological quality of foods. Traditional and modern methods for food preservation. Ecology, taxonomy, biochemistry and analytical technology of bacteria, yeasts, fungi and viruses associated with food spoilage, food-borne diseases and fermentations. Emphasis on new developments in food microbiology. Economic consequences of micro-organisms in food. Exploitation of micro-organisms in novel processes for the production of food ingredients.

MCB 322: Bacterial Diversity (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the morphology, life cycle and biochemical characteristics of bacteria;
2. discuss bacterial systematics and other prokaryotes; and
3. describe the identification and isolation of bacteria.

Course Contents
The morphology, life cycle and biochemical characteristics of bacteria. Systematic study of bacteria (autotrophic- photoautotrops, chemoautotrophs and heterotrophic-enterobacteriaceae, pseudomonadaceae, bacillaceae) and other prokaryotes (Mycoplasma, Clamydia), their nature, characteristics, habitats, identification and isolation.

MCB 324: Microbial Ecology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of this course, students will be able to:
1. describe microbial interactions between microbial populations;
2. explain microbial interactions between plants and animals;
3. identify microbial community dynamics;
4. elucidate transfer of matter and energy between trophic levels in an ecosystem; and
5. explain biotechnological aspects of microbial ecology (metal recovery, hydrocarbon recovery, biofuel generation)

Course Contents
Microbes and ecological theory. Microbial evolution (chemical and cellular evolution) and biodiversity, phylogeny, physiological, morphological and genetic adaptations of micro-organisms to their environment. Microbial interactions (interactions among microbial populations, interaction between microorganisms and plants interactions between microorganisms and animals). Micro-organisms in natural ecosystems. The life of micro-organisms in air, springs, rivers, lakes and seas. Biogeochemical cycling of elements in water, soil and sediments (including methanogenesis, methylotrophy transformations involving carbon, nitrogen, sulphur, phosphorus and manganese etc.). Microbial community dynamics (include genetic/molecular diversity indices, species diversity indices). Biotechnology aspects of microbial ecology (e.g. global warming, microbial enhanced oil recovery, liquid waste treatment, recovery of metals and biofuel generation). Aeromicrobiology.

MCB 399: Industrial Attachment II (12 Weeks) (3 Units C)

Learning Outcomes
At the end of the course, students will be able to
1. identify the needs of industry; and
2. recognise the role of a microbiologist in an industry.

Course Contents
Students will be posted to industrial establishments such as food processing, brewing, distillery, pharmaceutical, research institutes, petroleum companies, petrochemical companies, government regulatory agencies, medical and health institutions. A report is submitted for grading.

MCB 405: Principles of Epidemiology & Public Health Microbiology
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:

1. explain epidemiological concepts (distribution, frequency, determinants, population, pattern) indices;
2. explain herd immunity and its importance;
3. describe epidemiological field investigation methodologies;
4. illustrate mode of viral replication, episomes, virallatency(episomal latency and proviral latency); immunization, transmission of diseases by direct and indirect methods; and
5. explain schedules and zoonotic infections

Course Contents
Epidemiology and epidemiological concepts and types of epidemiology. Statistical applications to epidemiology. Nature of epidemiological investigations. Spectrum of infections. Herd immunity. Latency of infections. Multifactorial systems in epidemics. Zoonoses. Antigenic drifts. Biological products for immunization. Schedules for international control of infectious diseases. Transmission routes and infectious doses (airborne, waterborne, urogenital transmissions, arthropod borne, direct contact). Controlling epidemics (reducing or eliminating reservoirs, breaking transmission routes, reducing number of susceptible individuals, quarantine). Epidemiological investigations and surveillance. Disease surveillance. Emergency preparedness and global early warning System.

MCB 407: Pathogenic Microbiology (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. describe the pathogenesis (virulence factors) of common bacterial and viral pathogens; epidemiology;
2. explain mode of infections; and
3. describe laboratory diagnosis and treatment of specific bacterial and viral pathogens.

Course Contents
Study of some bacterial and viral pathogens of plants, animals and man with emphasis on those prevalent in Nigeria. The geographical distribution, isolation, identification, morphology, life cycle, source of infection, transmission and the host. Ecology and clinical manifestations and treatment of specific bacterial, viral and fungal pathogens of man.

MCB 412: Microbial Genetics (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. describe mutations and mutagens;
2. explain DNA transfer in bacteria, fungi and viruses;
3. describe Plasmids, Phages, Cosmids; and
4. list procedure for the transfer of the gene in Recombinant DNA Technology and procedures for recognition of transformed cell

Course Contents
Principles of genetic analysis; plasmids (conjugative and non-conjugative plasmids). Plasmid nomenclature, and transposable genetic elements, mutagenesis and DNA repairs, bacteriophages genetics and genetics of nitrogen fixation. Mechanism and nature of mutation, induction, isolation and characterization of mutants and mutagens. Genetic recombination in prokaryotes including transformation, transduction, conjugation, proptoplast fusion, site directed mutation, genetic engineering (recombinant DNA technology), DNA splicing, Restriction endonucleases and methylases DNA ligases, their nomenclature phage conversion (cosmids) and transfection. Recent techniques in microbial genetics. Chemical coding and expression of genetic information. Fungal genetics. Principles and applications of genetic engineering.

MCB 423: Industrial Microbiology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the scope of industrial microbiology and biotechnology;
2. identify industrial media composition, preparation and sources, commonly used microorganisms in industrial microbiology;
3. describe primary and secondary metabolites production and gene regulation;
4. identify sources and methods of strain improvements;
5. describe culture collection centers and preservation methods; and
6. explain fermentor design and operation

Course Contents
Microorganisms used in industrial microbiology. Screening for productive strains. Strain improvement. Fermentation systems. Design and use of fermenters. Micro-organisms of industrial importance. Patent and intellectual property rights. Classification of microbial products by use. Relationship between primary and secondary metabolism. Characteristics, sources and strain improvement of industrial micro-organisms. Microbial preservation of industrial organisms. Culture collections. Microbial growth and product formation in industrial processes. Media for industrial fermentations. Foaming, Major products of Industrial Microbiology. Enzyme production and immobilization. Production of vitamins, amino acids, antibiotics, organic acids, beer and wine.

MCB 424: Microbial Physiology & Metabolism (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the growth dynamics of bacterial cultures;
2. discuss the effect of physical and chemical factors affecting bacterial growth;
3. identify energy and carbon sources for autotrophic and heterotrophic bacteria;
4. describe metabolic pathways for biosynthesis of industrial microbiology;
5. elucidate anabolic and catabolic reactions,
6. explain gibbs free energy, entropy, enthalpy and their relationships; and
7. discuss energy of catabolic reactions and anabolic reactions and enzymes and activation energy.

Course Contents
Review of bacterial anatomy and cytochemistry. Dynamics of growth (batch and continuous culture). Nutrition and energy metabolism of micro-organisms. Effect of physical and chemical factors on growth; biochemistry of various microbial processes such as transport, regulation and respiration. Biosynthesis of microbial products. Bioenergetics, autotrophic (photoautotrophs and chemoautotrophs) metabolism, catabolism and anabolic reactions, activation energy and Enzyme action and control Buffer preparation and standardization. Basic separation techniques in microbiology, dialysis, salting out, gel filtration, electrophoresis etc. Assay techniques for various metabolites including microbial enzymes, acids etc.

MCB 425: Environmental Microbiology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the various definitions of environmental pollution;
2. identify types of environmental pollution;
3. discuss inorganic, organic and biological indices of pollution;
4. identify regulatory agencies involved in Pollution monitoring in Nigeria;
5. discuss the impact of urbanization on pollution;
6. explain impact assessment (Environmental Impact Assessment, Environmental Evaluation Studies, Post Impact Assessment) and Microbiological aspects of impact assessment;
7. elucidate bioaccumulation (bioconcentration, biomagnification and depuration)
8. identify methods of sewage treatment;
9. explain membrane filtration and Multiple tube fermentation methods for estimating bacterial populations in water; and
10. describe biochemical and Chemical Oxygen Demand, Waterborne diseases and transmission, Total and Faecal Coliforms.

Course Contents
Impact Assessment (IA) of microbial contamination of soil, surface water, ground water and air in relation to the deterioration of the environment. Legal frame work for impact assessment; environmental impact assessment (EIA); post impact assessment (PIA); environmental evaluation studies(EES). Environmental audits, environmental compliance monitoring reports; soil, air and water pollution. Organic, inorganic pollutants in the environment; microbiology of aquatic, terrestrial environments. Carbon trading; acute toxicity testing, bioaccumulation (bioconcentration and biomagnification). Waste disposal (physical, chemical and biological methods) and management (cradle to grave). Microbial indicators for inorganic and organic pollution in water, methods of water and sewage treatment with emphasis on specific micro-organisms involved. Techniques for estimation of microbial populations in water (Membrane filtration and multiple tube fermentation techniques). Total and faecal coliform; disease transmission by water. Biochemical and chemical oxygen demand

MCB 431: Petroleum Microbiology (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students will be able to:

1. identify petroleum biogenesis and chemical composition;
2. discuss upstream, midstream and downstream activities in the petroleum industry in Nigeria;
3. explain management of wastes from activities in the petroleum industry;
4. describe petroleum prospecting and recovery of hydrocarbon fluids; microbial oil recovery procedures; microbial influenced corrosion of surface and subsurface assets and control;
5. elucidate reservoir souring, Sulphate Reducing Bacteria and Seawater reinjection challenges; and
6. explain oil spill countermeasures, chemical surfactants and biosurfactants.

Course Contents

Definition of petroleum, types of petroleum and origin of petroleum. Geological formations (types of reservoirs). Exploration and production activities (upstream, mid-stream and downstream activities). Surface assets, subsurface assets, offshore and onshore operations. Drilling wastes, production wastes, management of these wastes. Sanitary water, hydrotest water, Produced water, formation water, Injection water, drilling fluids chemical composition, drill cuttings (top hole and bottom hole). Environmental considerations in the discharge of wastes onshore and offshore, cutting reinjection technology and thermo desorption units (TDU). Biogenesis of fossil fuels with emphasis on the role of micro-organisms. Petroleum prospecting; primary recovery. Secondary recovery and tertiary recovery. Microbial corrosion of pipes and equipment. Methanogenesis and methanotrophy. Effects of oil spill on microbial activities in aquatic and terrestrial ecosystems. Biodeterioration and biotransformation of hydrocarbons. Biodegradation of organics. Factors affecting persistence/recalcitrance of organics. Biodegradability testing, bioremediation strategies (In-situ and ex-situ techniques, biostimulation and bioaugumentation) reservoir souring, sulphate reducing bacteria, seawater reinjection challenges. Bacterial desulfurisation and denitrogenisation of crude oil, oil spill countermeasures, surfactants and biosurfactants. Emusification and demulsification.

MCB 482: Virology & Tissue Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students will be able to:

1. identify virus classification;
2. describe replication and cytopathic effects;
3. discuss isolation, cultivation, purification and assay of viruses;
4. explain culture of viruses in egg yolk, egg white, chicken embryo, monoclonal antibodies; and
5. describe maintenance of plant and animal cells *in-vivo*

Course Contents

Structure, properties and classification of viruses. Principles of isolation, cultivation and maintenance of plant and animal cells *in vivo.* Application of cell culture technique in virology; viruses as agents of diseases in animals.General characteristics of plant, animal and bacterial viruses. Viral replication, spread and cytopathic effects. Virus classification, purification and assay.

Regulation of lytic development and maintenance of the lysogenic state in bacteriophages lambda, P2 and 14 single stranded DNA and RNA phageviroids as pathogens.

MCB 491: Research Project (6 Units C: PH 270)

Learning Outcomes
Students will be able to
1. carryout independent research;
2. review relevant literature;
3. arrange data in a scientific manner;
4. make scientific presentations; and
5. identify methods of citing and acknowledging appropriate sources of literature.

Course Contents
A research project to be undertaken on any area of microbiological and/or biotechnological interest. The project should be such that students could complete it (production of final report) within a period of not more than five months.

Minimum Academic Standards

Staffing

Academic Staff
The guidelines on academic staff/student ratio of 1:20 for Science Programmes shall apply. To start any programme in Science, there should be a minimum of six academic staff. There is need to have a reasonable number of staff with PhD degrees accounting for at least 70% of the total number and having adequate teaching experience for every programme in the Discipline.

Administrative Support Staff
The services of the administrative support staff are indispensable in the proper administration of departments and faculty offices. It is important to recruit very competent, computer literate senior staff.

Technical Support Personnel
The services of technical support staff, which are indispensable in the proper running of laboratories and workshops, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.
In addition, there should be supporting office staff: secretary, typist, higher executive officer and messenger.

Library
(a)Library and information resources
Universities should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition, well stock and current hardcopies

of reference and other textual materials should be provided centrally at the level of the faculty. A well network digital library should serve the entire university community. Availability of wireless facilities (Wi-Fi) with adequate bandwidth should enhance access to these electronic resources. In any case, there should be internet ready workstations available in the library for least 25% of the total student enrolled in each academic programme. The funding of the library should be in line with NUC guidelines.
There should be a Departmental Library that can contain a minimum of 50 students and equipped with relevant books, journal articles and other relevant news articles particularly on Marine Science.

Classroom, Laboratories, Clinics, Workshops and Offices Spaces

The NUC recommends the following physical space requirements:

Description		**Size m²**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

Laboratory Resources
Adequate space should be provided for all departments in the sciences. Effort must be made to provide each department with at least:
i) Four (4) large laboratories calculated according to specifications of 7.5 m2 per FTE; a minimum of four (4) preparatory rooms for each laboratory at the NUC specifications of 7 m2 each.
ii) At least two lecture rooms capable of sitting at least sixty students at the specification of 1 m2 per FTE.
iii) A Departmental conference room.
iv) Staff common room.

Equipment

1	Computers
2	Microscopes(Simple, Compound and Dissecting)
3	Autoclaves of various capacities
4	Incubators of various sizes
5	Centrifuges of various capacities
6	Refrigerated Centrifuge
7	Ultracentrifuge
8	Weighing balance (Electronic Top-pan balance, Double-pan Analytical Balance and Analytical Balance) of various capacities
9	Desiccators
10	Water baths including Shaking water bath

11	Shakers
12	Anaerobic jars
13	Electronic Colony Counter
14	Electronic Cell Counter
15	Magnetic Stirrer
16	Sonicator
17	Quebec Colony Counter
18	Automated Bacterial Identification Systems
19	Refrigerators of various capacities
20	Deep freezers of various capacities
21	Electric ovens (Dry oven)
22	Gas cookers with ovens (Hot air ovens) with Gas cylinders
23	Laminar Flow Chamber
24	Distilled water plant
25	Ultra-water Purification System
26	Homogeniser(Blenders) of various capacities
27	Vortex Mixer
28	Hot Plate
29	Work benches
30	Fire extinguishers
31	pH meters (digital and non-digital)
32	Total Dissolved Solids (TDS), Electrical Conductivity, Salinity meters
33	Ultra-Violets Spectrophotometers
34	Infra- red spectrophotometers
35	Turbidometers
36	Polymerase Chain Reaction Thermocycler
37	Gas Chromatograph
38	High Performance Liquid Chromatography
39	Thin Layer Chromatography
40	Paper Chromatography
41	Column Chromatography
42	Electrophoresis Unit
43	Glassware (beakers, measuring Cylinders, pipettes, Petri dishes, Syringes etc.)
44	Membrane Filtration Units
45	Air Quality Meters
46	Biochemical Oxygen Demand Incubator
47	Microtox Analyser
48	Aquaria of different sizes
49	Hemocytometer

B.Sc. Petroleum Chemistry

Overview
Petroleum Chemistry is concerned mainly with the chemistry of upstream and downstream activities of the petroleum industry, as well as the downstream investment sector, which is the petrochemical industry. Upstream, midstream and downstream refer to the three major components of the industry. Whereas the Upstream refers to exploration and extraction of crude oil, midstream encompasses transportation and storage of crude oil, and downstream concerns the refining of crude oil into various end products.

Apart from petroleum and petrochemicals, the Petroleum Chemistry program adopts various multidisciplinary approaches, drawing from key areas including geochemistry, industrial chemistry, environmental chemistry, corrosion chemistry, oilfield chemistry, green chemistry, and petroleum and gas engineering. In addition, it provides opportunity to obtain a thorough fundamental knowledge of all traditional fields in Chemistry viz: Analytical, Physical, Inorganic and Organic Chemistry. The program also provides a number of optional courses or electives in areas such as stratigraphy, petroleum geology, petroleum economics, and oil and gas law among others, with hands-on, creative entrepreneurial skills.

The program is therefore skewed towards acquiring knowledge and skills as professionals in petroleum and petrochemical fields with focus on modern concepts and innovations. The graduate will have the ability to work efficiently in a multi-disciplinary environment involving chemistry. He or she would have acquired suitable skills to apply standard methodologies to proffer solutions to theoretical and practical chemistry problems in contemporary petroleum and allied industries.

Philosophy
Petroleum Chemistry Programme is meant to develop indigenous capacity in petroleum prospecting, recovery and refining as well as its processing into petrochemicals so as to reduce the over dependence on foreign expertise. This brings home the Nigeria's yearning of domesticating modern technologies for the oil and gas industry and general industrial development.

Objectives
The objectives of the programme are to:

1. instil, in students, an enthusiasm for chemistry, an appreciation of its application in different contexts and to involve them in an intellectually stimulating and satisfying experience of learning and studying;
2. establish, in students, an appreciation of the importance of the chemical sciences in an industrial, academic, economic, environmental and social context;
3. provide students with full understanding of origin and chemical nature of petroleum (and other fossil fuels) and how knowledge of chemistry can be used in transforming them into refined sources for energy, industrial raw materials, household products etc;
4. develop, in students, the ability to apply standard methodologies to the solution of problems in chemical processes;

5. provide students with knowledge and skills to enable them work efficiently in multi-disciplinary environment involving chemistry;
6. provide students with enough basic knowledge and skills to enable them further their studies in chemistry and multi-disciplinary fields involving chemistry;
7. produce graduates that are well equipped to pursue careers both in general chemical sciences and specifically in oil and gas industry as well as the public sector; and
8. provide a broad and balanced training in laboratory and research skills.

Unique Features of the Programme
Unique features of the program include:
1. Program-based entrepreneurial studies
2. Multidisciplinary approach to acquiring knowledge for petroleum and petrochemical industries
3. Robust and comprehensive curriculum
4. safety and sustainability of the environment for industrial chemical practice

Employability Skills
A graduate of petroleum chemistry is equipped with requisite skills and understanding that would successfully launch him or her into the employment market. The graduate can work in petroleum and allied industries as a Production Chemist, Product Development Chemist, Laboratory Analyst, *etc*.

21st Century Skills
Petroleum Chemistry program emphasizes the following 21st century skills:
1. Digital literacy
2. Critical thinking
3. Interrogative reasoning
4. Imaginative and creative
5. Research skills and practices
6. Flexibility, collaborative and result-oriented

Admission and Graduation Requirements

Admission Requirements
There are two different pathways by which candidates can be admitted into the programme: the Indirect-Entry and Direct Entry.

Indirect-Entry
Admission through U.M.E. shall take the student to 100 level. The candidate must have in addition a minimum of credit level pass in five subjects at not more than two sittings in Senior Secondary Certificate (SSC) or its equivalent. The required credit level passes are: English language, Mathematics, Chemistry, Physics and any relevant Science Subject. The UTME subjects are: English Language, Mathematics, Chemistry and Physics.

Direct Entry
Admission into 200 level (three-year programme) is solely by Direct Entry. The candidate must possess five credit passes in SSC, two of which must be at the Advanced level. Subjects to be passed at Advanced level chemistry and physics or mathematics.

Graduation Requirements
For a student to qualify for the award of B.Sc. degree in Petroleum Chemistry, he/she must satisfy the following requirements:

- Earned a minimum of **90** (for direct entry candidates) and **120** (for UTME candidates) credit units.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
COS 101	Introduction to Computing Sciences	3	C	30	45
CHM 101	General Chemistry I	2	C	30	-
CHM 107	General Chemistry Practical I	1	C	-	45
CHM 102	General Chemistry II	2	C	30	-
CHM 108	General Chemistry Practical II	1	C	-	45
	Total	**17**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
CHM 211	Organic Chemistry I	2	C	30	-
CHM 213	Analytical Chemistry I	2	C	30	-
CHM 201	Practical Chemistry II	1	C	-	45
PCM 201	Origin and Formation of Petroleum	2	C	30	-
PCM 203	Natural Gas I	2	C	30	-
PCM 204	Petroleum Chemistry Lab I	1	C	-	45
PCM 202	Classification and Properties of Petroleum	2	C	30	-

Course Code	Course Title	Unit(s)	Status	LH	PH
PCM 205	Petroleum Chemistry Lab II	1	C	-	45
	Total	**17**			

300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolutions	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
PCM 301	Introduction to Petroleum Exploration & Recovery	2	C	30	-
PCM 302	Introduction to Petroleum Geochemistry	2	C	30	-
PCM 303	Polymer Chemistry	2	C	30	-
PCM 304	Petroleum Chemistry Lab II	1	C	-	45
PCM 305	Petroleum Refining	2	C	30	-
PCM 306	Instrumental methods of Analysis	2	C	30	-
PCM 307	Natural Gas II	2	C	30	-
PCM 308	Petroleum Products	1	C	15	-
PCM 309	Oil Production Chemistry	2	C	30	-
CHM 319	Environmental Chemistry	2	C	30	-
ICH 305	Petroleum Chemistry	2	C	30	-
	Total	**24**			

400 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
PCM 400	Seminar	2	C	-	30
PCM 401	Research Project	6	C	-	270
PCM 402	Students' Work Experience Scheme (SIWES)	3	C	-	180
PCM 403	Introduction to Catalysis	2	C	30	-
PCM 404	Petrochemicals I	2	C	30	-
PCM 405	Petrochemicals II	2	C	30	-
PCM 406	Coal & Oil Shale Chemistry	2	C	30	-
PCM 408	Corrosion Chemistry	2	C	30	-
PCM 409	Gas Hydrates	1	C	15	-
PCM 410	Petroleum Operations and Environment	2	C	30	-
PCM 411	Entrepreneurial Skills in Petrochemistry	2	C	30	-
	Total	**26**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. identify possible sound patterns in English Language;
2. list notable Language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English Language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and Deductive Argument and Reasoning Methods, Analogy, Generalisation and Explanations). Ethical considerations, Copyright Rules and Infringements. Writing Activities: (Pre-writing , Writing, Post writing, Editing and Proofreading; Brainstorming, outlining, Paragraphing, Types of writing, Summary, Essays, Letter, Curriculum Vitae, Report writing, Note making etc. Mechanics of writing). Comprehension Strategies: (Reading and types of Reading, Comprehension Skills, 3RsQ). Information and Communication Technology in modern Language Learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of Trade, Economic and Self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building
6. analyse the role of the Judiciary in upholding people's fundamental rights
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents
Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification. Judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation; Re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption(WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic definition of set, subsets, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers, integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers, algebra of complex numbers, the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative as limit of rate of change. Techniques of differentiation. Extreme curve sketching. Integration as an inverse of differentiation. Methods of integration. Definite integrals. Application to areas, volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

CHM 101: General Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. define atom, molecules and chemical reactions;
2. discuss the Modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. illustrate shapes of simple molecules and hybridized orbitals;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and

10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents
Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence Forces. Structure of solids. Chemical equations and stoichiometry; Chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry. Rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II (2 Unit C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reactions;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. describe basic properties of Transition metals.

Course Contents
Historical survey of the development and importance of Organic Chemistry. Fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures, nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The Chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify the differences between primary and secondary standards;
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents
Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify and carry out preliminary tests which includes ignition, boiling point, melting point, test on known and unknown organic compounds;
5. perform solubility tests on known and unknown organic compounds;
6. conduct elemental tests on known and unknown compounds; and
7. conduct functional group/confirmatory test on known and unknown compounds which could be acidic / basic / neutral organic compounds.

Course Contents
Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students should be able to:

1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking,
2. state the characteristics of an entrepreneur;
3. analyze the importance of micro and small businesses in wealth creation, employment, and financial independence
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents

Concept of Entrepreneurship (Entrepreneurship, Intrapreneurship/Corporate Entrepreneurship). Theories, Rationale and relevance of Entrepreneurship (Schumpeterian and other perspectives, Risk-Taking, Necessity and opportunity-based entrepreneurship and Creative destruction). Characteristics of Entrepreneurs (Opportunity seeker, Risk taker, Natural and Nurtured, Problem solver and change agent, Innovator and creative thinker). Entrepreneurial thinking (Critical thinking, Reflective thinking, and Creative thinking). Innovation (Concept of innovation, Dimensions of innovation, Change and innovation, Knowledge and innovation). Enterprise formation, partnership and networking (Basics of Business Plan, Forms of business ownership, Business registration and Forming alliances and join ventures). Contemporary Entrepreneurship Issues (Knowledge, Skills and Technology, Intellectual property, Virtual office, Networking). Entrepreneurship in Nigeria (Biography of inspirational Entrepreneurs, Youth and women entrepreneurship, Entrepreneurship support institutions, Youth enterprise networks and Environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

PCM 201: Origin and Formation of Petroleum (2 Units C: LH 30)

Learning Outcomes

At the end of this course, students should be able:

1. describe definitions of petroleum, crude oil, bitumen, tar sand, natural gas, and coal;
2. discuss the origin of petroleum;
3. explain chronological histography of petroleum;
4. describe occurrence of petroleum;
5. elucidate evolution of sedimentary organic matter; and
6. explain future outlook of petroleum.

Course Contents

Definitions: Definitions of petroleum, crude oil, bitumen, tar sand, natural gas, and coal. **Origin:** Theories of origin of petroleum and the evidences of each; Biogenic theory. Detailed discussion of the biogenic theory of petroleum formation, stages of transformation of sedimentary organic matter and their distinguishing characteristics. **Occurrence**: World distribution of petroleum and bitumen. Major Oil producing countries and worldwide scenario with respect to demand and

supply of petroleum. Forecasting future petroleum demand and prospects. **Historical context:** Brief history of petroleum discovery, utilisation and processing in the world and Nigeria.

PCM 202: Properties and Classification of Petroleum (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the student should be able to:
1. describe physic-chemical properties of petroleum;
2. explain methods of characterizing petroleum;
3. discuss the nature and molecular composition of petroleum; and
4. enumerate various ways of classifying petroleum

Course Contents
Physico-chemical properties of petroleum: Colour, density, viscosity, metals content, sulphur content etc; Methods for characterisation of petroleum. Composition: Complexity in molecular composition of petroleum, major classes of compounds, compositional variation with source, and effect of composition on market value. Classification of petroleum: Discussion of various classification systems e.g. based on viscosity, density, correlation index, chemical composition, etc.

PCM 203: Natural Gas I: Formation and treatment (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the student should be able to:
1. explain the nature of natural gas;
2. describe formation of natural gas;
3. explain composition of natural gas and the differences;
4. enumerate global distribution of natural gas;
5. demonstrate how to compare and contrast between wet and dry gas, biogenic and thermogenic gas, associated and non-associated gas, sour and sweet gas;
6. describe natural gas treatment methods; and
7. demonstrate production of liquefied natural gas

Course Contents
Definition of terms: Natural gas, wet and dry gas, biogenic and thermogenic gas, associated and non-associated gas, sour and sweet gas. Formation, composition and world distribution; Physical and chemical properties of natural gas. Natural gas treatment processes (chemistry & technology). Acid gas treatments (physical and chemical methods). Gas dehydration. Recovery of natural gas liquids. Production of liquefied natural gas.

PCM 204: Petroleum Chemistry Lab I (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the student should be able to:
1. determine density and specific gravity of petroleum;
2. determine hydrocarbon groups in petroleum fractions by sulphuric acid treatment;
3. estimate percent aromatic hydrocarbons by Aniline Point method;
4. determine of correlation index of hydrocarbon;

5. determine wax content of crude oil; and
6. determine the viscosity of petroleum products.

Course Contents
Determination of hydrocarbon groups in petroleum fractions by sulphuric acid treatment. Determination of hydrocarbon group composition in petroleum fractions by method of Fluorescent indicator Adsorption Technique. Estimation of percent aromatic hydrocarbons by Aniline point method. Determination of Density and specific gravity of petroleum. Determination of viscosity of petroleum products by Ostwald viscometer. Determination of correlation index of hydrocarbon. Determination of wax in crude oil.

PCM 205: Petroleum Chemistry Lab II (1 Unit C: PH 45)

Leaning Outcomes
At the end of the course, the student should be able to:
1. estimate sulphur content;
2. estimate calorific value; and
3. estimate other characteristic indices of petroleum and petroleum products , such as molecular weight, density and specific gravity.

Course Contents
Estimation of sulphur content and calorific value of petroleum fraction by Bomb calorimeter. Estimation of percent C and H contents in petroleum fractions. Study of etherification reactions by using dilute HCl, dilute H_2SO_4 as catalysts. Determination of Bromine Number. Estimation of Molecular Weight. Determination of Density and specific gravity of petroleum products. Determination of Viscosity-Gravity Constant (VGC) of petroleum products. Determination of Universal Oil Product (UOP) characterization factor.

CHM 211: Organic Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe and solve problems in chemistry of aromatic compounds;
2. describe the structures of simple sugars, starch and cellulose, peptides and proteins and show the difference in their conformation structure;
3. describe and solve problems in chemistry of bifunctional compounds;
4. explain he mechanisms of substitution, elimination, addition and rearrangement reactions;
5. describe stereochemistry and its application;
6. describe condition and pathways of the following organic reactions - Grignard reaction, Aldol and related reactions; and
7. describe simple alicyclic carbon compounds and their synthesis.

Course Contents
Chemistry of aromatic compounds. Structures of simple sugars, starch and cellulose, peptides and proteins. Chemistry of bifunctional compounds. Energetics, kinetics and the investigation of reaction mechanisms. Mechanisms of substitution, elimination, addition and rearrangement reactions. Stereochemistry. Examples of various named organic reactions e.g. Grignard reaction. Aldol and related reactions. Simple alicyclic carbon compounds and their synthesis.

CHM 213: Analytical Chemistry I **(2 Units C: LH 30)**

Learning Outcomes
At the end of this course, the students should be able to:
1. explain analytical processes which include description of chemist as a problem solver;
2. describe and diffrentiate forms of error;
3. explain its implication on laboratory analysis;
4. state different statistical tool use in treatment of data;
5. solve practical problems using the statistical tools;
6. define sampling and give reasons for sampling in field work;
7. state and describe different sampling techniques;
8. state different forms of sample collection and processing;
9. describe volumetric method of analysis and solve some practical problems; and
10. describe gravimetric method of analysis and solve some practical problems.

Course Contents
Theory of errors; and statistical treatment of data: Theory of sampling. Chemical methods of analysis including volumetric, gravimetric, data analysis and presentation. and. Physicochemical methods, Optical methods of analysis; separation methods.

ENT 312: Venture Creation **(2 Units C: LH 15; PH 45)**

Learning Outcomes
At the end of this course, students, through case study and practical approaches, should be able to:
1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents
Opportunity Identification (Sources of business opportunities in Nigeria. Environmental scanning. Demand and supply gap/unmet needs/market gaps/Market Research, Unutilised resources. Social and climate conditions and Technology adoption gap). New business development (business planning, market research). Entrepreneurial Finance (Venture capital, Equity finance, Micro finance, Personal savings, Small business investment organizations and Business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, Customer Acquisition & Retention, B2B, C2C and B2C models of e-commerce, First Mover Advantage, E-commerce business models and Successful E-Commerce Companies,). Small Business Management/Family Business: Leadership & Management, Basic book keeping, Nature of family business and Family Business Growth Model. Negotiation and Business communication (Strategy and tactics of negotiation/bargaining, Traditional and modern business communication methods).

Opportunity Discovery Demonstrations (Business idea generation presentations, Business idea Contest, Brainstorming sessions, Idea pitching). Technological Solutions (The Concept of Market/Customer Solution, Customer Solution and Emerging Technologies, Business Applications of New Technologies - Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy etc. Digital Business and E-Commerce Strategies).

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents

Concepts of Peace, Conflict and Security in a multi-ethnic nation. Types and Theories of Conflicts: Ethnic, Religious, Economic, Geo-political Conflicts. Structural Conflict Theory. Realist Theory of Conflict. Frustration-Aggression Conflict Theory. Root causes of Conflict and Violence in Africa: Indigene and settlers Phenomenon; Boundaries/boarder disputes; Political disputes; Ethnic disputes and rivalries; Economic Inequalities; Social disputes; Nationalist Movements and Agitations. Selected Conflict Case Studies – Tiv-Junkun; Zango Kartaf, Chieftaincy and Land disputes etc. Peace Building, Management of Conflicts and Security: Peace & Human Development. Approaches to Peace & Conflict Management --- (Religious, Government, Community Leaders etc.). Elements of Peace Studies and Conflict Resolution: Conflict dynamics assessment Scales. Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice; The Nigeria Legal System. Insurgency and Terrorism. Peace Mediation and Peace Keeping. Peace & Security Council (International, National and Local levels) Agents of Conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of International Organizations in Conflict Resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping. Media and Traditional Institutions in Peace Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis

PCM 301: Fundamentals of Petroleum Exploration and Recovery
(2 Units C: 30)

Learning Outcomes
At the end of this course, students should be able to:
1. define source rock, seal, trap, and reservoir;
2. explain concept of hydrocarbon migration;
3. demonstrate activities of the upstream petroleum sector, such as well appraisal, development and production processes;
4. describe drilling operations;
5. explain the significance and use of chemicals needed for production; and
6. discuss the challenges and techniques for recovery and extraction of bitumen

Course Contents
Basic definitions: source rock, seal, trap, and reservoir. The value chain: exploration, well appraisal and development. Production, reserves addition and reserves growth, field abandonment and reactivation. Exploration: techniques used in exploration e.g. gravity, seismic, magnetic, borehole logging etc.; Drilling operations; Recovery methods: primary and secondary recovery and recovery enhancement; Offshore production; Introduction to oil field treatment; Challenges and techniques for recovery and extraction of bitumen

PCM 302: Fundamentals of Petroleum Geochemistry (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the student should be able:
1. explain definitions of petroleum, source rock, carrier bed, reservoir, caprock, etc;
2. describe basic concept of petroleum geochemistry;
3. elucidate the importance of petroleum geochemistry in petroleum exploration;
4. demonstrate geochemical evaluation of source rocks,
5. explain genetic potentials and different methods of classification;
6. identify oil/oil and oil/source rock correlations;
7. enumerate migration of petroleum
8. describe biomarker chemistry and crude oil characterization;
9. describe extent of biodegradation and thermal alteration;
10. explain Rock-Eval pyrolysis; and
11. discuss oil/oil and oil/source rock correlations.

Course Contents
Definitions: petroleum, source rock, carrier bed, reservoir, caprock, etc. Importance of petroleum geochemistry in petroleum exploration and recovery. Source rocks: characterisation and classification: different methods of classifying source rocks e.g. optical methods, Rock-Eval pyrolysis etc. Potential source rock, active source rock etc. Estimation of petroleum potential of source rock. Migration of petroleum: primary and secondary migrations and factors affecting the migration. Use of biomarkers for crude oil characterization. Determination of source rock facies from biomarkers. Maturity derived from biomarkers. Extent of biodegradation and thermal alteration. Correlations based on bulk parameters, oil/oil and oil/source rock correlations.

PCM 303: Polymer Chemistry (3 Units C: LH 45)

Learning Outcomes

At the end of this course, the student should be able to:

1. list sources of raw materials for the polymer industry;
2. discuss concepts of polymer synthesis;
3. explain polymer additive;
4. describe polymer reactions;
5. list mechanical properties of polymers;
6. describe vulcanisation and stabilization processes of polymers;
7. illustrate analysis and testing of polymers; and
8. explain end-use properties and applications of commercial polymers.

Course Contents

Introduction to Macromolecules. Polymer Nomenclature. Sources of raw materials for the polymer industries. **Polymer Synthesis**:-Addition polymerisation, condensation polymerization, copolymerization. Polymerisation techniques-bulk, solution, precipitation, emulsion, suspension and gas phase. **Polymer additives**. Thermodynamics of Polymer Solutions. Fibre forming polymers and biopolymers. **Polymer reactions:-**Thermal oxidative and Photo-oxidative degradations. Crosslinking reactions. mechanical degradation. Vulcanisation and stabilization processes of polymers. Mechanical properties of polymers. Analysis and testing of polymers. Rubber elasticity. Introduction to physical and mechanical properties of polymers. End-use properties and applications of commercial polymers.

PCM 304: Petroleum Chemistry Lab II (1 Unit C: PH 45)

Learning Outcomes

At the end of this course, the student should be able to:

1. explain basic standard procedures and equipment.
2. determine correlation index, density, specific gravity and API gravity;
3. determine fire point, aniline point & diesel index, ash content and other indices used for evaluating crude oil and petroleum products;
4. determine water content;
5. determine total acid number (TAN);
6. determine total base number (TBN); and
7. determine sulfur content.

Course Contents

Determination of Correlation Index, Density, Specific Gravity and API Gravity and Volatility, Distillation Curve. Determination of Pour Point & Cloud point, Flash Point: Open cup and Close cup, Fire Point, Aniline Point & diesel index. Determination of Ash Content, Heat of Combustion, Salt Content, Viscosity, Viscosity Index and Viscosity-Gravity Constant (V.G.C), n.d.M (n: Refractive index, d: Density, M: Freezing point), Water content, Total acid number (TAN), Total base number (TBN), Sulfur content. [At least ten practicals per semester].

PCM 305: Petroleum Refining (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the student should be able to
1. discuss crude oil pre-treatment processes such as desalting and dehydration;
2. explain the main problems of salty crude oil;
3. describe the chemistry and technology of separation processes;
4. discuss the chemistry and technology of conversion processes;
5. elucidate catalytic reforming, catalytic cracking, and hydrotreating processes.

Course Contents
Crude oil pre-treatments: Crude oil impurities (water, salt and solids); Dehydration. Variables affecting crude oil dehydration; Desalting. Main problems of salty crude oil, Oil desalting principles, Electrostatic theory; Separation processes: Atmospheric distillation, vacuum distillation, azeotrophic and extractive distillation. Conversion processes: Thermal conversion processes (Coking Processes, Delayed Coking, Fluid Coking, Vis-breaking) and catalytic conversion processes (catalytic reforming, catalytic cracking, hydrotreating Process). Emphasis should be given to feeds, process conditions, product distribution and chemistry and technology of each process.

PCM 306: Instrumental Method of Analysis (2 Units C: LH 30)

Learning Outcomes
The student should, at the end of the course, be able to:
1. explain basic theory and principles of instrumental methods of analysis;
2. Applications of basic instruments such as UV/Visible Spectrometry, IR Spectrometry. Flame Emission and Atomic Absorption Spectrometry, etc.

Course Contents
Theory, principles and applications of; UV/Visible Spectrometry, IR Spectrometry. Flame Emission and Atomic Absorption Spectrometry. Flourescence and Phosphorescence spectrometry, Nuclear Magnetic resonance and Electron spin resonance. Introduction to Electro Analytical Techniques. X-ray and radiochemical methods of analysis. Other instrumental methods: Refractometry and, Polarimetry, Polarography, Calorimetry.

PCM 307: Natural Gas II: Applications and Conversion Technologies (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain current technologies for utilization of natural gas;
2. convert natural gas into petrochemicals;
3. demonstrate the extraction and conversion of C_{2+} hydrocarbons to olefins; and
4. explain the process of producing ammonia from natural gas via synthesis gas

Course Contents
Direct applications of natural gas as fuel. Current technologies for more efficient utilisation of natural gas as fuel. Natural as source of raw materials (C_{2+} hydrocarbons) for petrochemical industry. Extraction of C_{2+} hydrocarbons and their conversion to olefins for petrochemicals. Chemistry and technology of conversion of natural gas (C_1) into petrochemicals via synthesis gas. Ammonia from natural gas via synthesis gas.

PCM 308: Petroleum Products (1 Unit C: LH 15)

Learning Outcomes
The student at the end of the course should be able to:
1. identify end use products of petroleum refinery process;
2. discuss the importance of physico-chemical properties and applications of petroleum products;
3. describe various additives used in petroleum products and their importance; and
4. explain petroleum product specifications and significance, and therefore be conversant with adulterated products through property specification(s)

Course Contents
Production and uses of various petroleum products (e.g. Liquefied Petroleum Gas, Natural Gas, Refinery Gas, Naphtha, Gasoline, Aviation Fuel, Kerosene, Diesel fuel, Lubricants etc); Importance of physico-chemical properties of the products to their applications; Various additives used in petroleum products and their importance.

PCM 309: Oil production Chemistry (2 Units C: LH 30)

Leaning Outcomes
At the end of the course, the student should be able to:
1. discuss the basic theory and principles of oil field emulsions;
2. explain the chemistry, principles and use of oil field chemicals;
3. describe different additives and treatment chemicals such as defoamers, scale inhibitors, H_2S scavengers, etc;
4. explain the environmental perspectives of oilfield chemicals;
5. identify toxicity limits and guidelines; and
6. discuss Probit analysis and risk assessment indices such as LC_{50}, ET_{50}, sub-lethal effects, etc

Course Contents
Emulsion: Basics of oil field emulsions. Theory, Stabilization and Destabilization. Physical chemistry of emulsions. Impact of organic acids and asphaltenes on crude oil emulsion. De-emulsifier requirements and selections. Stoke's Law Settling theory or gravity separation. **Foaming**: Foams. Defoamers. Foam basics. Field application of foams. How defoamers work. **Scaling:** Compounds that cause scaling. Predication of scaling tendency. Scale inhibitors. Solvents to dissolve scales. **Waxes:** Causes of paraffin (wax) problems. Paraffin treatment chemicals. Asphaltene stability tests, Asphaltene treatment chemicals. Chemicals used as H_2S scavengers. Application of scavengers. Oil carryover in water. Removal of oil and oily solids. Tests required for chemicals used in deep water. $LC._{50}$, $ET_{50,}$ etc General oil field chemicals. Green chemicals (Environmentally friendly chemicals). International guidelines.

CHM 319: Environmental Chemistry (2 Units C: LH 30)

Learning Outcomes

At the end of this course, the students should be able to:

1. explain the elementary circle of the following element oxygen, nitrogen, sulphur;
2. describe the stratification of the earth atmosphere and state characteristics of each strata;
3. state and describe different sources of environmental pollution;
4. state and describe different types of environmental pollution and their effect on the environment;
5. describe water and state qualities that define the uses of water;
6. describe and explain different sources of water contamination and its impact on agricultural land crops etc;
7. state and describe different methods use in treatment of waste water – chemical, biological and physical methods;
8. state and justify chemical and physical instrumentation in environmental chemistry;
9. describe environmental impact assessment; and
10. state and describe twelve principles of green chemistry and its practical applications.

Course Contents

Concepts of elementary cycles. Characteristics of the atmosphere. Sources, types and effects of environmental pollution. Wastewater treatment. Composition of domestic/industrial wastes and waste management. Water chemistry and analysis. Chemical and physical instrumentation in environmental sciences. Introduction to Environmental Impact Assessment. Twelve principles of green chemistry.

ICH 305: Petroleum Chemistry (2 Units C: LH 30)

Learning Outcomes

After completing the course, the students will be able to:

1. describe an overview of the chemical composition and physical properties of petroleum, petroleum products and renewable motor fuels;
2. specify quality criteria for petroleum products and renewable motor fuels;
3. present the chemistry of the most important refinery processes;
4. discuss an overview of the resource base for petroleum and renewable alternatives;
5. find information and perform individual evaluations of questions pertaining to production and use of petroleum from different sources and renewable motor fuels;
6. use geophysical and geological knowledge to interpret and map data for identification of potential prospects;
7. contribute to development of geo-based technology for exploration and improved recovery of petroleum resources;
8. explain the theory of hydraulics applied to fuels in pump-pipeline systems;
9. explain the fundamentals of electricity with emphases on electrical safety in petroleum; and
10. list lubrication and wear with importance attached to physical and chemical properties of lubricants.

Course Contents
Petroleum in the contemporary energy scene. Nature, classification and composition of crude petroleum and natural gases. Natural product chemical markers of petroleum and geological sediments. Distribution of petroleum and natural gas resources (the global and Nigerian situations). Petroleum technology, survey of refinery products and process. Petrochemicals in industrial raw materials. Prospects for the petrochemical industry in Nigeria. Aviation fuels; present and future Formulation of Lubricants. Theory of Hydraulics, as applied to fuels in pump-pipeline systems. Fundamentals of electricity with emphases on electrical safety in petroleum
Lubrication and wear, with importance attached to the physical and chemical properties of lubricants.

400 Level

PCM 403: Introduction to Catalysis (2 Units C: LH 30)

Learning Outcomes
At the end of the course, student should be able to:
1. explain the concept of catalysis;
2. describe types of catalysis;
3. describe the properties of catalysts;
4. discuss the role of catalysis in the chemical industry;
5. list examples of industrial applications of catalysts;
6. elucidate the process of catalytic cracking with zeolites;
7. explain catalytic reforming; and
8. discuss Fischer-Tropsch process, Harber process and Contact process

Course Contents
Definition of terms. The concept of catalysis. Mechanism of catalysis. Role of catalysis in the chemical industry. Types of catalysis. Properties of catalysts. Methods for characterisation of catalysts. Factors that determine industrial use of catalysts. Catalyst deactivation; catalyst recycling and management; examples of industrial applications of catalysts: Wacker process, catalytic cracking with zeolites. Catalytic reforming, Fischer-Tropsch process. Harber process, Contact process. Ziegler-type catalysts in polymerisation.

PCM 404: Petrochemicals I (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the student should be able to:
1. discuss downstream technology and investment options;
2. identify primary feedstock for the petrochemical industry;
3. identify secondary products of the petrochemical industry;
4. explain chemicals and polymers from ethylene and propylene; and
5. identify the environmental perspectives of petrochemicals

Course Contents
Introduction to petrochemicals and petrochemical industries. Primary feedstock for the petrochemical industry. Primary and secondary products of the petrochemical industry. Chemistry & technology of production of lower alkenes (ethylene and propylene) from petroleum fractions.

Chemistry & technology of production of chemicals and polymers from (a) ethylene, and (b) propylene. Environmental impact of petrochemicals.

PCM 411: Entrepreneurial Skills in Petrochemistry (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. develop innovative spirit and motivation to push forward ideas;
2. demonstrate start-up visions;
3. develop necessary entrepreneurial mind-set;
4. demonstrate experience on how to develop business ideas independently;
5. demonstrate and deploy product/services by way of advertising to potential investors and marketing.

Course Contents
This course will involve application of the fundamentals of Entrepreneurship, which will include planning, design, production, finishing, and marketing of the potential products/services. Each student or group of students is expected to initiate a project of his or her choice under supervision. Alternatively, the students can choose a project from the following pool of projects, *viz*:
-Production of Grease
-Production Vaseline jelly
-Production of Dyes
-Production of Hydrotol (An Antiseptic Disinfectant) and other Disinfectants
-Production of Starch
-Production of Dispersant
-Production of liquid Soaps
-Production of Detergents
-Production of Paints
-Production of Glue and Adhesives
-Production of pesticides

PCM 405: Petrochemicals II (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the basic chemical reactions of hydrocarbons: oxidation, halogenations, sulphonation and nitration;
2. explain polymers from C_4-C_5 and BTX streams; and
3. discuss potential non-petroleum sources of petrochemicals.

Course Contents
The prospects of petrochemical industry in Nigeria; Basic reactions of hydrocarbons: oxidation, halogenations, sulphonation and nitration; Chemistry & technology of production of C_4-C_5 and BTX streams from petroleum fractions; Chemistry & technology of production of chemicals and polymers from (a) C_4-C_5 streams, and (b) BTX stream; Potential non-petroleum sources of petrochemicals.

PCM 406: Coal & Oil Shale Chemistry (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the formation of coal and oil shales;
2. discuss coal and oil shale deposits in Nigeria;
3. describe how to mine oil shale;
4. describe the processing techniques for coal and shale oil;
5. demonstrate use of coal as source of petrochemicals/raw materials; and
6. explain the environmental implications of coal utilisation.

Course Contents
Formation, occurrence and potentials of coal and oil shale. Classifications of coal and shale. Coal and oil shale mining techniques. Coal and oil shale processing techniques. Coal as fuel. Efficient combustion techniques. Coal as source of cleaner fuels. Coal as source of petrochemicals/raw materials. Fischer-Tropsch process; coal utilisation and the environment

PCM 408: Corrosion Chemistry (2 Units C: LH 30)

Learning Outcomes
At the end of the course, the student should be able to:
1. explain the chemistry of corrosion;
2. list examples of corrosion inhibitors;
3. discuss corrosion in offshore production;
4. describe sources of corrosion in transportation, storage and refining operations; and
5. articulate corrosion control and management procedures.

Course Contents
Definitions and Economic implications of corrosion. Corrosion principles: electrochemical aspects. Corrosion mechanism. Basic corrosion cells, Polarization, Passivity. Theories of Corrosion. Factors affecting corrosion. Uniform attack, Galvanic corrosion, Pitting corrosion, Erosion corrosion, and Stress corrosion; Corrosion in chemical industries: corrosion in petroleum production, corrosion in transport and storage. Corrosion in refining operations, Corrosion in offshore production. Corrosion testing techniques. Corrosion control and management.

PCM 409: Gas hydrates (1 Unit C: LH 15)

Learning Outcomes
At the end of this course the student should be able to:
1. explain the chemistry of gas hydrates;
2. describe the occurrence of gas hydrates;
3. elucidate the significance of gas hydrates as future energy source; and
4. discuss potential extraction techniques.

Course Contents
Definitions, occurrence and distribution, importance as future energy source, conditions for formation and stability; Potential extraction techniques.

PCM 410: Petroleum Operations and Environment (2 Units C: LH 30)

Learning Outcomes

At the end of the course, the student should be able to:

1. discuss the environmental impacts of oil prospecting, drilling and production;
2. describe causes oil spillage and cite typical examples of incidents;
3. discuss the environmental effects and control of gas flaring;
4. explain environmental impact assessment (EIA); and
5. identify remediation protocols.

Course Contents

Environmental impacts of oil prospecting, drilling and production. Effects of oil spillage on water and land environments. Processes of treating oil spillage (chemical, biochemical and microbiological). Gas flaring. Effects and control of gas flaring. Methods of controlling the environmental impacts of oil and gas industry. Nigerian experiences on environmental effects of oil and gas operations. Current affairs.

Minimum Academic Standards

Equipment

1. Gas Chromatograph
2. Gas Chromatograph-Mass Spectrometer
3. Atomic Absorption Spectrophotometer
4. Infra-red Spectrometer
5. UV/Visible Spectrometer
6. NMR Spectrometer
7. Refractometer
8. Colorimeter
9. Calorimeter
10. Pulverizer
11. Ultrasonicator
12. Flame Photometer
13. Rotary Evaporator
14. Electric oven
15. Incubator
16. Centrifuge
17. Elemental Analizer
18. Soxhlet Extractor
19. pH Meter
20. Hydrometer
21. Flash Point Tester
22. Fume Cupboard
23. Water Bath

24. Refrigerator
25. Overhead Projector
26. Muffle Furnace
27. Homogenizer
28. Glass Viscometer

Staffing

Academic Staff
The guidelines on academic staff/student ratio of 1:20 for Science Programmes shall apply. There should be a minimum of six academic staff. There is need to have a reasonable number of staff with PhD degrees in Petroleum Chemistry and allied areas, accounting for at least 70% of the total number and having adequate teaching experience for every programme in the Discipline.

Administrative Support Staff
The services of the administrative support staff are indispensable in the proper administration of the Department. It is important to recruit very competent, computer literate senior staff.

Technical Support Personnel
The services of technical support staff, which are indispensable in the proper running of laboratories are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

Classrooms, Laboratories, Workshops and Office Space
The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

The following should be provided (with given space specification)

i) Four (4) large laboratories calculated according to specifications of 7.5 m^2 per FTE; a minimum of four (4) preparatory rooms for each laboratory at the NUC specifications of 7 m^2 each.
ii) At least two lecture rooms capable of sitting at least sixty students at the specification of 1 m^2 per FTE.
iii) A Departmental conference room.
iv) A staff common room.

Library

The Programme should a rich databases and other electronic/digital library and information resources. In addition, well stock and current hardcopies of reference and other textual materials should be provided centrally at the level of the faculty.

In any case, there should be internet ready workstations available in the library for least 25% of the total student enrolled in each academic programme.

The librarian should preferably hold a degree in any of the Chemical Sciences and an additional library certification, such as MLS.. Should also be a member of Nigerian Library association (NLA)

B.Sc. Physics with Electronics

Overview

The programme is intended to equip the students with broad knowledge of Physics and electronics to address the challenges of the 21st century. The classroom instruction includes lectures and laboratory research. Students industrial work experience scheme (SIWES) is included in the syllabus to provide students with necessary skills for employment and entrepreneurship. The first and second year comprise of introductory courses in physics, mathematics, computer science and general studies. Foundation courses in physics that underpin an understanding of electronics and basic electronics courses are provided at the third and fourth year with entrepreneurship courses that will equip the graduates of the programme with relevant skills for job creation and innovations in the areas of applied physics and electronics

Philosophy

The curriculum of physics with electronics is meant to broaden the electronics engineering base of students who may wish to study pure electronics with physics without the Electrical Engineering aspects and also prepares them for higher degrees in Physics and Electronics Engineering. The programme is designed to give the students theoretical and practical skills in the areas of applied physics and electronics such as medical radiology, magnetic resonance imaging, analogue electronics systems, digital electronics systems, etc.

Objectives

The objectives of the programme are to:

1. involve the students in intellectually stimulating and satisfying experience of learning and studying;
2. prepare the students for advanced Physics and professional fields of Electronics Engineering;
3. prepare students with skills for self-reliance and entrepreneurship;
4. prepare the students for postgraduate studies in either Physics or Electronics Engineering; and
5. prepare the students for research and innovation advancement in Physics and Electronics Engineering.

Unique Features

1. The programme is unique in the way in which it is designed to provide the students with broader knowledge of physics and electronics so that they can utilize modern discoveries in physics for innovations in electronics.
2. The programme is also unique in the way in which applied physics and digital electronics system courses are included in the curriculum to prepare the students for global challenges.

Employability Skills
The programme is designed to provide the students with employability skills in the following areas:

1. IT Skills
2. Time management
3. Creativity
4. Resourcefulness
5. Communication
6. Organization

21st Century Skills
The 21st century skills of the programme are
1. Communication
2. Creativity
3. Collaboration
4. Critical Thinking
5. Innovation
6. Technology literacy
7. Flexibility

Admission and Graduation Requirements

Admission Requirements
The entry requirements shall be at least passes at credit level at Senior Secondary Certificate (SSC) in five subjects at not more than two sittings. Such subjects include English Language, Mathematics, Physics and Chemistry. In addition, an acceptable pass in the Unified Tertiary Matriculation Examination (UTME) is required for admission into 100 Level.
Candidates with at least two A level passes in Physics and Mathematics at the Advanced Level may be considered for admission into 200 Level.

Graduation Requirements
Expected duration for UTME candidates shall be 4 years and students are required to pass a minimum of 120 units, while for direct entry students, expected duration for graduation shall be 3 years and would be expected to pass a minimum of 90 units which must include all compulsory courses.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
COS 101	Introduction to Computing Sciences	3	C	30	45

PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 103	General Physics III	2	C	30	
PHY 104	General Physics IV	2	C	30	-
PHY 107	General Physics Practical I	1	C	-	45
PHY 108	General Physics Practical II	1	C	-	45
	Total	**21**			

200 Level

Course Code	**Course Title**	**Units**	**Status**	**LH**	**PH**
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
PHY 205	Thermal Physics	3	C	45	-
PHY 206	General Physics VII (Energy & Environment)	2	C	30	-
PHY 211	Workshop Practice	2	C	15	45
PHY 213	Classical Physics I	2	C	30	
	Total	**13**			

300 Level

Course Code	**Course Title**	**Unit(s)**	**Status**	**LH**	**PH**
GST 312	Peace and Conflict Resolution	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
PHY 301	Analytical Mechanics I	2	C	30	-
PHY 303	Electromagnetism	3	C	45	-
PHY 305	Quantum Physics	3	C	45	-
PHY 306	Statistical and Thermal Physics	2	C	30	-
PHY 312	Analogue Electronics	2	C	30	-
PHY 315	Electronics	2	C	30	-
PHY 316	Circuit Theory	2	C	30	-
PHY 317	Experimental physics V	1	C	-	45
PHY 325	Measurement and Instrumentation	2	C	30	-
PHY 399	Industrial Attachment	3	C		
	Total	**26**			

400 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
PHY 401	Quantum Mechanics I	3	C	45	-
PHY 403	Mathematical Methods in Physics I	3	C	45	-
PHY 404	Mathematical Methods in Physics II	3	C	45	-
PHY 413	Digital Systems	2	C	30	-
PHY415	Digital Communication Systems	2	C	30	
PHY417	Advanced Electronics Lab	1	C	-	45
PHY422	Digital Electronics	2	C	30	-
PHY423	Entrepreneurship in Physics Electronics	2	C	30	
PHY499	Project	6	C	-	270
	Total	**24**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to
1. identify possible sound patterns in English Language;
2. list notable Language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English Language(vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and critical thinking and reasoning methods (logic and syllogism, inductive and deductive argument and reasoning methods, analogy, generalisation and explanations). Ethical considerations, Copyright rules and infringements. Writing activities: (pre-writing, writing, post writing, editing and proofreading; brainstorming, outlining, paragraphing. Types of writing: summary, essays, letter, curriculum vitae, report writing, note making etc. Mechanics of writing). Comprehension strategies: (reading and types of reading, comprehension skills, 3RsQ). Information and Communication Technology in modern language learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of Trade, Economic and Self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building
6. analyse the role of the Judiciary in upholding people's fundamental rights
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; Nationalist movements and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian civil war). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justice and national development (law definition and classification. Judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation; Re-orientation strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption(WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes
At the end of the course students should be able to:
1. explain basic definition of set, subset, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;.
3. solve trigonometric functions;
4. identify various types of numbers; and
5. solve some problems using Binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers; integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers; algebra of complex numbers; the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course students should be able to:
1. identify the types of rules in differentiation and Integration;
2. describe the meaning of Function of a real variable, graphs, limits and continuity; and
3. Solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative as limit of rate of change. Techniques of differentiation. Extreme curve sketching; Integration as an inverse of differentiation. Methods of integration, Definite integrals. Application to areas, volumes.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes

Upon the completion of course, the student should be able to:

1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents

space and time. units and dimension. vectors and scalars. differentiation of vectors: displacement, velocity and acceleration. Kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). relative motion. Application of Newtonian mechanics. equations of motion. conservation principles in physics, conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass. Rotational motion. torque, vector product, moment, rotation of coordinate axes and angular momentum, polar coordinates. conservation of angular momentum; Circular motion. Moments of inertia, gyroscopes and precession. gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General Physics II (Electricity & Magnetism) (2 Units C: LH 30)

Learning Outcomes

On completion, the students should be able to:

1. describe the electric field and potential, and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;
5. describe electromagnetic induction and related concepts, and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters; and
8. determine the characteristics of ac voltages and currents in resistors, capacitors, and inductors.

Course Contents

Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and

resistance. Ohm's law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

PHY 103: General Physics III (Behaviour of Matter) (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. explain the concepts of heat and temperature and relate the temperature scales;
2. define, derive, and apply the fundamental thermodynamic relations to thermal systems;
3. describe and explain the first and second laws of thermodynamics, and the concept of entropy;
4. state the assumptions of the kinetic theory and apply techniques of describing macroscopic behaviour;
5. deduce the formalism of thermodynamics and apply it to simple systems in thermal equilibrium; and
6. describe and determine the effect of forces and deformation of materials and surfaces.

Course Contents

Heat and temperature (temperature scales). Gas laws. General gas equation. Thermal conductivity. First Law of thermodynamics (heat, work and internal energy, reversibility). Thermodynamic processes (adiabatic, isothermal, isobaric). Second law of thermodynamics (heat engines and entropy). Zero's law of thermodynamics. Kinetic theory of gases. Molecular collisions and mean free path. Elasticity (Hooke's law, Young's, shear and bulk moduli). Hydrostatics (Pressure, buoyancy, Archimedes' principles). Bernoulli's equation and incompressible fluid flow. Surface tension (adhesion, cohesion, viscosity, capillarity, drops and bubbles).

PHY 104: General Physics IV (Vibration Waves and Optics)
(2 Units C: LH 30)

Learning Outcomes

On completion, the students should be able to;

1. describe and quantitatively analyse the behaviour of vibrating systems and wave energy;
2. explain the propagation and properties of waves in sound and light;
3. identify and apply the wave equations; and
4. explain geometrical optics and principles of optical instruments.

Course Contents

Simple harmonic motion (SHM): energy in a vibrating system, Damped SHM, Q values and power response curves, Forced SHM, resonance and transients, Coupled SHM. Normal modes. Waves: types and properties of waves as applied to sound; Transverse and Longitudinal waves; Superposition, interference, diffraction, dispersion, polarization; Waves at interfaces; Energy and power of waves, the 1-D wave equation, 2-D and 3-D wave equations, wave energy and power, phase and group velocities, echo, beats, the Doppler effect, Propagation of sound in gases, solids and liquids and their properties.

Optics: nature and propagation of light; reflection, refraction, and internal reflection, dispersion, scattering of light, reflection and refraction at plane and spherical surfaces, thin lenses and optical instruments; wave nature of light; Huygens's principle, interference and diffraction.

PHY 107: General Practical Physics I (1Unit C: PH 45)

Learning Outcomes
On completion, the students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasizes quantitative measurements, the treatment of measurement errors, and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc., covered in PHY 101, 102, 103 and PHY 104. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

PHY 108: General Practical Physics II (1Unit C: PH 45)

Learning Outcomes
On completion, the students should be able to;
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data; and
6. prepare and present practical reports.

Course Contents
This practical course is a continuation of PHY 107 and is intended to be taught during the second semester of the 100 level to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements, the treatment of measurement errors, and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;

3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity
2. seeking, new value creation, and risk taking;
3. state the characteristics of an entrepreneur;
4. analyse the importance of micro and small businesses in wealth creation, employment,
5. and financial independence;
6. engage in entrepreneurial thinking;
7. identify key elements in innovation;
8. describe stages in enterprise formation, partnership and networking including business planning;
9. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
10. state the basic principles of e-commerce.

Course Contents
Concept of entrepreneurship (entrepreneurship, intrapreneurship/corporate entrepreneurship,). Theories, rationale and relevance of entrepreneurship (Schumpeterian and other perspectives, risk-taking, necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of entrepreneurs (opportunity seeker, risk taker, natural and nurtured, problem solver and change agent, innovator and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking, and creative thinking). Innovation (concept of innovation, dimensions of innovation, change and innovation, knowledge and innovation). Enterprise formation, partnership and networking (basics of business plan, forms of business ownership, business registration and forming alliances and joint ventures). Contemporary entrepreneurship issues (knowledge, skills and technology, intellectual property, virtual office, networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, youth and women

entrepreneurship, entrepreneurship support institutions, youth enterprise networks and environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

PHY 205: Thermal Physics (3 Units C: LH 45)

Learning Outcomes
On completion, the students should be able to:
1. discuss the concept of heat and temperature;
2. explain and determine thermodynamic processes;
3. explain and evaluate properties of real and ideal gases;
4. evaluate the consequences of the thermodynamic laws;
5. describe the basis of the kinetic theory; and
6. describe the statistical behaviour of gases with applications.

Course Contents
The foundations of classical thermodynamics including the definition of temperature. The first law. Work, heat and internal energy. The second law. Carnot cycles and Carnot engines. Zeroth law. Entropy and irreversibility. Thermodynamic potentials and the Maxwell relations. Ideal gas equation. Internal energy and internal molecular modes. Qualitative discussion of phase transitions. Gibbs free energy. Clausius-Clapeyron equation. Examples of phase transitions. Van der Waals gas. Kinetic theory. Mean free path. Equi-partition of energy. Heat transfer. Diffusion rate.

PHY 206: General Physics VI (Energy and Environment) (2 Unit C: LH 30)

Learning Outcomes
On completion, the students should be able to:
1. explain the origin and sources of energy and power;
2. describe the inter relation and transformation of energy sources and types;
3. illustrate and explain the principles of generation of power;
4. outline the concept of energy demand and supply;
5. explain the economics, politics and problems associated with energy demand and supply;
6. identify and assess categories of environmental pollutants;
7. describe effect of carbon emission on global warming;
8. describe the environmental effect of energy generation, supply, and consumption; and
9. identify and evaluate the merits and demerits of power generation from different sources.

Course Contents
Energy sources and climate impacts. Energy requirements and consumption. Energy processing and conversion. Energy units and pricing. The greenhouse effect. Biological forms of energy (fossil fuels and biofuels). Basic nuclear physics. The atom, radioactivity and decay laws. Interaction of radiation with matter. Nuclear fission principles and energetics. Chain reaction and dynamics. Reactor types and control. Current status of nuclear fission as a power source. Nuclear fusion principles and energetics. (Examples in stars and on earth). Thermonuclear fusion. Nuclear fuels. Ignition and the Lawson criterion. Magnetic and inertial confinement. Current status of nuclear fusion as a power source. Stellar fusion. Proton-proton chain and CNO cycle. Solar power

technologies. Solar thermal. Solar photovoltaic. Wind energy. Nature of wind. Wind power and wind turbines. Betz criterion. Energy from waves and tides. Principles of water waves, energy, and power. Wave power extraction. Origin and properties of tides. Tidal stream power and tidal range power. Power from fluids. Hydro power. Energy transportation and storage. Thermal pollution. Energy costs, capacity, reserves, and efficiency. Emerging environmental effects of energy processing.

PHY 211: Workshop Practice (2 Units C: LH 15; PH 45)

Learning Outcomes

On completion, the students should be able to:

1. identify safety signs for various workshop types and abide by the underlining regulations while working in the workshop;
2. handle workshop tools and machineries;
3. illustrate simple metal processing methods;
4. describe the criteria for selection of construction materials;
5. identify electrical and electronic devices and explain some instrumentation techniques for measuring parameters; and
6. explain types and methods of wood and plastic processing.

Course Contents

Workshop layout and safety. Basic hand tools and bench work practices. Measurement and gauging. Sheet metal operations. Casting. Cutting, drilling, turning, and milling. Metal joining devices and adhesives in common use. Soldering techniques and wrap joints. Plain and cylindrical generation of smooth surface using power operated machines. Criteria for selection of materials used for construction (metallic and non-metallic). Instrumentation and measuring techniques. Multi-meters and oscilloscopes. Extension of instrument range. A survey of the use of electronic circuit devices (e.g., diodes, transistors including FET, integrated circuits). Photocells. Basic circuit development and analysis. Wood logging. Wood types and processing. Plastic types and working. Plastic moulding, bending, and encapsulation.

PHY 213: Classical Physics I (2 Units C: LH 30)

Learning Outcomes

On Completion, the students should be able to;

1. relate the concepts of space coordinates, time and linear motion;
2. describe particle dynamics, equilibrium and conservative forces;
3. solve problems on central forces, energy and angular momentum,
4. explain the dynamics of rotational motion;
5. discuss and apply the potential theory;
6. explain the dynamics of rigid bodies;
7. apply Newton's theory of gravitation to problems of planetary motion and space travel;
8. use inertial forces to explain motion from the viewpoint of rotating frames of reference; and
9. derive the general relation between the angular velocity and angular momentum of a rigid body, and use this to solve problems in rotational dynamics.

Course Contents
Introduction to classical mechanics. Space and time. Linear kinematics. Linear and angular momentum. Force and torque. Motion in a plane. Newtonian gravity. The two-body systems. Forces and equilibrium. Particle dynamics. Force fields and potentials. Collisions. Conservative forces. Inertial frames and non-inertial frames. Motion in rotating frames. Centrifugal force. Central force motions. Kepler's motion in a central force field. Particle orbits as conic sections. Kepler's laws. Rigid body motion and rotational dynamics. Moment of inertia. Free rotation and stability. Gyroscopes.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents
Concepts of peace, conflict and security in a multi-ethnic nation. Types and theories of conflicts: ethnic, religious, economic, geo-political conflicts; structural conflict theory, realist theory of conflict, frustration-aggression conflict theory. Root causes of conflict and violence in Africa: indigene and settlers phenomenon; Boundaries/boarder disputes; Political disputes; Ethnic disputes and rivalries; Economic inequalities; Social disputes; Nationalist movements and agitations; Selected conflict case studies – Tiv-Junkun; Zango Kataf, chieftaincy and land disputes etc. Peace building, management of conflicts and security: peace & human development. Approaches to peace & conflict management --- (religious, government, community leaders etc.). Elements of peace studies and conflict resolution: conflict dynamics assessment scales: constructive & destructive. Justice and legal framework: concepts of social justice; the Nigeria legal system. Insurgency and terrorism. Peace mediation and peace keeping. Peace & security council (international, national and local levels) Agents of conflict resolution – conventions, treaties community policing: evolution and imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of International Organizations in Conflict Resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in peace keeping. Media and traditional institutions in peace building. Managing post-conflict situations/crisis: refugees. Internally Displaced Persons, IDPs. The role of NGOs in post-conflict situations/crisis

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students, through case study and practical approaches, should be able to:

1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity identification (sources of business opportunities in Nigeria, environmental scanning, demand and supply gap/unmet needs/market gaps/market research, unutilised resources, social and climate conditions and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (venture capital, equity finance, micro finance, personal savings, small business investment organizations and business plan competition). Entrepreneurial marketing and e-commerce (principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first mover advantage, E-commerce business models and successful E-Commerce companies,). Small business management/family business: leadership & management, basic book keeping, nature of family business and family business growth model. Negotiation and business communication (strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological solutions (the concept of market/customer solution, customer solution and emerging technologies, business applications of new technologies - Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy etc. Digital Business and E-Commerce strategies).

PHY 301: Analytical Mechanics I (2 Units C: LH 30)

Learning Outcomes

On completion, the students should be able to:

1. explain particle motion in one, two, and three dimensions;
2. describe the two body problem and many body systems;
3. define and solve problems of conservative forces;
4. explain Newton theory of gravitation;
5. describe the nature of generalised motion;
6. explain the theory of relativity;
7. identify an appropriate set of generalised coordinates to describe a dynamical system and obtain its Lagrangian in terms of those coordinates and the associated 'velocities'; and

8. derive and solve the corresponding equations of motion. Treat small oscillations as an eigenvalue problem.

Course Contents
Review of Newtonian Mechanics. Motion of a particle in one, two and three dimensions. Internal forces. External forces. Forces of constraint. Systems of particles and collision theory. Newtonian gravitation; conservative forces and potentials, oscillations, central force problems; accelerated frames of reference. Rigid body dynamics. Rotational problems and space coordinates. Mechanics of continuous media. Galilean relativity. Relativistic kinematics and dynamics. Applications of relativistic kinematics.

PHY 303: Electromagnetism (3 Units C: LH 45)

Learning Outcomes
On completion, the students should be able to;
1. derive Maxwell's equation set from the empirical laws of electromagnetism;
2. identify the fundamental laws of electromagnetism to solve simple problems of electrostatics, magnetostatics and electromagnetic induction in a vacuum;
3. modify Maxwell's laws to apply in the presence of materials and solve problems involving them;
4. derive the electromagnetic boundary conditions which apply at the interface between two simple media, and to use them to solve problems involving two or more materials;
5. explain the properties of plane electromagnetic waves in a vacuum and in simple media and to be able to derive these properties from Maxwell's equations; and
6. apply the special theory of relativity to problems in electromagnetism.

Course Contents
Review of Vector calculus. Electrostatics and Magnetostatics. Magnetization and magnetic susceptibility. Laplace's equation and boundary value problems. Multipole expansions. EM waves in dielectric and magnetic materials. Polarization of EM waves. Electromagnetic induction. Faraday's and Lenz's laws. A.C. Circuits. Maxwell's equations. Lorentz covariance and special relativity. Gauss theorem in dielectrics. Poisson's equations. Uniqueness theorem. Magnetic properties. Motors. Generators. Poynting vectors.

PHY 305: Quantum Physics (3 Units C: LH 45)

Learning Outcomes
On completion, the students should be able to:
1. explain the origin of quantum physics and principles of quantum theory;
2. apply the mathematical tools of quantum physics;
3. explain how quantum states are described by wave functions;
4. apply operators and solve eigenvalue problems in quantum mechanics;
5. solve the Schrodinger equation and describe the properties of the simple harmonic oscillator;
6. use the algebra of angular momentum operators and solve the simple eigenvalue problems of an angular momentum in quantum mechanics;
7. apply quantum mechanics to describe the hydrogen atom;
8. employ quantum mechanics to describe the properties of one-electron atoms; and

9. use quantum mechanics to describe the simple multi-electron systems such as helium atom and hydrogen molecule.

Course Contents

Wave-particle duality and the uncertainty principle. Basic principles of the quantum theory. Time dependent Schrodinger equation. Energy levels and potential wells. Reflection and transmission of potential barriers. Operators and quantum states. Commutation relations and compatibility of different observables. Orbital angular momentum. Particle in two dimensions. Familiar wave phenomena and their associated wave equations. Physical interpretation of the wave function as a probability amplitude. Energy levels and stationary states. Energy bands in periodic lattice. Solution of Schrodinger equation for a central potential in three dimensions. The hydrogen atom. Multi-electron atoms. The harmonic oscillator. Exchange symmetry.

PHY 306: Statistical and Thermal Physics I (2 Units C: LH 30)

Learning Outcomes

On completion, the students should be able to;

1. describe an ideal gas on the basis of classical statistics;
2. explain the basic concepts of statistical mechanics, including entropy, its statistical interpretation and relation to disorder, and the statistical origin of the second law of thermodynamics;
3. illustrate the canonical and grand-canonical partition functions for systems in thermal equilibrium, and use them to obtain thermodynamic quantities of interest;
4. describe the implications of the indistinguishability of particles for systems of non-interacting quantum particles;
5. deduce the Bose-Einstein and Fermi-Dirac distribution functions, and apply them to calculate the properties of Bose and Fermi gases, for example in the context of White Dwarf stars and black-body radiation;
6. explain the physical origin of Bose-Einstein condensation, to characterise it quantitatively, and to explain the experiments confirming Bose-Einstein condensation.

Course Contents

Basic theory of thermodynamics. Basic of probability theory. Microstates and macrostates. The concept of ensembles. Statistical interpretation of entropy and temperature. Isolated systems and the microcanonical ensemble. Statistical physics of non-isolated systems. Derivation of the Boltzmann distribution and canonical ensemble. The partition function in thermodynamics. Non-interacting systems. Equipartition theorem. Density of states. Grand canonical ensemble. Fermi-Dirac and Bose-Einstein distributions. The ideal Fermi gas. Fermi energy. Heat capacity. The ideal Bose gas. Black body radiation. Bose-Einstein condensation.

PHY312: Analogue Electronic Circuits (2 Units C: LH 30)

Learning Outcomes

At the end of the course students will be able to:

1. explain single stage transistor amplifiers and operational amplifier circuits;
2. analyse and design multistage amplifiers;
3. design and analyse broadband and narrow band amplifiers circuits;
4. design and analyse RC and LC crystal oscillators circuits; and
5. develop skills to build and troubleshoot analogue electronic systems.

Course Contents
Review of single stage transistor amplifiers and operational amplifier circuits. Analysis and design of multistage amplifiers. Feedback, broadband and narrow band amplifiers, power amplifiers, voltage and current stabilizing circuits. Sinusoldal RC and LC crystal oscillators, other communication circuits.

PHY315: Electronics (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. describe behaviours of semiconductors and their significance in the development of modern electronics;
2. explain the operation of semiconductor devices and their advantages over their vacuum tube counter parts; and
3. demonstrate the significance of modulation in telecommunication.

Course Contents
Thermionic emission, vacuum tubes: diodes and transistors; semiconductors; p-n junction; characteristics of p-n junction; uses of diodes; bipolar junction and unipolar transistors, transistor biasing, transistor switch. Equivalent circuits of semi-conductors, diodes, transistors. Small and large signal operations. Wave from generation by transistors. Class A, B. and C amplifiers. Feedback amplifiers and control systems. Multi-vibrators. Transmission lines. Basic communication theory and its practical significance.

PHY317: Basic Experimental Physics V (1 Units C: LH 15)

Learning Outcomes
At the end of the course, students will be able to:
1. design experiments in the courses taught in the first semester 300 level;
2. acquire data in order to explore physical principles in the courses taught in the first semester 300 level and effectively communicate results; and
3. critically evaluate related scientific studies.

Course Contents
A 3 hour/week laboratory course covering basic experiments illustrative of the 2nd semester, 300 Level Physics Electronics syllabus.

PHY316: Circuit Theory (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. identify proper network reduction techniques, circuital laws and theorems for magnetic/electric circuit solution considering economic, performance, efficiency and availability constraints;
2. estimate parameters for different types of attenuators and filters used in signal modulation for power systems and communication systems;

3. analyse circuits and systems by their standard parameters to identify their characteristics in general form, applicable for generation, transmission and distribution considering economical, ethical and practical limitation;
4. develop various methodology/strategies through various domain of analysis to evaluate performance characteristics of electrical networks and analyse their operation under different operating conditions for various electrical /electromagnetic systems; and
5. apply computer mathematical and simulation programmes to various real life multidisciplinary topics through circuit solution.

Course Contents

Laplace and Fourier transformations, application of Laplace transformation to transient analysis of RLC circuits, transfer function concept, reliability of transfer functions, Foster and Cauer's methods of synthesis 2-port network synthesis, active filters. Analysis of continuous and discrete signals and systems, families. Concepts of small, medium, large and very large scale integration and their consequences. Some digital building blocks; flip-flops, counters, register, and decoders. Introduction to D/A and A/D conversion principles. Approximation to non-linear characteristics, analysis and synthesis of non-linear resistive circuits, harmonic analysis of non-linear dynamical circuits, transient states in non-linear circuits, applications of computers in the analysis of linear and non-linear circuits.

PHY325 Measurement and Instrumentation (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students will be able to:

1. describe mathematically and physically the design in measuring instruments and their use for measurements;
2. design and analyse different types of measuring instruments; and
3. design a variety of electronic instruments and measuring systems used in different fields.

Course Contents

General instrumentation, Basic meter DC measurement. Basic meter in AC measurement, rectifier voltmeter, electrodynamometer and wattmeter, instrument transformers, DC and AC bridges and their applications, general form of AC bridge, universal impedance bridge, electronic instruments for the measurement of voltage, current, resistance and other circuit parameter, electronic voltmeters, AC voltmeters using rectifiers, electronic voltmeter, digital voltmeters, oscilloscope, vertical deflection system, horizontal deflection system, sampling CRO, instrument for generating and analysing waveforms, square wave and pulse generator, signal generators, function generators, wave analyzers, electronic counters and their applications, time base circuitry, universal counter measurement modes, analogue and digital data acquisition systems, tape recorders.

PHY 399: Industrial Attachment (3 Units C: 12 weeks)

Learning Outcomes
On completion, the students should be able to:
1. develop practical skills of the theories learned in the classroom;
2. acquire working experience of the industries;
3. handle relevant tools and equipment in the industries; and
4. write technical reports on their industrial work and present seminar.

Course Contents
Students should be attached to some relevant organisations for additional 12 weeks at the 300 Level for the four (4) year program preferably during the long vacation, and for 24 weeks at the 400 Level for the five (5) year B.Tech. programme during the second semester and the long....

PHY 401: Quantum Mechanics I (3 Units C: LH 45)

Learning Outcomes
On completion, the students should be able to:
1. state the postulates of quantum mechanics
2. explain the basics of vectors and tensor operators;
3. solve a variety of physical problems using the Schrodinger equation;
4. work with angular momentum operators and their eigenvalues both qualitatively and quantitatively;
5. explain electron spin and the Pauli principle; and
6. apply perturbation theory and other methods to find approximate solutions to problems in quantum mechanics, including the fine-structure of energy levels of hydrogen.

Course Contents
The formulation of quantum mechanics in terms of state vectors and linear operators. Time evolution of the Schrodinger equation. The theory of angular momentum and spin. Electron spin and the Stern-Gerlach experiment. Identical particles and the Pauli exclusion principle. Multi-electron atoms. Approximation methods. Variational methods and WKB approximation for bound states and tunnelling. Time - independent perturbation theory. The fine structure of hydrogen. Harmonic oscillator. Creation and annihilation operators. External fields. Zeeman and Stark effects in hydrogen.

PHY 403: Mathematical Methods for Physics I (3 Units C: LH 45)

Learning Outcomes
On completion, the students should be able to;
1. explain the concepts of scalar and vector fields;
2. describe the properties of div, grad and curl and be able to calculate the divergence and
3. curl of vector fields in various coordinate systems;
4. calculate surface and volume integrals in various coordinate systems;
5. calculate flux integrals and relate them to the divergence and the divergence theorem;
6. calculate line integrals and relate them to the curl and to Stokes' theorem;
7. apply the methods of vector calculus to physical problems; and

8. calculate the Fourier series associated with simple functions and apply them to selected physical problems.

Course Contents
Vector and scalar fields. Vector operators. Div, grad, and curl. Divergence theorem. Stoke's theorem. Linear Algebra and functional Analysis. Transformations in linear vector spaces and matrix theory. Hilbert space and complete sets of orthogonal functions. Special functions of mathematical physics (The gamma function; hypergeometric functions; Legendre functions; Bessel functions. Hermite and Laguerre functions. The Dirac - Delta function. Integral transforms and fourier series. Fourier series and fourier transforms. The Dirichlet conditions. orthogonality of functions. Fourier coefficients. Complex representation of fourier series. Laplace transform. Applications of transform methods to the solution of elementary differential equations of interest in physics and engineering.

PHY 404: Mathematical Methods for Physics II (3 Units C: LH 45)

Learning Outcomes
On completion, the students should be able to:
1. describe the properties of different types of functions and be able to sketch them in both 2D Cartesian and polar coordinates;
2. integrate and differentiate functions of one variable using a range of techniques and be able to apply integration and differentiation to a range of physical problems;
3. show how smooth functions can be expressed in terms of power series;
4. explain the properties of complex numbers and construct some basic complex functions;
5. employ matrix notation, carry out matrix algebra and use matrices to solve systems of linear equations;
6. compute the properties of determinants, be able to evaluate them, and use them to test for unique solutions of linear equations; and
7. solve first and second order ordinary differential equations using a range of techniques.

Course Contents
Partial differential equations. Solution of boundary value problems of partial differential equations by various methods which include separation of variables, the method of integral transforms. Sturm-Liouville theory; uniqueness of solutions. Calculus of residues and applications to evaluation of integrals and summation of series. Applications to various physical situations, which may include, electromagnetic theory, quantum theory, diffusion phenomena; complex variable theory and their relation to selected physical problems. Complex differentiation and integration. Cauchy's theorem. Taylor's and Laurent's series. Ordinary differential equations of first and second order and their physical applications. Homogeneous partial differential equations.

PHY413: Digital Systems (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. demonstrate a thorough understanding of digital electronics;
2. examine and illustrate the structure of various number systems and its application in digital design;
3. analyse and design various combinational and sequential circuits; and

4. identify basic requirements for a design application and propose a cost effective solution.

Course Contents
Introduction to analysis and design of digital systems. Boolean algebra and mapping methods; Karnaugh and variable-entered maps, combinational logic realization with gates, multiplexers, read only memories (ROMs) and programmable logic arrays (PLAs). State machine analysis and design: state diagrams, state flip-flops, input and output forming logic, gate assignments, redundant states sequential counters, and mainly synchronous systems, state machine, realization with multiplexers, ROMs and PLAs. Asynchronous systems, approach to digital system design; top-down design, trial-and-error methods. Codes, number systems, and arithmetic operations, introduction to computer structures: register transfers, hardware programming methods. Von Neumann machines, and memory systems.

PHY415: Digital Communication Systems (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the principles of digital communication systems;
2. demonstrate in-depth knowledge of various digital modulation schemes; and
3. explain the advantages of digital communication over its analogue counterpart

Course Contents
Block diagram of digital communication system, sampling theorem, Shanon theorem and applications in digital communication system. Advantages of digital signals. Noise in digital signals. Filtering and equalisation. Digital modulation techniques: FSK, ASK, QPSK, M-PSK, QAM, etc. Error detection and correction techniques. Encoders and decoders. Applications of digital communication system: satellite communication, telephoning, microwave, wireless communication, optical communication, broadband communication, internet technology.

PHY417: Advanced Electronics Lab (1 Units: C PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. design and implement experiments on advanced analogue circuits;
2. design and implement experiments on digital electronic circuits; and
3. design and implement experiments on microprocessors.

Course Contents
A 6-hour/week laboratory course on selected advanced experiments in analogue and digital electronics circuits taught.

PHY 422: Digital Electronics (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. explain positive and negative logic states, TTL, MOS, CMOS integrated circuit;
2. illustrate the working of flip-flips; and

3. develop skills to build and troubleshoot digital electronics circuits.

Course Contents
Review of elementary concepts. Switching properties of electronic devices. Switching and wave-shaping circuits. Generation of non-sinusoidal waveform: astable, monostable and bistable multivibrators, comparator, Schmitt trigger and time-base generators using discrete transistor, operational amplifier or other integrated circuits. Timer chips and their applications. Analysis and design of logic gates of various families (diode logic, RTL, TTL, ECL, MOS, and CMOS) of digital integrated circuits, interfacing between various logic numerical differentiation and integrations: initial and boundary value problems. Euler's method, Taylor series method, Runge-Kutta, predictors corrector methods, multi-step methods. Systems of equations and higher order equations. Finite difference calculus: difference equations.

PHY423: Entrepreneurship in Physics Electronics (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. apply electrical exploration method;
2. demonstrate and apply principles of borehole drilling;
3. operate X-ray machines for medical diagnosis;
4. describe operations and maintenance of MRI machines;
5. design and analyse analogue and digital electronics systems; and
6. apply techniques of troubleshooting in analogue and digital electronics systems.

Course Contents
Electrical resistivity exploration method, principles of borehole geophysics, methods of medical X-ray radiography, techniques of magnetic resonance imaging (MRI), design and analysis of analogue electronics systems, design and analysis of digital electronics systems, methods of troubleshooting in analogue and digital systems, methods of troubleshooting in digital computers.

PHY499: Research Project (6 Units C: PH 270)

The course enables the student to carry out a specific research project under the supervision of any experienced staff member. Many kinds of problems are acceptable – the only restriction is that the problem shall be a piece of work (experimental or theoretical) which will take about 15% of the student's time during the session and which is judged to be of adequate standard and non-trivial. A departmental committee chaired by the head of department will conduct an oral examination on the project. The mark will be awarded both on the basis of this report and on his performance at the oral examination.

Minimum Academic Standards

Equipment

i) Electrical and Electronics

S/No	Equipment
1.	Functional fire extinguisher
2.	Well-equipped first aid box
3.	Resistance boxes
4.	Meter Bridges
5.	Potentiometers
6.	KOH Electrolytes
7.	Frank Hertz power supply
8.	Power supply 4.5 VDC 0.3A
9.	Universal plug boards
10.	Hofmann Volt meters
11.	Photocells
12.	Electric field meters
13.	Magnetic compasses (38mm)
14.	Magnetic compasses (18mm)
15.	Gamma detectors
16.	Solar batteries (2u d = 80mm)
17.	Thermopiles
18.	Electrodes (zinc rod)
19.	Multimeters
20.	Charge mass ratio equipment
21.	Leyden Jah
22.	Galvonometers
23.	Resistors
24.	Electronics kit
25.	Connection box (06030.20)
26.	Ultrasonic pickups
27.	Electroscope (rectangular case)
28.	Gold leaf electroscopes
29.	Friction ebonite rods
30.	Polythene rods
31.	Flint glasses
32.	Insulating glasses
33.	Discharger electrostatics
34.	Vacbipolar junction transistorsuum tube diodes
35.	Nylon rod
36.	Nylon lacing cord
37.	Teslameter with 2 probes
38.	Potentiometer 100Q
39.	Transistors,
40.	Diodes
41.	Operational amplifiers

S/No	Equipment
42.	Analog ICs
43.	Soldering irons
44.	Oscilloscopes
45.	Capacitors
46.	Inductors
47.	Solar cells
48.	Logic gates
49.	Programmable logic gates
50.	Microprocessors
51.	Registers
52.	ROMs
53.	RAMs
54.	Connection wires
55.	Amete3A Ac, D_c
56.	Voltmeter moving coil 0-10_v
57.	Voltmeter 2 Cale 10 - 5_V, 0 - 15_v
58.	Ammeter moving coil 0-2 5A
59.	Shunt 0-10A D_c
60.	Shunt 0 -10 M_A
61.	Rheostats 33 Ω(3.1A)
62.	Bread boards
63.	Antenna test bench
64.	Horn antenna
65.	Gunn diode power supply
66.	Induction coils 150 TURNS, D25mm
67.	Induction coils 300 TURNS, D25mm
68.	Induction coils 300 TURNS, D33mm
69.	Induction coils 100 TURNS,D40mm
70.	Digital oscilloscopes
71.	GM TUBEs
72.	GM TUBE holder & lead
73.	Electro mag. induction apparatus
74.	Demonstration induction coils
75.	Coil tapped 140 turns
76.	Oscilloscopes
77.	Function generators
78.	Transformer stand & core
79.	U-cores
80.	Transmission lines
81.	Signal generators
82.	Breadboards
83.	Stripboards

S/No	Equipment
84.	Platinum electrodes
85.	Vacuum tubes

ii) Optics, Acoustics and Special Experiments Laboratory

S/No	Equipment
1.	GM TUBEs
2.	GM TUBE holder & lead
3.	Spectrometer intermediate
4.	Screen metal 300x300mm
5.	Screen translucent 250x250mm
6.	Organ pipe - Open C
7.	Turning forks box
8.	Sonometer wood board
9.	Turning forks C- motor scale
10.	Optical bench model A
11.	Resonance tube apparatus
12.	Turning for'ks2000h2
13.	Turning forks mounted with harmer
14.	Sonometer wood board x EL-340L
15.	Sonometer wire
16.	Turning forks 1700 H_2
17.	Turning forks 1000 H_2
18.	Stricking harmmer rubber
19.	Turning forks C Masor scarce
20.	Experiment lamps 5
21.	Ware machine
22.	Stroboscope hand
23.	Narrow beam tube
24.	Ripple tank assembly
25.	Power supply for CS 150w
26.	Power supply for spectral lamps
27.	Stroboscope motor driven
28.	Power supply for ripple tank
29.	Lamp transformer GV AC
30.	Control transformer
31.	Spectrum tube necon
32.	Quiet holder 85x100mm
33.	Optical bench 500mm zesis
34.	Diaphram holder
35.	Fresnel mirror
36.	Steel rail, pentagon section
37.	Optical shutter
38.	Holder for mirror wooden
39.	Lens holder wood v-shape

S/No	Equipment
40.	Lens holder universal
41.	Object holder 50x50mm
42.	Lens holder 08012.00
43.	Newtons rings apparatus j
44.	Slit objectable 08049.00
45.	Slide mounted for zesis bench
46.	Slide mounted lateral adjust
47.	Slide mounted exten. for zesis bench
48.	Slide mount lateral adj. 08082.00
49.	Slide mount for zesis 60/30mm
50.	Slide mount for zesis 60/46mm
51.	Slide mount forpPentagon section
52.	Experiment lamps 308143.00
53.	Holder for steel rails
54.	Swinging arm 08256.00
55.	Socket wrench for slide mount
56.	Mercury discharge lamp 24-OV
57.	Na lamp 220 - 200V AC
58.	Laser He - Ne 1.0mm, 220V AC
59.	Experiment lamp 08141.00
60.	Hydrogen discharge tube
61.	Argon tube
62.	Spectrum tube neon
63.	Spectral lamp zinc (2N)
64.	Spectral lamp Ha
65.	Spectral Lamp He
66.	Spectral Lamp Cd
67.	Spectral Lamp Na, Pico
68.	Spectral Lamp Ne,
69.	Connecting hinge for zesis
70.	Double slits kit
71.	Lamp holder 08119.00
72.	Shank screw for zesis
73.	Extension tube 08131.02
74.	Plate holder 02063.00
75.	Interference filter, Set of 3
76.	Lycopodium powder
77.	Student microscope 150mrn scales
78.	Camera shutter with Iris diaphiapen scope
79.	Critical angle apparatus
80.	Telescope model telestrial
81.	Astronomical telescope

S/No	Equipment
82.	White screen XEL760C
83.	Kundes tube, apparatus
84.	Light meter, exposume meter
85.	Table top on stand
86.	Concave, convex and plane mirrors
87.	Hollow glass L 60°, 60°, 60°
88.	Prism table with prism
89.	Glass prison L90°. 45°. 45°. 32 x SOmm
90.	Rect. glass block, 114x63x19mm
91.	Prison 60° L = 30mm Crown
92.	Prison 60° L = 30mm Flint
94.	Lens mounted F = + 50mm
95.	Lens mounted F = - 50mm
96.	Lens mounted F = 200mm
97.	Prisimtable with holder
98.	Iris diaphram
99.	Double condenser F = 60mm
100	Functional fire extinguisher
101	Well-equipped first aid box

iii) General Physics Laboratory

S/No	Equipment
1.	Spherometer
2.	Overhead projector
3.	Spirit level
4.	Weighted glass bulb
5.	Aquarium pump
6.	Heating apparatus (for high vapour pressure)
7.	HIGH PRASAHRA (vapour unit)
8.	Weighing Bridge (130x50x50 mm)
9.	Watch glass (30 mm)
10.	Watch glass (100 mm)
11.	Youngs modulus
12.	Aquarium pump (220V AC)
13.	Gas syringe
14.	Precision manometer
15.	Glass beakers (1000 ml)
16.	Glass beaker
17.	Glass beakers (600 m!)
18.	Glass beakers
19.	Flask, flat bottom (050 ml)

S/No	Equipment
20.	Glass beakers (400 ml)
21.	Glass beaker (100 ml)
22.	Cork borers (4-10 mm bores)
23.	Cork borers (4-18 mm bores)
24.	Charle's law app.
25.	Leslie cube
26.	Air thermometer (fonstenr volume)
27.	Air thermometer (constant valuma)
28.	Funnel (plain soda lime glass 70 mm)
29.	Fly weel (200 mm)
30.	Bench vice
31.	Graduated cylinder
32.	Glass beads (6 mm)
33.	Conductivity app. (EDSER)
34.	Trolley (two trays)
35.	Thermometer (5-500C
36.	Bunsen burner
37.	Thermometer
38.	Thermometer (Max/Min. Six's Pattern)
39.	Hygrometer (regnault single
40.	Specific gravity bottle
41.	Bearing brass head
42.	Bearing brass head
43.	Laboratory jack
44.	Calorimeter (Joule Aluminum, LV)
45.	Calorimeter (continuous flow)
46.	Ice calorimeter
47.	Slotted rack
48.	Hydrometer 1-00-1-50
49.	Spring balance phywe
50.	Wash bottle plastic
51.	Micrometer screw gauge
52.	Scale pan (Plastic)
53.	Univ. bending machine
54.	Spring balance mech. 0-500g
55.	Spring balance flat 0 – lOOOg
56.	Gas syringe holder
57.	Metal cubes
58.	Spring balance 200 x 3g
59.	Electronic balance
60.	Geometric equivolume
61.	Vernier caliper gauge (17cm x 6)(18
62.	Water distillers
63.	Barometer fortin

S/No	Equipment
64.	Connecting tube (heat condi copper)
65.	Torsion apparatus
66.	Gas law apparatus
67.	Vernier caliper 0 -12 cm
68.	Spring balance 0 - 200g
69.	Spring balance 0 – 100g
70.	Crystallizing dish 190 mm
71.	Pipette as kci. S ml
72.	Mercury tray wooden
73.	Mat
74.	Three limb tube (U -tube & Hares app.)
75.	Glass tube
76.	Torque
77.	Scale pam light alloy
78.	Pollygon of Forcds??? App.
79.	U –tube
80.	Fylctal cylinder (Set of 6)
81.	Iron cylinder
82.	Metal cylinder (Set of 3)
83.	Pendulum bob
84.	Meter rules
85.	Half meter rules
86	Functional fire extinguisher
87	Well-equipped first aid box

iv) Workshop

S/No	Equipment
1.	Basic hand tools
2.	Workbench
3.	Hand machines
4.	Drilling machine
5.	Lathe machine
6.	Vises
7.	Functional fire extinguisher
8.	Well-equipped first aid box
9.	Welding equipment

Staffing

Academic Staff

The guidelines on academic staff/student ratio of 1:20 for Science Programmes shall apply. To start any programme in Science, there should be a minimum of six academic staff. There is need to have a reasonable number of staff with PhD degrees accounting for at least 70% of the total number and having adequate teaching experience for every programme in the Discipline.

Administrative Support Staff

The services of the administrative support staff are indispensable in the proper administration of the Department. It is important to recruit very competent, computer literate senior staff.

Technical Support Personnel

The services of technical support staff, which are indispensable in the proper running of laboratories are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

Classrooms, Laboratories, Workshops and Office Space

The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

The Head of Department office has a toilet attached to it. The department should be provided with at least:

1. Four (4) large laboratories calculated according to specifications of 7.5 m2 per FTE; a minimum of four (4) preparatory rooms for each laboratory at the NUC specifications of 7 m2 each.
2. At least two lecture rooms capable of sitting at least sixty students at the specification of 1 m^2 per FTE.
3. A departmental conference room.
4. A staff common room.

Library

Universities should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition, well stock and current hardcopies of reference and other textual materials should be provided centrally at the level of the faculty. A well network digital library should serve the entire university community. Availability of wireless facilities (Wifi) with adequate bandwidth should enhance access to these electronic resources.

In any case, there should be internet-ready workstations available in the library for at least 25% of the total student enrolled in each academic programme. The funding of the library should be in line with NUC guidelines.

B.Sc. Physics

Overview

The B.Sc. Physics degree program is design to provide basic foundation of Physics in the first and second year through courses covering classical physics, electricity and magnetism, waves and optics, dynamics, thermodynamics, modern physics, computer literacy, and special theory of relativity, as well as underlining mathematical concepts that underpin a better understanding of the courses. The scope of energy and environment as well as weather and space science had been widened in line with the global concern on sustainable development. A new course on workshop practice had been introduced to provide the students with a flavour of engineering design and electronic instrumentation.

The third-year courses of the program build on the basic foundations and cover the transition between classical and quantum physics including electromagnetic waves, electromagnetism, statistical physics, and the student industrial work experience scheme design to compliment the theory learned in the classroom and practical applications and experience of the industries. The diverse topics covered as taught courses will be complimented during each year by laboratory practical's that enable the students understand and appreciate the principles, theorems, and laws in physics.

The fourth-year courses of the program are designed to provide further mathematical knowledge that buttress the applications of quantum mechanics, nuclear physics, and of special mathematical functions in physics. A range of diverse modern courses have been introduced to enable the students choose from various fields of specialization in physics as well as to carry out a scientific research project.

Philosophy

The philosophy of the programme is to provide supportive learning environment for the training of students in both theoretical knowledge and experimental skills in physics, ready and capable for further academic pursuit, research, or work in all relevant fields for human development.

Objectives

The objectives of the programme are to;

1. provide students with a broad and balanced foundation of physics knowledge and practical skills;
2. instil in students a sense of enthusiasm for physics, and appreciation of its applications in different contexts;
3. instil in students a culture of creativity and critical thinking that will enable them to seek solutions to problems;
4. involve the students in intellectually stimulating and satisfying experience in knowledge pursuit;
5. develop in students the ability to apply their knowledge and skills in Physics to the solution of theoretical and practical problems;
6. develop in students through an education in Physics a range of transferable skills of value in physics and other areas; and
7. provide students with a knowledge and skills base for further studies in Physics or multi-disciplinary areas involving physics.

Unique Features of the Programme

The blend of courses in this revised curriculum are meant to provide:

1. topics that cover modern areas of research and developments in physics in tune with best practices of globally top rated universities;
2. course structures that are also designed in such a way to prepare the students towards multidisciplinary advanced studies.;
3. a course on workshop practices which is intended to expose the students to instrumentation and engineering design that will enable them produce simple instruments for either training and or research; and
4. a course on entrepreneurship for physicist which is also intended to provide the students with the required skills for innovation and job creation.

Employability Skills

The range of courses to be covered in the program are intended to prepare and equip the student's with the necessary and relevant theoretical knowledge and practical skills that are required of a physicist in;

1. Foresight
2. Resourcefulness
3. Planning
4. Organization
5. Time management
6. Design and execution of local and global challenges with solutions that are multidimensional and with professionalism.

21st Century Skills

1. Creativity
2. Communication and IT
3. Design and Construction
4. Planning and Experimentation
5. Innovation and Entrepreneurship

Admission and Graduation Requirements

Admission Requirements

Candidates can be admitted into the programme through either the indirect-entry mode or direct entry (DE).

Indirect -entry mode

The entry requirements shall be at least credit level passes in five subjects including English language, mathematics, physics and chemistry to form the core subjects with credit in one other relevant science subject at the senior secondary certificate (SSC) or its equivalent. In addition, an acceptable pass in the unified tertiary matriculation examination (UTME) is required for admission into 100-level

Direct entry (DE)

Candidates with two passes (graded A-E) at the advanced level in physics and one of two relevant subjects (chemistry, and mathematics) may be admitted into 200-level.

Graduation Requirements

Candidates admitted into the 100 level of the 4-year program are required to pass a minimum of 120 prescribed credits (comprising of the faculty courses MTH 101, 102, and COS 101 and all core courses) to be eligible for graduation while candidates admitted into the 100 level of the 5-year program are required to pass a minimum of 150 prescribed credits. Direct entry candidates admitted into 200 level of the 4-year program are required to pass a minimum of 90 prescribed credits to be eligible for graduation. Candidates admitted into 200 level of the 5-year program are required to pass a minimum of 120 credits before graduation.

Global Course Structure

A: Four (4) Year B.Sc. Physics program

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian People and Culture	2	C	30	-
COS 101	Introduction to Computer Science	3	C	30	45
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 103	General Physics III	2	C	30	-
PHY 104	General Physics IV	2	C	30	-
PHY 107	General Physics Practical I	1	C	-	45
PHY 108	General Physics Practical II	1	C	-	45
	Total	**21**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
PHY 201	General Physics V (Modern Physics)	2	C	30	-
PHY 202	Introduction to Electric Circuits & Electronics	2	C	30	-
PHY 204	General Physics VI (Waves and Optics)	2	C	30	-
PHY 205	Thermal Physics	2	C	30	-
PHY 206	General Physics VII (Energy & Environment)	2	C	30	-
PHY 207	General Physics Practical	1	C	-	45
PHY 208	General Physics Practical	1	C	-	45

Course Code	Course Title	Unit(s)	Status	LH	PH
PHY 211	Workshop Practice	2	C	15	45
	Total	**18**			

300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolutions	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
PHY 301	Analytical Mechanics I	2	C	30	-
PHY 303	Electromagnetism	3	C	45	-
PHY 304	Electromagnetic Waves and Optics	3	C	45	-
PHY 305	Quantum Physics	3	C	45	-
PHY 306	Statistical and Thermal Physics	2	C	30	-
PHY 307	General Physics Practical V	1	C	-	45
PHY 308	General Physics Practical VI	1	C	-	45
PHY 318	Semiconductor Devices	3	C	45	-
PHY 399	Industrial Attachment II (12 Weeks)	3	C		
	Total	**25**			

400 Level

Course Code	Course Title	Units	Status	LH	PH
PHY 401	Quantum Mechanics I	3	C	45	-
PHY 402	Quantum Physics II	3	C	45	-
PHY 403	Mathematical Methods in Physics I	3	C	45	-
PHY 404	Mathematical Methods in Physics II	3	C	45	-
PHY 405	Physics Entrepreneurship	2	C	30	-
PHY 455	Research Project	6	C	-	270
	Total	**20**			

B: Five (5) Year B.Sc./B.Tech. Physics Program

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian People and Culture	2	C	30	-
COS 101	Introduction to Computer Science	3	C	30	45
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 103	General Physics III	2	C	30	
PHY 104	General Physics IV	2	C	30	-
PHY 107	General Physics Practical I	1	C	-	45
PHY 108	General Physics Practical II	1	C	-	45
	Total	**21**			

200 Level

Course Code	Course Title	Units	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
PHY 201	General Physics V (Modern Physics)	2	C	30	-
PHY 202	Introduction to Electric Circuits & Electronics	2	C	30	-
PHY 204	General Physics VI (Waves and Optics)	2	C	30	-
PHY 205	Thermal Physics	2	C	30	-
PHY 206	General Physics VII (Energy & Environment)	2	C	30	-
PHY 211	Workshop Practice	2	C	15	45
PHY 213	Classical Physics I	2	C	30	
PHY 214	Classical Physics II	2	C	30	-
	Total	**20**			

300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolutions	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
PHY 301	Analytical Mechanics I	2	C	30	-
PHY 303	Electromagnetism	3	C	45	-
PHY 304	Electromagnetic Waves and Optics	3	C	45	-
PHY 305	Quantum Physics	3	C	45	-
PHY 306	Statistical and Thermal Physics	2	C	30	-
PHY 307	General Physics Practical V	1	C	-	45
PHY 308	General Physics Practical VI	1	C	-	45
PHY 311	Complex Variables and Vector Space	3	C	45	-
	Total	**22**			

400 Level

Course Code	Course Title	Units	Status	LH	PH
PHY 401	Quantum Mechanics I	3	C	45	-
PHY 403	Mathematical Methods of Physics I	3	C	45	-
PHY 405	Physics Entrepreneurship	2	C	30	
PHY 411	Nuclear and Particle Physics I	2	C	30	
PHY 414	Solid State Physics I	2	C	30	
PHY 418	Semiconductor Devices	3	C	45	-
PHY 421	Biophysics I	2	C	30	
PHY 499	Industrial Attachment II (24 Weeks)	6	C		
	Total	**23**			

500 Level

Course Code	Course Title	Units	Status	LH	PH
PHY 502	Quantum Mechanics II	3	C	45	-
PHY 504	Mathematical Methods in Physics II	3	C	45	-
PHY 513	Physics of Solar Systems	2	C	30	-
PHY 527	Introduction to Photonics	3	C	45	-

Course Code	Course Title	Units	Status	LH	PH
PHY 529	Introduction to Astrophysics and Cosmology	2	C	30	-
PHY 555	Research Project	6	C	-	270
	Total	**19**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to
1. identify possible sound patterns in English Language;
2. list notable Language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English Language (vowels and consonants, phonetics, and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple, and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and critical thinking and reasoning methods (logic and syllogism, inductive and deductive argument and reasoning methods, analogy, generalisation and explanations). Ethical considerations, copyright rules, and infringements. Writing activities: (pre-writing, writing, post writing, editing and proofreading; brainstorming, outlining, paragraphing). Types of writing: summary, essays, letter, curriculum vitae, report writing, note making etc. Mechanics of writing. Comprehension Strategies: (reading and types of reading, comprehension skills, 3RsQ). Information and Communication Technology in modern Language Learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian peoples and culture (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;

4. analyse the concepts of Trade, Economic and Self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building;
6. analyse the role of the Judiciary in upholding people's fundamental rights;
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents
Nigerian history, culture and art up to 1800 (yoruba, hausa and igbo peoples and culture, peoples and culture of the ethnic minority groups). Nigeria under colonial rule: (advent of colonial rule in Nigeria, Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914, formation of political parties in Nigeria, Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian civil war). Concept of trade and economics of self-reliance (indigenous trade and market system, indigenous apprenticeship system among Nigeria people, trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification). Judiciary and fundamental human rights. Individual, norms, and values (basic Nigeria norms and values, patterns of citizenship acquisition, citizenship and civic responsibilities, indigenous languages, usage, and development, negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – reconstruction, rehabilitation and re-orientation strategies, operation feed the nation (OFN), green revolution, austerity measures, war against indiscipline (WAI), war against indiscipline and corruption (WAIC), mass mobilization for self-reliance; social justice and economic recovery (MAMSER), national orientation agency (NOA), current socio-political and cultural developments in Nigeria).

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the basic definition of set, subset, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify and use various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers; integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers; algebra of complex numbers; the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules of differentiation and integration;
2. describe the meaning of function of a real variable, graphs, limits and continuity and their applications; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable (graphs, limits, and idea of continuity). The derivative as limit of rate of change. Techniques of differentiation. Extreme curve sketching. Integration as an inverse of differentiation. Methods of integration. Definite integrals (application to areas and volumes).

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcome
At the end of the course, students should be able to:
1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;

5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents

Space and time. Units and dimension. Vectors and scalars. Differentiation of vectors (displacement, velocity and acceleration). Kinematics. Newton laws of motion (Inertial frames, impulse, force and action at a distance, momentum conservation). Relative motion. Application of Newtonian mechanics. Equations of motion. Conservation principles in physics (conservative forces, conservation of linear momentum, kinetic energy and work, potential energy). System of particles. Centre of mass. Rotational motion (torque, vector product, moment, rotation of coordinate axes and angular momentum). Coordinate systems. Polar coordinates. Conservation of angular momentum. Circular motion. Moments of inertia (gyroscopes, and precession). Gravitation (Newton's Law of Gravitation, Kepler's laws of planetary motion, gravitational potential energy, escape velocity, satellites motion and orbits).

PHY 102: General physics II (Electricity & Magnetism) (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. describe the electric field and potential, and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law, and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;
5. describe electromagnetic induction and related concepts and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters; and
8. determine the characteristics of ac voltages and currents in resistors, capacitors, and Inductors.

Course Contents

Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and resistance. Ohm's law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

PHY 103: General physics III (Behaviour of Matter) (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. explain the concepts of heat and temperature and relate the temperature scales;
2. define, derive, and apply the fundamental thermodynamic relations to thermal systems;
3. describe and explain the first and second laws of thermodynamics, and the concept of entropy;
4. state the assumptions of the kinetic theory and apply techniques of describing macroscopic behaviour;
5. deduce the formalism of thermodynamics and apply it to simple systems in thermal equilibrium; and
6. describe and determine the effect of forces and deformation of materials and surfaces.

Course Contents

Heat and temperature (temperature scales). Gas laws. General gas equation. Thermal conductivity. First Law of thermodynamics (heat, work and internal energy, reversibility). Thermodynamic processes (adiabatic, isothermal, isobaric). Second law of thermodynamics (heat engines and entropy). Zero's law of thermodynamics. Kinetic theory of gases. Molecular collisions and mean free path. Elasticity (Hooke's law, Young's, shear and bulk moduli). Hydrostatics (Pressure, buoyancy, Archimedes' principles). Bernoulli's equation and incompressible fluid flow. Surface tension (adhesion, cohesion, viscosity, capillarity, drops and bubbles).

PHY 104: General Physics IV (Vibration Waves and Optics)
(2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. describe and quantitatively analyse the behaviour of vibrating systems and wave energy;
2. explain the propagation and properties of waves in sound and light;
3. identify and apply the wave equations; and
4. explain geometrical optics and principles of optical instruments.

Course Contents

Simple harmonic motion (SHM). Energy in a vibrating system. Damped SHM. Resonance and transients. Coupled SHM. Q values and power response curves. Normal modes. Waves (types and properties of waves as applied to sound). Transverse and longitudinal waves (superposition, interference, diffraction, dispersion, polarization). Waves at interfaces (energy and power of waves. The wave equation. 2-D and 3-D wave equations. Wave energy and power. Phase and group velocities. Echo and beats. The Doppler-effect. Propagation of sound in gases, solids and liquids and their properties.

Optics: Nature and propagation of light. Reflection and refraction. Internal reflection. Scattering of light. Reflection and refraction at plane and spherical surfaces. Thin lenses and optical instruments. Wave nature of light. Dispersion. Huygens's principle (interference and diffraction).

PHY 107: General Practical Physics I (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasizes quantitative measurements. Experimental techniques. The treatment of measurement errors. Graphical analysis. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc. (covered in PHY 101, 102, 103 and PHY 104). However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis, and deduction.

PHY 108: General Practical Physics II (1Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data; and
6. prepare and present practical reports.

Course Contents
This practical course is a continuation of PHY 107 and is intended to be taught during the second semester of the 100 level to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements, the treatment of measurement errors, and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;

7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence; and
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa, and the rest of the world.
8. state the basic principles of e-commerce.

Course Contents
Concept of entrepreneurship (entrepreneurship, intrapreneurship/corporate entrepreneurship,). Theories, rationale, and relevance of entrepreneurship (Schumpeterian and other perspectives. Risk-taking, necessity and opportunity-based entrepreneurship and Creative deduction. Characteristics of entrepreneurs (opportunity seeker, risk taker, natural and nurtured, problem solver and change agent, innovator, and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking, and creative thinking). Innovation (concept of innovation, dimensions of innovation, change and innovation, knowledge, and innovation). Enterprise formation. Partnership and networking (basics of business plan, forms of business ownership, business registration and forming alliances and join ventures). Contemporary entrepreneurship issues (knowledge, skills and technology, intellectual property, virtual office, networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, youth and women entrepreneurship. Entrepreneurship support institutions. Youth enterprise networks and environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

PHY 201: General physics IV (Elementary Modern Physics)
(2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. explain the notion of an inertial frame and the concept of an observer;
2. relate the limitations imposed by and consequences of motion of bodies at the speed of light;
3. state the principles of Special Relativity and use them to derive relations for time dilation and length contraction;
4. perform calculations using the Lorentz transformation formulae;
5. derive relativistic energy and momentum and use these to solve problems in mechanics;
6. apply the mathematical treatment of the wave function and Schrodinger's equation;
7. relate the atomic structure and energy associated with the particles of the atom;
8. apply the ideas of a wave-particle duality and the uncertainty principle to solve problems in quantum mechanics;
9. apply the Bohr formula to calculate energies and wavelengths in the context of atomic hydrogen; and
10. explain the interaction of photons and electrons with matter.

Course Contents

Defects in Newtonian Mechanics. Galilean relativity. The speed of light. Inertial frames and the concept of an observer. The principles of Einstein's Special Theory of Relativity. Lorentz transformation. Time dilation and length contraction. Transformation of velocities. Doppler effect. Relativistic energy and momentum. Basic properties of atoms and molecules. Experimental basis of quantum theory. Electrons and quanta. Bohr's theory of atomic structure. Energy levels and spectra. De Broglie hypothesis. The uncertainty principle. Black body radiation. The momentum operator. Time-independent Schrödinger equation. The infinite square well. Simple applications in particle and nuclear physics. Compton effect. Thermionic emission. Radioactivity. Detection and measurement of charged particles (including the treatment of detectors). X-rays.

PHY 202: Introduction to Electric Circuits and Electronics (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. identify circuit diagrams and symbols;
2. determine current flows, potential drops, power, and energy dissipation in circuits using Ohm's law;
3. simplify series and parallel combinations of resistors;
4. state Kirchhoff's laws and apply same in solving for currents and voltages in dc. and ac. circuits;
5. apply potential divider and current divider techniques in calculating circuit potential differences and branch currents;
6. state and apply circuit theorems and principles to solve problems;
7. apply the Mesh currents and Node – Voltage methods in network analysis;
8. discuss the nature of ac. currents and voltages in resistors, inductors, capacitors and determine impedances;
9. analyse a.c. circuits using phasor diagrams;
10. determine power, Q-factor, and resonance in ac. circuits;

11. explain the principle of the transformer and applications;
12. distinguish between conductors, semiconductors, and insulators and explain crystal and band structure;
13. identify semiconductor devices and explain their principle of operation;
14. explain the current – voltage characteristics of semiconductor devices; and
15. explain the function of semiconductor devices (diodes, transistors etc.)

Course Contents

D.C. Circuits. Sources of emf and current. Resistor combinations. Kirchhoff's Laws. Network analysis and circuit theorems. Mesh currents method, Node-voltage, Thevenin and Norton theorem, superposition principle. A.C. Circuits. Sinusoidal wave-forms. RMS and peak values. Power. Resistance, inductance and capacitance in a.c. circuits. Impedance and admittance. Series and parallel RLC circuits. Q factor. Resonance. The transformer. Electronics: filters. Amplification and the transistor. Bipolar junction and field effect transistors. Equivalent circuits. Amplifiers. Feedback. Oscillators. Signal generators. Semiconductors (devices and characteristics). The pn-junction. Simple diodes. Photodiodes. LEDs.

PHY 204: General Physics V (Waves and optics) (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:
1. describe the wave phenomena and explain the nature and properties of waves;
2. explain wave propagation in different media;
3. describe geometric optics and image formation;
4. analyse simple examples of interference and diffraction phenomena;
5. identify and explain functions of optical devices;
6. explain the principles of optical instruments and applications;
7. explain the principles of operation of the Michelson interferometer;
8. describe the polarization states of light.

Course Contents

Wave phenomena (types and properties of waves). SHM. Harmonic oscillator. Waves on a string. Energy in wave motion. Longitudinal waves. Standing waves. Acoustical waves. Group and phase velocities. Doppler effects. Physical Optics: Spherical waves. Interference. Superposition. Young's slits. Single and double slits. Multiple slits. The Michelson interferometer. Diffraction. The diffraction grating and spectrometers. Thin films. Dispersion and scattering. Echo and beats. Sound in gases, liquids, and solids. Geometrical optics (waves and rays). Reflection at plane and spherical surfaces. Refraction. Thin lenses. Prism. Optical lenses and optical instruments e.g., microscopes, telescopes, etc. Lens maker's formula. Polarization and polarization states. Unpolarised and partially polarized light. Brewster's angle. Polarizing beam splitters. Photometry and light spectrum analysis.

PHY 205: Thermal Physics (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:
1. discuss the concept of heat and temperature;
2. explain and determine thermodynamic processes;

3. explain and evaluate properties of real and ideal gases;
4. evaluate the consequences of the thermodynamic laws;
5. describe the basis of the kinetic theory; and
6. describe the statistical behaviour of gases with applications.

Course Contents
The foundations of classical thermodynamics including the definition of temperature. The first law. Work, heat and internal energy. The second law. Carnot cycles and Carnot engines. Zeroth law. Entropy and irreversibility. Thermodynamic potentials and the Maxwell relations. Ideal gas equation. Internal energy and internal molecular modes. Qualitative discussion of phase transitions. Gibbs free energy. Clausius-Clapeyron equation. Examples of phase transitions. Van der Waals gas. Kinetic theory. Mean free path. Equi-partition of energy. Heat transfer. Diffusion rate.

PHY 206: General Physics VI (Energy and Environment) (2 Unit C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the origin and sources of energy and power;
2. describe the inter relation and transformation of energy sources and types;
3. illustrate and explain the principles of generation of power;
4. outline the concept of energy demand and supply;
5. explain the economics, politics and problems associated with energy demand and supply;
6. identify and assess categories of environmental pollutants;
7. describe effect of carbon emission on global warming;
8. describe the environmental effect of energy generation, supply, and consumption; and
9. identify and evaluate the merits and demerits of power generation from different sources.

Course Contents
Energy sources and climate impacts. Energy requirements and consumption. Energy processing and conversion. Energy units and pricing. The greenhouse effect. Biological forms of energy (fossil fuels and biofuels). Basic nuclear physics. **T**he atom, radioactivity and decay laws. Interaction of radiation with matter. Nuclear fission principles and energetics. Chain reaction and dynamics. Reactor types and control. Current status of nuclear fission as a power source. Nuclear fusion principles and energetics. (Examples in stars and on earth). Thermonuclear fusion. Nuclear fuels. Ignition and the Lawson criterion. Magnetic and inertial confinement. Current status of nuclear fusion as a power source. Stellar fusion. Proton-proton chain and CNO cycle. Solar power technologies. Solar thermal. Solar photovoltaic. Wind energy. Nature of wind. Wind power and wind turbines. Betz criterion. Energy from waves and tides. Principles of water waves, energy, and power. Wave power extraction. Origin and properties of tides. Tidal stream power and tidal range power. Power from fluids. Hydro power. Energy transportation and storage. Thermal pollution. Energy costs, capacity, reserves, and efficiency. Emerging environmental effects of energy processing.

PHY 207/208: Experimental Physics I & II (2 Units C: PH 90)

Learning Outcomes
Upon the completion of the course, the students should be able to:

1. identify the two physical quantities to be measured as independent and dependent variables;
2. determine the relationship between the two variables in form of graph;
3. determine some physical constants such as acceleration due to gravity, force constant of a spring, refractive index of a prism and focal length of converging and diverging lenses using different methods; and
4. determine momentum of inertia of a fly wheel and determine coefficient of static and dynamic friction for wood.

Course Contents
The laboratory course consists of a group of experiments drawn from diverse areas of Physics (optics, electromagnetism, mechanics, Modern Physics, etc.). It is accompanied by seminar studies of standard experimental techniques and the analyses of famous and challenging experiments.

PHY 213: Classical Physics I (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. relate the concepts of space coordinates, time, and linear motion;
2. describe particle dynamics, equilibrium, and conservative forces;
3. solve problems on central forces, energy, and angular momentum;
4. explain the dynamics of rotational motion;
5. discuss and apply the potential theory;
6. explain the dynamics of rigid bodies;
7. apply Newton's theory of gravitation to problems of planetary motion and space travel;
8. use inertial forces to explain motion from the viewpoint of rotating frames of reference; and
9. derive the general relation between the angular velocity and angular momentum of a rigid; body and use this to solve problems in rotational dynamics.

Course Contents
Introduction to classical mechanics. Space and time. Linear kinematics. Linear and angular momentum. Force and torque. Motion in a plane. Newtonian gravity. The two-body systems. Forces and equilibrium. Particle dynamics. Force fields and potentials. Collisions. Conservative forces. Inertial frames and non-inertial frames. Motion in rotating frames. Centrifugal force. Central force motions. Kepler’s motion in a central force field. Particle orbits as conic sections. Kepler’s laws. Rigid body motion and rotational dynamics. Moment of inertia. Free rotation and stability. Gyroscopes.

PHY 214: Classical Physics II (Electrodynamics) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. use scalar and vector potentials and explain the concept of gauge invariance;
2. demonstrate the compatibility of electrodynamics and special relativity;
3. use Lorentz covariant formalism in the context of electrodynamics and special relativity;
4. solve Poisson's equation and the inhomogeneous wave equation;

PHY 211: Workshop Practice (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. identify safety signs for various workshop types and abide by the underlining regulations while working in the workshop;
2. handle workshop tools and machineries;
3. illustrate simple metal processing methods;
4. describe the criteria for selection of construction materials;
5. identify electrical and electronic devices and explain some instrumentation techniques for measuring parameters;
6. explain types and methods of wood and plastic processing.

Course Contents
Workshop layout and safety. Basic hand tools and bench work practices. Measurement and gauging. Sheet metal operations. Casting. Cutting, drilling, turning, and milling. Metal joining devices and adhesives in common use. Soldering techniques and wrap joints. Plain and cylindrical generation of smooth surface using power operated machines. Criteria for selection of materials used for construction (metallic and non-metallic). Instrumentation and measuring techniques. Multi-meters and oscilloscopes. Extension of instrument range. A survey of the use of electronic circuit devices (e.g., diodes, transistors including FET, integrated circuits). Photocells. Basic circuit development and analysis. Wood logging. Wood types and processing. Plastic types and working. Plastic moulding, bending, and encapsulation.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict, and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies;
5. describe roles of international organisations, media, and traditional institutions in peace building.

Course Contents
Concepts of peace, conflict and security in a multi-ethnic nation. Types and theories of Conflicts (ethnic, religious, economic, and geo-political conflicts). Structural conflict theory. Realist theory of conflict. Frustration-aggression conflict theory. Root causes of conflict and violence in Africa (Indigene and settlers phenomenon; boundaries/boarder disputes; political disputes; ethnic disputes and rivalries; economic inequalities; social disputes). Nationalist movements and agitations. Selected conflict case studies – Tiv-Jukun; Zango Kartaf, chieftaincy and land disputes etc. Peace building. Management of conflicts and security. Peace & human development. Approaches to peace & conflict management --- (religious, government, community leaders etc.). Elements of peace studies and conflict resolution. Conflict dynamics assessment Scales (constructive & destructive). Justice and legal framework: Concepts of social justice; The Nigeria

legal system. Insurgency and terrorism. Peace mediation and peace keeping. Peace & security Council (international, national and local levels). Agents of conflict resolution (conventions, treaties, community policing, evolution and imperatives. Alternative dispute resolution, ADR. a). Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of international Organizations in conflict resolution. (a). The United Nations, UN and its conflict resolution organs. (b). The African Union & Peace Security Council (c). ECOWAS in peace keeping. Media and traditional institutions in peace building. Managing post-conflict situations/crisis (Refugees. Internally displaced persons, IDPs0. The role of NGOs in Post-conflict situations/crisis.

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students, through case study and practical approaches, should be able to:

1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises.
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship;
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity identification (sources of business opportunities in Nigeria, environmental scanning, demand and supply gap/unmet needs/market gaps/market research, unutilised resources, social and climate conditions and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (venture capital, equity finance, Micro finance, Personal savings, small business investment organizations and business plan competition). Entrepreneurial marketing and e-commerce (principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first mover advantage, E-commerce business models and successful E-commerce companies,). Small business management/family business; leadership & management, basic book keeping, nature of family business and family business growth model; negotiation and business communication (Strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, Idea pitching); technological solutions (the concept of market/customer solution, customer solution and emerging technologies, business applications of new technologies - Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), blockchain, cloud computing, renewable energy etc. Digital Business and E-commerce strategies).

PHY 301: Analytical Mechanics I **(2 Units C: LH 30)**

Learning Outcomes
At the end of the course, students should be able to:
1. explain and evaluate particle motion in one, two, and three dimensions;
2. describe the two-body problem and many body systems;
3. define and solve problems of conservative forces;
4. explain Newton theory of gravitation;
5. describe the nature of generalized motion;
6. explain the theory of relativity;
7. choose an appropriate set of generalized coordinates to describe a dynamical system and obtain its Lagrangian in terms of those coordinates and the associated 'velocities'; and
8. derive and solve the corresponding equations of motion. Treat small oscillations as an eigenvalue problem.

Course Contents
Review of Newtonian Mechanics. Motion of a particle in one, two and three dimensions. Internal forces. External forces. Forces of constraint. Systems of particles and collision theory. Newtonian gravitation; conservative forces and potentials, oscillations, central force problems; accelerated frames of reference. Rigid body dynamics. Rotational problems and space coordinates. Mechanics of continuous media. Galilean relativity. Relativistic kinematics and dynamics. Applications of relativistic kinematics.

PHY 303: Electromagnetism **(3 Units C: LH 45)**

Learning Outcomes
At the end of the course, students should be able to:
1. derive Maxwell's equation set from the empirical laws of electromagnetism;
2. use the fundamental laws of electromagnetism to solve simple problems of electrostatics, magnetostatics and electromagnetic induction in a vacuum;
3. modify Maxwell's laws to apply in the presence of materials and solve problems involving them;
4. derive the electromagnetic boundary conditions which apply at the interface between two simple media, and to use them to solve problems involving two or more materials;
5. explain the properties of plane electromagnetic waves in a vacuum and in simple media and to be able to derive these properties from Maxwell's equations;
6. apply the special theory of relativity to problems in electromagnetism.

Course Contents
Review of Vector calculus. Electrostatics and Magnetostatics. Magnetization and magnetic susceptibility. Laplace's equation and boundary value problems. Multipole expansions. EM waves in dielectric and magnetic materials. Polarization of EM waves. Electromagnetic induction. Faraday's and Lenz's laws. A.C. Circuits. Maxwell's equations. Lorentz covariance and special relativity. Gauss theorem in dielectrics. Poisson's equations. Uniqueness theorem. Magnetic properties. Motors. Generators. Poynting vectors.

PHY 304: Electromagnetic Waves and Optics (3 Units C: LH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. explain plane electromagnetic waves and waves propagation;
2. derive the wave equation;
3. describe the transport of electromagnetic energy;
4. explain scattering, interference, diffraction, reflection, polarization, and refraction of electromagnetic waves;
5. use complex notation competently for wave phenomena;
6. solve problems which require the use of wave representations of electric and magnetic fields in propagating electromagnetic waves;
7. analyse simple examples of interference and diffraction phenomena;
8. explain the principles of operation of a range of equipment used in modern optics, notably the Michelson interferometer and Fabry-Perot etalon;
9. explain the physics of the laser and processes involved in producing laser radiation to solve simple problems;

Course Contents

Review of Maxwell's equations and wave equations in a dielectric. Electromagnetic potentials. Propagation of plane and spherical waves. Huygen's wavelets and Fermat's principle. Recap of polarization states. Interference. Michelson interferometer and Fabry-Perot etalon. Fourier transform spectroscopy. Young's slits. Lloyd's mirror. Fraunhofer diffraction. Resolution of optical instruments. Reflection and refraction. Transmission lines. Wave guides and optical cavities. Lasers (rate equation, Steady state operation; threshold and efficiency).

PHY 305: Quantum Physics (3 Units C: LH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. explain the origin of quantum physics and principles of quantum theory;
2. apply the mathematical tools of quantum physics;
3. explain how quantum states are described by wave functions;
4. apply operators and solve eigenvalue problems in quantum mechanics;
5. solve the Schrodinger equation and describe the properties of the simple harmonic oscillator;
6. use the algebra of angular momentum operators and solve the simple eigenvalue problems of an angular momentum in quantum mechanics;
7. apply quantum mechanics to describe the hydrogen atom;
8. employ quantum mechanics to describe the properties of one-electron atoms;
9. use quantum mechanics to describe the simple multi-electron systems such as helium atom and hydrogen molecule.

Course Contents

Wave-particle duality and the uncertainty principle. Basic principles of the quantum theory. Time dependent Schrodinger equation. Energy levels and potential wells. Reflection and transmission of potential barriers. Operators and quantum states. Commutation relations and compatibility of different observables. Orbital angular momentum. Particle in two dimensions. Familiar wave phenomena and their associated wave equations. Physical interpretation of the wave function as

a probability amplitude. Energy levels and stationary states. Energy bands in periodic lattice. Solution of Schrodinger equation for a central potential in three dimensions. The hydrogen atom. Multi-electron atoms. The harmonic oscillator. Exchange symmetry.

PHY 306: Statistical and thermal physics I (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. describe an ideal gas on the basis of classical statistics;
2. explain the basic concepts of statistical mechanics, including entropy, its statistical interpretation and relation to disorder, and the statistical origin of the second law of thermodynamics;
3. illustrate the canonical and grand-canonical partition functions for systems in thermal equilibrium and use them to obtain thermodynamic quantities of interest;
4. describe the implications of the indistinguishability of particles for systems of non-interacting quantum particles;
5. deduce the Bose-Einstein and Fermi-Dirac distribution functions and apply them to calculate the properties of Bose and Fermi gases, for example in the context of white dwarf stars and black-body radiation; and
6. explain the physical origin of Bose-Einstein condensation, to characterize it quantitatively, and to explain the experiments confirming Bose-Einstein condensation

Course Contents

Basic theory of thermodynamics. Basic of probability theory. Microstates and macrostates. The concept of ensembles. Statistical interpretation of entropy and temperature. Isolated systems and the microcanonical ensemble. Statistical physics of non-isolated systems. Derivation of the Boltzmann distribution and canonical ensemble. The partition function in thermodynamics. Non-interacting systems. Equipartition theorem. Density of states. Grand canonical ensemble. Fermi-Dirac and Bose-Einstein distributions. The ideal Fermi gas. Fermi energy. Heat capacity. The ideal Bose gas. Black body radiation. Bose-Einstein condensation.

PHY 307/308: Experimental Physics V & VI (2 Units C: PH 90)

Learning Outcomes

On completion, the students should be able to:

1. verify some equations, physical laws and theorems;
2. identify apparatus, design and set up experiments;
3. investigate relationships between physical quantities numerically and graphically; and
4. prepare and present laboratory reports.

Course Contents

A year-long series of mini courses on important experimental techniques. Topics covered include electronics, optics, electricity, atomic, molecular nuclear and low temperature physics, statistics and data handling and scientific writing.

PHY 311 Complex Variable and Vector Space (3 Units C: LH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. determine whether or not a given function of a complex variable is differentiable;
2. use conformal mappings of the complex plane to solve problems in 2D electrostatics, fluid flow and heat flow;
3. construct the Taylor-Laurent series for functions that are analytic in an annular region of the complex plane;
4. determine the location and nature of the singularities of a function and determine the order of a pole and its residue;
5. use the residue theorem to evaluate integrals of functions of a complex variable, and identify appropriate contours to assist in the summation of series and the evaluation of real integrals;
6. find an orthonormal basis for a given vector space;
7. define the adjoint of a linear operator and determine whether a given operator is Hermitian and/or unitary; and
8. employ methods from this and prerequisite units to solve previously unseen problems in linear algebra, using Dirac's notation where appropriate.

Course Contents

Complex numbers. Functions of complex variable. Functions as mappings. Complex differentiation, analytic functions and the Cauchy-Riemann equations. Conformal mappings. solutions of 2D Laplace equation in physics. Integration in the complex plane. Contour integration. Cauchy's Theorem. Cauchy's integral formulae. Taylor and Laurent Series. Cauchy's residue theorem. Real integrals and series. Vector spaces. (Abstract vector spaces, linear independence, basis and dimensions, representations, Inner products, linear operators). Hermitian and unitary operators. Eigenvalues and eigenvectors.

400 Level

PHY 414: Solid State Physics I (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. explain crystal binding, structure, and dynamics;
2. describe models of the free electron and transport properties of conduction electron
3. describe band structure;
4. determine reciprocal lattices of simple crystal structure and relate them to x-ray diffraction data;
5. calculate band structures for simple 2D and 3D tight-binding models and construct nearly-free electron approximations;
6. use the nearly-free-electron approximation to calculate equilibrium properties;
7. apply the semiclassical dynamics of electrons in solids to interpret magneto-conductance data and its relationship with the Fermi surface; and
8. describe and make use of the relationship between bonding and electronic structure of semiconductors, metals, and insulators;

Course Contents
Crystal structure and binding. Reciprocal lattice. Basic concepts of the quantum theory in solids. The free electron model. Weak and tight binding approximations. Energy band structures in metal, semiconductors and insulators. Electrons in solids. Density of states. Fermi surface. Fermi-Dirac distribution. Weidemann-Franz law. Interaction of electron with crystal lattice. Scattering of electrons. Crystal defects. Physics of surfaces. Schottky devices. Use of photo-electric emission in the study of solids. Elastic properties. Lattice vibrations. Super-conductivity. Graphene (Band structure and properties).

PHY 318/418: Semiconductor Devices (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the type, functionality, and operation of semiconductor devices;
2. distinguish between conductors, semiconductors, and insulators;
3. describe the crystal structure of representative semiconductor diodes and amplifying devices;
4. describe the operation of semiconducting devices in a circuit;
5. be familiar with semiconductor device packaging and symbol representations;
6. recognize the functional operation of diodes and amplifying semiconductor devices;
7. describe how to test semiconductor devices and evaluate their status;
8. describe forward and reverse bias characteristics of diodes;
9. explain voltage-current characteristics of semiconductor devices;
10. explain the physics and operation of the transistors;
11. describe metal - semiconductor junction characteristics;
12. explain the basics of FET's and MOSFET's structures; and
13. state the principle of operation of photonic devices.

Course Contents
Classes of semiconductor. The physics of semiconductors. Band structure of metals, semiconductors, and insulators. Semiconductor equilibrium. Doping and statistics. Carrier distribution, transport, and recombination. Carrier drift, diffusion, and conductivity. Hall effect. semiconductor growth. Semiconductor quantum structures. Modelling and application of selected semiconductor devices. P-n junction. Review of junction and bipolar transistor physics. Major emphasis on MOS devices including field effect transistors and charge coupled devices. Consideration of advanced bipolar structures. Schottky barrier devices. Optical properties of semiconductors (light emitting diodes and photo-detectors). Solar cells.

PHY 399/499: Industrial Attachment II (12/24 weeks) (3/6 Units C)

Learning Outcomes
At the end of the course, students should be able to:
1. develop practical skills of the theories learned in the classroom;
2. acquire working experience of the industries;
3. handle relevant tools and equipment in the industries; and
4. write technical reports on their industrial work and present seminar.

Course Contents
Students should be attached to some relevant organizations for additional 12 weeks at the 300 level for the four (4) year program preferably during the long vacation, and for 24 weeks at the 400 Level for the five (5) year B.Tech. program during the second semester and the long vacation for more industrial experience training. Students to be assessed based on seminar presentation, technical reports, and assessment by supervisors.

400 Level

PHY 401: Quantum Mechanics I (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. state the postulates of quantum mechanics;
2. explain the basics of vectors and tensor operators;
3. solve a variety of physical problems using the Schrodinger equation;
4. work with angular momentum operators and their eigenvalues both qualitatively and quantitatively;
5. explain electron spin and the Pauli principle; and
6. apply perturbation theory and other methods to find approximate solutions to problems in quantum mechanics, including the fine-structure of energy levels of hydrogen.

Course Contents
The formulation of quantum mechanics in terms of state vectors and linear operators. Time evolution of the Schrodinger equation. The theory of angular momentum and spin. Electron spin and the Stern-Gerlach experiment. Identical particles and the Pauli exclusion principle. Multi-electron atoms. Approximation methods. Variational methods and WKB approximation for bound states and tunnelling. Time - independent perturbation theory. The fine structure of hydrogen. Harmonic oscillator. Creation and annihilation operators. External fields. Zeeman and Stark effects in hydrogen.

PHY 402/502: Quantum Mechanics II (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. apply the mathematical tools of quantum mechanics;
2. recognise approximation methods in quantum mechanics;
3. explain the scattering theory;
4. identify the unitary transformations linked to symmetry operations;
5. apply time-dependent perturbation theory to variety of problems;
6. derive a mathematical description of quantum motion in electromagnetic fields;
7. apply the relativistic wave equations to simple single-particle problems; and
8. use Dirac notation to represent quantum-mechanical states and manipulate operators in terms of their matrix elements.

Course Contents
Time-independent and time-dependent perturbation theory. Scattering theory. Elastic potential scattering. Green's function and partial wave methods. Symmetries in quantum mechanics.

Rotations, space-time reflections and parity. Selection rules for atomic transitions. Emission and absorption of radiation. Selection rules for hydrogen. Description and interpretation of selected phenomena from each of atomic physics, molecular physics, solid-state physics, and nuclear physics using quantum mechanical models. Relativistic wave equation. The Klein-Gordon equation. The Dirac equation. Chirality. Lorentz invariance and non-relativistic limit.

PHY 403: Mathematical Methods for Physics I: (3 Units C: LH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. explain the concepts of scalar and vector fields;
2. describe the properties of div, grad and curl and be able to calculate the divergence and curl of vector fields in various coordinate systems;
3. calculate surface and volume integrals in various coordinate systems;
4. calculate flux integrals and relate them to the divergence and the divergence theorem;
5. calculate line integrals and relate them to the curl and to Stokes' theorem;
6. apply the methods of vector calculus to physical problems; and
7. calculate the fourier series associated with simple functions and apply them to selected physical problems.

Course Contents

Vector and scalar fields. Vector operators. Div, grad, and curl. Divergence theorem. Stoke's theorem. Linear Algebra and functional Analysis. Transformations in linear vector spaces and matrix theory. Hilbert space and complete sets of orthogonal functions. Special functions of mathematical physics (The gamma function; hypergeometric functions; Legendre functions; Bessel functions. Hermite and Laguerre functions. The Dirac - Delta function. Integral transforms and fourier series. Fourier series and fourier transforms. The Dirichlet conditions. orthogonality of functions. Fourier coefficients. Complex representation of fourier series. Laplace transform. Applications of transform methods to the solution of elementary differential equations of interest in physics and engineering.

PHY 404/504: Mathematical Methods for Physics II (3 Units C: LH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. describe the properties of different types of functions and be able to sketch them in both 2D Cartesian and polar coordinates;
2. integrate and differentiate functions of one variable using a range of techniques and be able to apply integration and differentiation to a range of physical problems;
3. show how smooth functions can be expressed in terms of power series;
4. explain the properties of complex numbers and construct some basic complex functions;
5. employ matrix notation, carry out matrix algebra and use matrices to solve systems of linear equations;
6. compute the properties of determinants, be able to evaluate them, and use them to test for unique solutions of linear equations; and
7. solve first and second order ordinary differential equations using a range of techniques.

Course Contents
Partial differential equations. Solution of boundary value problems of partial differential equations by various methods which include separation of variables, the method of integral transforms. Sturm-Liouville theory; uniqueness of solutions. Calculus of residues and applications to evaluation of integrals and summation of series. Applications to various physical situations, which may include, electromagnetic theory, quantum theory, diffusion phenomena; complex variable theory and their relation to selected physical problems. Complex differentiation and integration. Cauchy's theorem. Taylor's and Laurent's series. Ordinary differential equations of first and second order and their physical applications. Homogeneous partial differential equations.

PHY 405: Physics Entrepreneurship (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. develop creative ability to apply physics knowledge to real-world settings;
2. generate ideas of innovation and entrepreneurship; and
3. apply entrepreneurial skills and mindset in approaching societal problems.

Course Contents
Creativity. Developing questioning attitude. Concept development. Reconstructionism. Critical thinking and brainstorming. Use of practical and creative techniques in concept development. Identifying underlining physics principles in real life situations and physics principles driving equipment design. Product development and requirements. Team building. Product and service design concepts. Consumer driven design. Business planning. Marketing and market research. Intellectual property. Pricing and financial strategies. Finding sources of funding.

PHY 411: Nuclear and Particle Physics I (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the nuclear structure and properties;
2. explain the nuclear forces;
3. explain nuclear particle reactions and nuclear reactors;
4. illustrate the mechanism of scattering and absorption of nuclear particles;
5. describe the models for nuclear reactions;
6. calculate binding energies in nuclear reactions;
7. determine the decay rate in nuclear reactions.

Course Contents
Basic concepts in nuclear physics. Measurements of nuclear mass and charge radii. Electron scattering. Muonic atoms. Electromagnetic moments. Hyperfine structure. Nuclear deformation. Mechanisms of nuclear decay (α decay). Barrier penetration; Geiger-Nuttal systematics. Relationship to proton/heavy fragment emission. β decay. Fermi theory. Selection rules. γ decay of excited states. Multipolarity. Selection rules and decay probabilities. Excited States of Nuclei. Description of the properties of excited states using the nuclear shell model. Rotational and vibrational states. Nuclear reactions (cross section; simple features of nuclear reactions. direct and compound nuclear mechanisms; fusion and fission; liquid drop model.

PHY 513: Physics of the Solar Systems (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. provide a qualitative description of the solar system from origin to present state;
2. apply dynamical principles to understand phenomena such as tides and orbits in the solar system;
3. carry out a simple orbit calculation, based on energy and angular momentum conservation on the basis of Kepler's laws and the Virial theorem;
4. describe the nature of the sun by considering it as a black body and body in hydrostatic equilibrium;
5. explain the basic principles behind the energy generation in the sun;
6. describe the nature of planetary atmospheres and explain the origin of the Earth's greenhouse effect;
7. describe the internal constituents of the planets;
8. explain how planetary ring systems may be formed;
9. state the consequences of planetary interaction in the solar system; and
10. explain the evolution of the solar system.

Course Contents

Overview of the solar system (general description and inventory). Coordinates and time keeping. Gravity. (Kepler's laws and Newton's law of gravity). Properties of orbits. The virial theorem. Tidal forces and tidal friction. Evolution of the moon and the Sun. Freefall time scale and Kelvin Helmholtz time scale. Hydrostatic equilibrium. Nuclear reactions. Neutrinos. Helioseismology. Planetary atmospheres. Albedo and optical depth. Scale height. Reducing and oxidizing atmospheres. Greenhouse effect. Ice ages. Planetary surfaces: Impact craters. Isotope dating. Planetary interiors. Liquid cores. Heat generation. The formation of the solar system.

PHY 529: Introduction to Astrophysics and Cosmology (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. explain the composition and structure of the atmosphere;
2. explain the magnetosphere and its boundaries and interactions with plasma;
3. state the nature of the sun’s radiation and principles of radiative heat transfer;
4. describe the sources and nature of atmospheric turbulence;
5. apply the concept of charge production, transport, and loss in the atmosphere; and
6. explain the transport of atmospheric electricity via thunderstorm and the fair-weather condition.

Course Contents

The Universe and its physics (A tour of the Universe, its scale and contents, gravity, pressure and radiation). The age of the universe. Evolution of the universe. Evidence for the Big Bang theory. Observational astronomy. The electromagnetic spectrum. Geometrical optics. Resolving power and the diffraction limit. Telescopes and detectors. Gravitational waves. Astronomical distances. Parallax measurements. Standard candles. Physics of the sun and stars. Blackbody radiation. Stefan-Boltzmann and Wien laws. Effective temperature. Interstellar reddening. Hydrogen spectral lines and Doppler effect. Hertzprung-Russell diagram. Freefall and Kelvin-Helmholtz time.

Nuclear fission and fusion. Basic stellar structure (hydrostatic equilibrium, equation of state). White dwarfs. Neutron stars and black holes. Planetary systems. Kepler's laws. Detection methods of extrasolar planets. Search for life elsewhere. SETI. Galaxies. Star formation and the interstellar medium. Stellar populations. Galaxy rotation curves. Mass and dark matter. Galaxy collisions. Cosmology: Olber's paradox. Hubble's Law. Dark energy and the accelerating Universe.

PHY 421: Biophysics I **(2 Units C: LH 30)**

Learning Outcomes
At the end of the course, students should be able to:
1. describe the processes and effect of interactions of radiation with matter;
2. explain the concept of electricity and magnetism at the cellular levels;
3. illustrate and explain the effect of impulse in nerves and muscles; and
4. explain solute transport in membranes.

Course Contents
Molecules and Cells. Mesoscopic forces. Phase transitions. Motility. Aggregating and self-assembly. Surface phenomena. Biomacromolecules. Charged ions. Polymers. Membranes. Rheology. Sensory motors. Chemical kinetics. Enzyme kinetics. System biology. Spikes. Physiology of cells and organisms. Biological sensors. Ionization of biomolecules. Thermodynamic principles. Energy transfer in living systems. Bioelectricity (ion channels, action potentials nerve impulse transmission).

PHY 455/555: Research Project **(6 Units C: PH 270)**

Learning Outcomes
At the end of the course, students should be able to:
1. design and or conduct a research work on the basis of some physical laws or principles;
2. write scientific reports;
3. present and depend on a scientific research work.

Course Contents
The course offers students the opportunity to do research in contemporary physics under the supervision of a staff. A detailed report on the research is to be presented and depended by the student when the project is completed.

Minimum Academic Standards

Staffing

Academic Staff
The guidelines on academic staff/student ratio of 1:20 for Science Programmes shall apply. To start any programme in Science, there should be a minimum of six academic staff. There is need to have a reasonable number of staff with PhD degrees accounting for at least 70% of the total number and having adequate teaching experience for every programme in the Discipline.

Administrative Support Staff
The services of the administrative support staff are indispensable in the proper administration of the Department. It is important to recruit very competent, computer literate senior staff.

Technical Support Personnel
The services of technical support staff, which are indispensable in the proper running of laboratories are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

Classrooms, Laboratories, Workshops and Office Space
The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

Library
The University Central Library should be well stocked with current journals, textbooks, and reference materials for the use of staff and students. The library should be linked with internet for information sourcing. There should be subscription to at least two relevant database.

Equipment

S/N	Description
1	Measuring cylinder 250 ml (glass + plastic)
2	Measuring cylinder 50ml
3	Measuring cylinder 25ml
4	Measuring cylinder glass (0 – 1000 ml)

S/N	Description
5	Harris ripple tank
6	Beaker (50ml, 250 cc)
7	Glass beaker (4,000ml)
8	Flat bottom flask
9	Stopwatch
10	Stop clock
11	Weight (1Kg, 2Kg, 5Kg)
12	Weight (500g, 200g, 100g, 50g, 20g, 10g, 5g)
13	Weighing balance digital
14	Weighing balance Metter
15	Air blower
16	Pulleys
17	Calorimeter
18	T Square
19	Wet cells
20	Tripod stand
21	Hydrometer
22	Spring balance
23	U Tube
24	Glass funnel
25	Conventional air apparatus
26	Rectangular glass block
27	Convex lens
28	Glass prism
29	Bar and gauge
30	Telescope
31	Linear expansion apparatus
32	Bulb hide
33	Mercury metal (800g)
34	Resistor Box (100Ω, 1000Ω)
35	Resistor (0.6Ω)
36	Turning forks
37	Standard resistors (1, 2, 5, 10, 20, 50, 100 Ω etc.)
38	Rheostat
39	Decade resistance box
40	Oscilloscope (Double beam)
41	Signal generator
42	Spectrometer
43	Transformer
44	Sodium lamp
45	Mercury lamp
46	Extensometer
47	Density bottle
48	Wooden board
49	Meter bridge

S/N	Description
50	One way key
51	Boyles law apparatus
52	Voltmeter
53	Ammeter
54	Galvanometer
55	Universal indicator
56	Relays
57	Burette
58	Meter rule
59	Table lamp
60	Optical bench
61	Micrometre screw gauge
62	Vernier calliper
63	Filter paper
64	Litmus paper
65	Standing fan
66	Thermometer (Mercury in glass, alcohol in glass)
67	Slotted masses (1, 2, 5, 10 Kg)
68	Slotted masses (5, 10, 20, 100, 200, 500g)
69	Micro amplifier
70	Pyrometer
71	Micrometre screw gauge
72	Decade capacitor
73	Standard capacitors
74	Long Glass tubes
75	High Current DC power supply
76	Turning forks
77	Plastic tubes
78	Aluminium sheets
79	Tetrameter
80	Connecting cable
81	Metal electrode
82	Interface cable
83	Metallic-bucket
84	Drawing board
85	Force board
86	Young modulus apparatus
87	Meter rule
88	Optical bench (Wooden)
89	Ray box
90	Avometer (Analogue)
91	Copper sheets
92	Discharge lamp
93	Meldes apparatus
94	Soldering wire

S/N	Description
95	Battery charger
96	Burette (50cc)
97	Lens holder (Wooden)
98	Spiral spring
99	Plane mirror
100	Microscope slide
101	Sonometer
102	Soldering iron
103	Simple Microscope
104	Travelling microscope
105	Specific gravity bottle
106	Barometer
107	Hydrometer
108	Diffraction grating
109	Sodium lamp
110	Table lamp
111	AC Ammeter /voltmeter
112	Ammeter (Double Range)
113	Milliammeter (Double Range)
114	Beaker (Pyrex 500cc)
115	Retort Stand (Complete)
116	Millivolt meter
117	Chemical Balance
118	Galvanometer
119	One-Way-Key
120	Jockey
121	Wheatstone Bridge
122	Electrolyte Capacitor
123	P – N Junction Diode
124	Standard Electrodes
125	Bar Magnet
126	Decade Capacitance Box
127	High Vacuum Intonation (Edwards)
128	Projector
129	Science Workshop 750 Interface (USB)
130	Model CI 75gg with accessories
131	Vacuum Pump
132	Spectrum Analyzer
133	Model 80 801OB
134	Hydro - electrical Power Station Apparatus
135	Volume determination of a solid Kit No.042
136	Air as a thermal insulator Kit No.045
137	Steam Canon KL No. 017
138	Osmotic pressure Kit No. 084
139	Conductivity of Solution with Kit No.006

S/N	Description
140	Conductivity of Solid Kit No.005
141	Visualizing Hydrostatic pressure Kit No.063
142	Marioff's column and flow rate devices Kit No.064
143	Liquid at different sensitivities Kit No.048
144	Conductivity in Liquids Kit Nos. 036 & 037
145	Porosity of Bricks Kit No. 072
146	Chemical activation of an electric motor Kit No. 032
147	Floating Bodies in Liquids of different densities Kit No.049
148	Thermal expansion of a bimetallic strip Kit No. 040
149	Prism Kit 075+076+077
150	Experiments in electromagnetism Kit Nos. 003 & 007
151	Electric Generator Kit No.018
152	Steady hand Kit No. 038
153	The cave of Dogs Kit No.079
154	Two –ball pendulum Kit No.030
155	Melting a metal in Hot Water Bismuth Alloy Kit No.046
156	Flow rate of Liquids with different viscosities Kit No.055
157	Maxwell's Pendulum Kit No.031
158	Air Occupies Space Kit No.041
159	Intermolecular Spaces in Liquids Kit No.069
160	Inter atomic forces in metals Kit No. 068
161	Conductivity of Solutions and Solids Kit No.004
162	Heating Water with a Concave Mirror Kit No.078
163	Electromagnetism: Oested's effect Kit
164	Double Slit
165	Grating
166	Convex Mirror
167	Plane Mirror
168	Electric field meter
169	Altitude meter
170	Hot Plate
171	Digital Stop Clock
172	Compound Pendulum
173	Optical Bench (Metallic Screen& Lens Holder)
174	Avometer (Analogue)
175	Avometer (Digital)
176	Mercury Lamp
177	Box of Aluminium Foil
178	Handling Tong
179	Radioactive Sources
180	Radioactive Cabinet
181	EMS Radiation Meter
182	Heat Index Meter
183	New Temperature Coefficient Apparatus

S/N	Description
184	Distiller
185	Ammeter (Variable range AC/DC or DC))
186	Angle Table Lamp
187	Abingdon Sound Wave Kit
188	Air Cell
189	Adaptor WPA (Shunts)
190	A/C Potentiometer (Wide Range)
191	Tetrameter SAS 1000
192	Adaptor WPA (Shunts)
193	A/C Potentiometer (Wide Range)
194	Audio Amplifier
195	A/C – DC Lamp (S N)
196	AC/DC Converter Trainer (AD 4101)
197	AC/DC Power Supply Baku (BK 1502 DD)
198	Analogue dial (Various turns)
199	Aluminium Solder (16 SWG)
200	AM/DSB Transmitter (KL 93061)
201	AM Radio Transmitter
202	Battery Charger
203	Basic Spark Source
204	Bunsen Burner
205	Bi-convex Lens (Various focal length)
206	Bi-concave Lens (Various focal length)
207	Beaker Pyrex (Various ml)
208	Beaker Plastic (250 ml)
209	Beaker CSN (Various ml)
210	Bar Magnet
211	Blade Connector
212	Battery Clips
213	Cathode ray tube (Unilab)
214	Ballistic Module 099624
215	Bench Power Supply (Philip Harris G85458)
216	Copper Wire
217	Constantan Wire
218	Constantan Alloy
219	Camera Lens
220	Camera (Simple type)
221	Camera (For Oscilloscope)
222	Capacitance Box (Type C500)
223	Capacitance substitution box 012308
224	Cathode ray Oscilloscope 099622
225	Convex Mirror (Various Focal Length)
226	Concave Mirror (Various Focal Length)
227	Coiled Core
228	Cable (3 Core)

S/N	Description
229	Cable, (Individually screened 4 core)
230	" (Screened, twin)
231	" (Low noise)
232	" (Air spaced coax)
233	" (300 Ohms twin feeder)
234	Capacitor, electrolyte (Various values)
235	Cable Polystyrene (Various values)
236	" Silvered mica (Various values)
237	" Ceramic (Various values)
238	" Paper (Various values)
239	" M D C (Various values)
240	" Trimmers Compression
241	" Trimmers
242	Circuit Breaker (Various amps)
243	Capacitor Suppression
244	Choke Suppression (Various values)
245	CMOS Logic checker
246	Crystal Sockets
247	Crimp connectors (Various types and sizes)
248	Communing block
249	Communing connectors
250	Clock timer IC
251	Condenser microphone
252	Dart Board Set
253	Discharge lamp holder
254	Discharge lamp transformer
255	Discharge lamp, sodium
256	Discharge lamp, cadmium
257	Discharge lamp, mercury
258	Discharge lamp, Helium
259	Discharge lamp, Neon
260	Digital multimeter
261	Diode (Various types)
262	Digital dial (10 turns)
263	Differential amplifier 1445
264	Diffraction Grating
265	Digital Clock module
266	D to A converter IC ZN 425 E
267	Darlington drivers
268	4-Decade counter driver
269	Dual pin recorder
270	D C Power Supply (ST 4078)
271	Electric timer 6 – 12V AC
272	Etch resist ink pen
273	Electro conductive paint

S/N	Description
274	Electronic alternator IC
275	Electricity LAB (NV6000)
276	Electronics Kit (Basic Elect. Expt PK101)
277	e/m Apparatus (SE 9638)
278	Frequency counter
279	Fuses (Various values and sizes)
280	Fresnel Biprism
281	Ferrite beads
282	F E T input OP amp DIL
283	" (Various types)
284	Function Generator
285	Fibre Optic Kit (Fok 721)
286	FM Transmitter (KL 93063)
287	Geissher's tube Helium
288	" " Argon
289	" " Hydrogen
290	" " Nitrogen
291	" " Mercury
292	" " Oxygen
293	" " Neon
294	" " Unknown
295	" " Carbon Dioxide
296	" " Holden
297	Galvanometer
298	" Electronic
299	Manganin wire
300	Mobile Phone Trainer
301	Nanovolt pre-amplifier
302	Neon indicator 250V (Various colours)
303	Nichrome wire
304	Solar Cells
305	LED Lights
306	Waveform generator
307	Holography set
308	Interferometer
309	Physical optics kit
310	Leak rate meter
311	Photocell
312	Photodiode
313	Rectifier unit
314	T S Module 401.1 Diode characteristics
315	T S Module 401.2 DC power supply unit
316	Transmission Line Trainer (ST 2261)
317	Junction transistor common base connection
318	Junction transistor common emitter

S/N	Description
319	Transistor Tester
320	Unijunction transistor (U J T)
321	Constant Current Source
322	Emitter Follower voltage stabilizer
323	Free-running multivibrator
324	Silicon controlled rectifier
325	Travelling microscope
326	Multivibrator
327	555 Timer
328	Relay
329	Sunshine Recorder with Accessories
330	Solar Power Meter
331	Sound Level Meter
332	Advanced Spectrometer
333	Semiconductor Kit
334	Modern Tech. & Electronic Trainer System
335	Communication Training System
336	Technology & The Computer Training System
337	Analog Communication Training System
338	Digital Communication Training System
339	Optical Communication Trainer
340	Analog-Digital Signal Conversion Trainer
341	Electricity & Semiconductors Training System
342	Analog Electronics Training System

B. Sc. Science Laboratory Technology

Overview

The programme Science Laboratory Technology (SLT) is a multifaceted professional programme designed to produce skilled technologists with a broad and balanced scientific foundation and enhanced practical skills that would make them stand out in technological skill application, entrepreneurship, job creation, wealth generation, and employability after graduation. The curriculum enables the student to explore a variety of study options that range from agriculture, biological, marine, and physical sciences, to basic medical and engineering principles. Students are exposed to the various laboratory techniques of the study programme option of their choice and also acquire the skill to operate and maintain various types of tools and equipment associated with their study option.

Graduates of the programme are inducted into the Nigerian Institute of Science Laboratory Technology (NISLT) and become licensed professionals in the fields of Science Laboratory Technology.

Philosophy

Science Laboratory Technologist programme is designed to inculcate the spirit of critical thinking and logical reasoning using diverse methods of investigation, observation, and technical knowledge to assist research in diverse laboratories and industries.

Objectives

The main objectives of the Science Laboratory Technology Programme include:

1. production of highly skilled, professionally competent laboratory technologists with practical and theoretical knowledge based on an interdisciplinary approach to the sciences;
2. production of science laboratory technologists with the capacity to design, develop, test, produce, and maintain devices, systems, and products that are beneficial to human race;
3. production of science laboratory technologists with the capacity to coordinate science-based experiments and research in the laboratories and workshops;
4. contribution to the enhancement of technical manpower in national development to satisfy the needs of laboratory requirements in educational institutions, research institutes, industries, and private laboratories; and
5. ensuring socio-economic relevance of the academic programme with particular reference to capacity of graduates for self-employment and the needs of employers of labour.

Unique Features of the Programme

1. The availability of several study options provide students with a wide range of choices that best relate to their talents.
2. The nature of the training programme enables each student to acquire practical, job-ready experience.
3. The development of a course related entrepreneurial skills places graduates on a significant advantage of not only gainfully engaging themselves but also providing employment opportunities to others.

Employability Skills

1. numerical skills;
2. teamwork ability;
3. attention to detail;
4. time management;
5. hand-eye coordination;
6. organisational skills;
7. logical reasoning;
8. management and maintenance skills;
9. practical, job-ready experience.

21st Century Skills

1. creativity
2. critical thinking
3. collaboration
4. communication
5. Innovation
6. Technology literacy
7. Flexibility

Admission and Graduation Requirements

Admission requirements

UTME

Five (5) credit level passes in senior secondary certificate (SSC) or its equivalent in Physics, Chemistry, Biology, Mathematics and English Language obtained at not more than two (2) sittings. This is in addition to an acceptable level of pass at the UTME.

Direct Entry (DE)

Candidates for Direct Entry should in addition to the SS requirements possess either of the followings:

- National Diploma (ND) at least an overall pass at Upper Credit level (CGPA of not less than 3.50) in Science Laboratory Technology;
- Two Advanced Level in any of Biology, Chemistry and Physics at one sitting.

Graduation Requirements

In addition, to fulfilling the general university requirements for graduation, an SLT student must offer and pass courses totalling 150 credit units for the five-year programme and 120 credit units in case of DE candidates, including all the compulsory courses. The minimum cumulative grade point average for graduation must not be below 1.0.

Available options

1 Biology Technology
2 Biochemistry Technology
3 Chemistry Technology
4 Chemical/Petroleum Technology
5 Geology/Mining Technology
6 Microbiology/Biotechnology Technology

7 Physics/Electronics Technology
8 Physiology/Pharmacology Technology

Global Course Structure
All students registered for various techniques of the B.Sc. Science Laboratory Technology degree programme take the same set of courses at the 100 Level. However, the course structures for the different techniques differ from 200 Level when the students commence their specialisation.

100 Level for all Programme Options

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
GLT 101	Hazards & Safety in the Laboratory /Laboratory Maintenance & Fittings	2	C	15	45
GLT 102	Workshop Technology and Practice	2	C	15	45
GLT 104	Glass-Blowing Technology	2	C	15	45
BIO 101	General Biology I	2	C	30	-
BIO 102	General Biology II	2	C	30	-
BIO 107	General Biology Practical I	1	C	-	45
BIO 108	General Biology Practical II	1	C	-	45
CHM 101	General Chemistry I	2	C	30	-
CHM 102	General Chemistry II	2	C	30	-
CHM 107	General Chemistry Practical I	1	C	-	45
CHM 108	General Chemistry Practical II	1	C	-	45
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 107	General Physics Practical I	1	C	-	45
PHY 108	General Physics Practical II	1	C	-	45
Total		**35**			

Course Structure for Biology Technology Programme Option at 200 Level

Course Code	Course Title	Units	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45

Course Code	Course Title	Units	Status	LH	PH
BCH 201	General Biochemistry I	2	C	30	
BCH 202	General Biochemistry II	2	C	30	
BIO 201	Genetics I	2	C	30	-
BIO 203	General Physiology I	2	C	30	-
BOT 202	Seedless Plants	2	C	30	-
CHM 211	Organic Chemistry I	2	C	15	45
MCB 221	General Microbiology I	2	C	15	45
SLT 204	Biological Laboratory Techniques I	2	C	15	45
	Total	**20**			

Course Structure for Biology Technology Programme Option at 300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace And Conflict Resolutions	2	C	30	
ENT 312	Venture Creation	2	C	15	45
SLT 301	Entrepreneurship and Management of SLT Business Venture	2	C	15	45
SLT 304	Biological Laboratory Techniques II	2	C	15	45
SLT 331	Bioinformatics for SLT Students 1	2	C	15	45
BIO 301	Genetics II	3	C	30	45
BIO 307	Industrial Field Course I	1	C	15	-
	Total	**14**			

Course Structure for Biology Technology Programme Option at 400 Level

Course Code	Course Title	Units	Status	LH	PH
SLT 402	Students' Industrial Work Experience	6	C		24 weeks
SLT 431	Bioinformatics for SLT Students 11	2	C	15	45
BIO 404	Nigerian Plants and Animals in Prophylactics & Therapeutics	2	C	30	-
BIO 414	Molecular Biology	3	C	30	45
MCB 412	Microbial Genetics	2	C	15	45
	Total	**15**			

Course Structure for Biology Technology Programme Option at 500 Level

Course Code	Course Title	Units	Status	LH	PH
GLT 501	Laboratory Organisation & Management I	3	C	30	45
GLT 502	Laboratory Organisation & Management I1	3	C	30	45
GLT 508	Photography and Illustrations	2	C	15	45
SLT 501	Seminar	2	C	30	
SLT 502	Research Project	6	C	-	270
SLT 504	Biological Laboratory Techniques III	2	C	15	45
	Total	**18**			

Course Structure for Microbiology/Biotechnology Technology Programme Option at 200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
BIO 201	Genetics I	2	C	30	-
BCH 201	General Biochemistry I	2	C	30	-
CHM 201	Inorganic Chemistry I	2	C	30	-
CHM 213	Analytical Chemistry I	2	C	15	45
MCB 221	General Microbiology	2	C	15	45
MCB 231	Basic Techniques in Microbiology	2	C	-	90
BTG 202	Introduction to Biotechnology	2	C	30	-
BTG 204	Practical in Biotechnology	1	C	-	45
	Total	**19**			

Course Structure for Microbiology/Biotechnology Technology Programme Option at 300 Level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace And Conflict Resolutions	2	C	30	
ENT 312	Venture Creation	2	C	15	45
MCB 307	Immunology	3	C	30	45
SLT 301	Entrepreneurship and Management of SLT Business Venture	2	C	15	45
SLT 331	Bioinformatics for SLT 1	2	C	15	45

Course Code	Course Title	Units	Status	LH	PH
BTG 305	Techniques in Biotechnology	2	C	30	45
	Total	**13**			

Course Structure for Microbiology/Biotechnology Technology Programme Option at 400 Level

Course Code	Course Title	Units	Status	LH	PH
MCB 403	Pharmaceutical Microbiology	2	C	30	-
MCB 405	Principles of Epidemiology and Public Health Management	2	C	30	45
MCB 423	Industrial Microbiology	2	C	30	45
MCB 424	Microbial Physiology and Metabolism	3	C	30	45
MCB 482	Virology & Tissue Culture	2	C	30	45
SLT 402	Students' Industrial Work Experience	6	C	-	24 weeks
SLT 431	Bioinformatics for SLT Students 1I	2	C	15	45
	Total	**19**			

Course Structure for Microbiology/Biotechnology Technology Programme Option at 500 Level

Course Code	Course Title	Units	Status	LH	PH
GLT 501	Laboratory Organisation & Management I	3	C	30	45
GLT 502	Laboratory Organization and Management II	3	C	30	45
GLT 508	Photography and Illustration	2	C	15	45
SLT 501	Seminar	2	C	30	**-**
SLT 502	Research Project	6	C	-	270
	Total	**16**			

Course Structure for Chemistry Technology Programme Option at 200 level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
CHM 207	General Chemistry Practical III	1	C	-	45
CHM 208	General Chemistry Practical IV	1	C	-	45
CHM 210	Physical Chemistry I	2	C	30	-
CHM 211	Organic Chemistry I	2	C	30	-
CHM 212	Inorganic Chemistry I	2	C	30	-
CHM 213	Analytical Chemistry I	2	C	30	-
GLT 201	Instrument Maintenance I	2	C	15	45
STA 202	Statistics for Physical Sciences & Engineering	3	C	45	-
	Total	**19**			

Course structure for Chemistry Technology Programme Option at 300 level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace And Conflict Resolutions	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
CHM 301	Physical Chemistry II	2	C	15	45
CHM 302	Inorganic Chemistry II	2	C	15	45
CHM 303	Organic Chemistry II	2	C	15	45
CHM 304	Atomic & Molecular Structure & Symmetry	2	C	30	-
CHM 312	Analytical Atomic spectroscopy	2	C	15	45
CHM 316	Applied Spectroscopy	2	C	30	-
CHM 319	Environmental Chemistry	2	C	30	-
SLT 301	Entrepreneurship and Management of SLT Business Venture	2	C	15	45
	Total	**20**			

Course Structure for Chemistry Technology Programme Option at 400 Level

Course Code	Course Title	Units	Status	LH	PH
CHM 406	Reaction Kinetics	2	C	30	-
CHM 410	Analytical Chemistry II	3	C	30	45
CHM 423	Organometallic Chemistry	2	C	30	-

Course Code	Course Title	Units	Status	LH	PH
SLT 402	Students' Industrial Work Experience	6	C	-	24 weeks
	Total	**13**			

Course Structure for Chemistry Technology Programme Option at 500 Level

Course Code	Course Title	Units	Status	LH	PH
GLT 501	Laboratory Organisation & Management I	3	C	30	45
GLT 502	Laboratory organization & Management II	3	C	30	45
GLT 508	Photography and Illustration	2	C	15	45
SLT 501	Seminar	2	C	30	
SLT 502	Research Project	6	C	-	270
	Total	**16**			

Course Structure for Biochemistry Technology Programme Option at 200 Level

Course Code	Course Title	Units	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
BCH 201	General Biochemistry I	2	C	30	-
BCH 202	General Biochemistry II	2	C	30	-
CHM 201	Inorganic Chemistry I	2	C	30	-
CHM 202	Analytical Chemistry I	2	C	30	-
CHM 205	Physical Chemistry I	2	C	30	-
CHM 211	Organic Chemistry I	2	C	30	-
CHM 222	Organic Chemistry II	2	C	30	-
GLT 201	Instrument Maintenance I	2	C	15	45
SLT 204	Biological Laboratory Techniques I	2	C	15	45
	Total	**22**			

Course Structure for Biochemistry Technology Programme Option at 300 Level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace and Conflict Resolutions	2	C	30	
ENT 312	Venture Creation	2	C	15	45

Course Code	Course Title	Units	Status	LH	PH
BCH 306	Analytical Methods in Biochemistry	3	C	30	45
CHM 301	Physical Chemistry II	2	C	30	-
CHM 315	Instrumental Method of Analysis	3	C	30	45
CHM 320	Chemistry Laboratory Techniques & Practice I	3	C	15	90
SLT 301	Entrepreneurship and Management of SLT Business Venture	2	C	15	45
SLT 331	Bioinformatics for SLT 1	2	C	15	45
	Total	**19**			

Course Structure for Biochemistry Technology Programme Option at 400 Level

Course Code	Course Title	Units	Status	LH	PH
BCH 402	Molecular Biochemistry	2	C	30	-
SLT 402	Students' Industrial Work Experience	6	C	-	24 weeks
SLT 431	Bioinformatics for SLT 1I	2	C	15	45
	Total	**10**			

Course Structure for Biochemistry Technology Programme Option at 500 Level

Course Code	Course Title	Units	Status	LH	PH
GLT 501	Laboratory Organisation and Management I	3	C	30	45
GLT 502	Laboratory Organisation & Management II	3	C	30	45
GLT 508	Photography and Illustration	2	C	15	45
SLT 501	Seminar	2	C		
SLT 502	Research Project	6	C	-	270
	Total	**16**			

Course Structure for Physics/Electronics Technology Programme Option at 200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
MTH 201	Mathematics Method I	3	C	45	-
COS 201	Computer Programming I	3	C	30	45
PHY 205	Thermal Physics	3	C	45	-
PHY 207	Physics Practical III	1	C	-	45

Course Code	Course Title	Unit(s)	Status	LH	PH
PHY 208	Physics Practical IV	1	C	-	45
PHY 210	Physics of Solid Earth	2	C	30	
PHY 211	Workshop Practice	3	C	30	45
GLT 201	Instrument Maintenance I	2	C	15	45
	Total	**22**			

Course Structure for Physics/Electronics Technology Programme Option at 300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace And Conflict Resolutions	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
PHY 301	Analytical Mechanics II	3	C	45	-
PHY 307	Practical Physics IV	1	C	-	45
PHY 308	Practical Physics V	1	C	-	45
PHY 311	Physics Lab. Techniques & Practice I	2	C	-	90
PHY 314	Solid State Physics I	3	C	45	-
PHY 316	Electronics I	3	C	30	45
SLT 301	Entrepreneurship and Management of SLT Business Venture	2	C	15	45
	Total	**19**			

Course Structure for Physics/Electronics Technology Programme Option at 400 Level

Course Code	Course Title	Units	Status	LH	PH
PHY 401	Quantum Mechanics I	3	C	45	-
PHY 407	Computational Physics	3	C	45	-
SLT 402	Students' Industrial Work Experience	6	C		24 weeks
	Total	**12**			

Course Structure for Physics/Electronics Technology Programme Option at 500 Level

Course Code	Course Title	Units	Status	LH	PH
GLT 501	Laboratory Organisation and Management I	3	C	30	45
GLT 502	Laboratory Organisation & Management II	3	C	30	45

Course Code	Course Title	Units	Status	LH	PH
GLT 508	Photography and Illustration	2	C	15	45
SLT 501	Seminar	2	C	30	-
SLT 502	Research Project	6	C	-	270
	Total	**16**			

Course Structure for Geology/Mining Technology Programme Option at 200 Level

Course Code	Course Title	Units	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
GEY 202	Crystallography and Systematic Mineralogy	2	C	15	45
GEY 203	Introduction to Petrology	2	C	15	45
GEY 207	Principles of Stratigraphy	2	C	30	-
GEY 209	Introduction to Surveying	3	C	15	90
GEY 210	Introduction to Structural Geology and Geological Map Interpretation	2	C	15	45
GEY 212	Introduction to Field Mapping	2	C	-	90
	Total	**17**			

Course Structure for Geology/Mining Technology Programme Option at 300 Level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace And Conflict Resolutions	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
GEY 301	Geochronology & Precambrian Geology of Africa	2	C	30	-
GEY 305	Sedimentary Depositional Environments and Basins of Africa	2	C	30	-
GEY 310	Independent Geological Mapping	3	C	15	90
GEY 313	Structural Geology	3	C	30	45
SLT 301	Entrepreneurship and Management of SLT Business Venture	2	C	15	45
	Total	**16**			

Course Structure for Geology/Mining Technology Programme Option at 400 Level

Course Code	Course Title	Units	Status	LH	PH
GEY 406	Micropalaeontology and Palynology	3	C	30	45
GEY 409	Applied Geophysics	3	C	30	45
GEY 410	Engineering Geology	2	C	30	-
GEY 411	Hydrogeology	2	C	30	-
GEY 415	Geology of Nigeria	2	C	-	90
SLT 402	Students' Industrial Work Experience	6	C		24 weeks
	Total	**18**			

Course Structure for Geology/Mining Technology Programme Option at 500 Level

Course Code	Course Title	Units	Status	LH	PH
GLT 501	Laboratory Organisation & Management I	3	C	30	45
GLT 502	Laboratory Organisation & Management II	3	C	30	45
GLT 508	Photography and Illustration	2	C	15	45
SLT 501	Seminar	2	C	30	-
SLT 502	Research Project	6	C	-	270
	Total	**16**			

Course Structure for Chemical/Petroleum Technology Programme Option at 200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
COS 201	Computer Programming I	3	C	30	45
COS 202	Computer Programming II	3	C	30	45
CHM 201	Inorganic Chemistry I	2	C	30	**-**
CHM 205	Physical Chemistry I	2	C	30	-
CHM 211	Organic Chemistry	2	C	30	-
CHM 225	Petroleum Chemistry	3	C	45	-
PCM 204	Petroleum Chemistry Lab I	1	C	-	45
PCM 205	Petroleum Chemistry Lab II	1	C	-	45
GLT 201	Instrument Maintenance	2	C	15	45
	Total	**23**			

Course Structure for Chemical/Petroleum Technology Programme Option at 300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolutions	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
CHM 312	Separation Methods and Analysis	3	C	30	45
PCM 304	Petroleum Chemistry Lab II	1	C	-	45
PCM 305	Petroleum Refining	2	C	30	-
PCM 306	Instrumental Method of Analysis	2	C	30	-
SLT 301	Entrepreneurship and Management of SLT Business Venture	2	C	15	45
	Total	**14**			

Course Structure for Chemical/Petroleum Technology Programme Option at 400 Level

Course Code	Course Title	Units	Status	LH	PH
PCM 403	Introduction to Catalysis	2	C	30	-
PCM 404	Petrochemicals I	2	C	30	-
PCM 405	Petrochemicals II	2	C	30	-
PCM 408	Corrosion Chemistry	2	C	30	-
SLT 402	Students' Industrial Work Experience	6	C		24 weeks
	Total	**14**			

Course Structure for Chemical/Petroleum Technology Programme Option at 500 Level

Course Code	Course Title	Units	Status	LH	PH
GLT 501	Laboratory Organisation & Management I	3	C	30	45
GLT 502	Laboratory Organisation & Management II	3	C	30	45
GLT 508	Photography and Illustration	2	C	15	45
SLT 5O1	Seminar	2	C	C	
SLT 502	Research Project	6	C	-	270
	Total	**16**			

Course Structure for Physiology/Pharmacology Technology Programme Option at 200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
GLT 201	Instrument Maintenance I	2	C	15	45
PIO 201	Introductory Physiology & Blood	2	C	30	-
PIO 212	Renal & Body fluids Physiology	2	C	30	-
PIO 214	Introduction to Cardiovascular & Respiratory Physiology	3	C	45	-
PIO 216	Gastrointestinal Physiology	2	C	30	-
PIO 218	Introduction to Laboratory Physiology I	1	C	-	45
PCH 203	Pharmaceutical Organic Chemistry	2	C	30	45
	Total	**18**			

Course Structure for Physiology/Pharmacology Technology Programme Option at 300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolutions	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
PHA 301	General Principles of Pharmacology	2	C	30	-
PHA 302	Pharmacokinetics and Pharmacogenetics	2	C	30	-
PHA 304	Autonomic Pharmacology II	1	C	30	**-**
PHA 305	Neuropharmacology: CNS Depressants and Stimulants	2	C	15	45
PHA 306	Pharmacology of Respiratory and Cardiovascular Systems	2	C	15	45
PIO 309	Practical Physiology II	1	C	**-**	45
SLT 301	Entrepreneurship and Management of SLT Business Venture	2	C	15	45
SLT 331	Bioinformatics for SLT students 1	2	C	15	45
	Total	**19**			

Course Structure for Physiology/Pharmacology Technology Programme Option at 400 Level

Course Code	Course Title	Units	Status	LH	PH
PHA 405	Ethnopharmacology	2	C	15	45
PHA 409	Quantitative Pharmacology	2	C	15	45
PIO 414	Cardiopulmonary Physiology	2	C	30	-
SLT 402	Students' Industrial Work Experience (24 Weeks)	6	C		270
SLT 431	Bioinformatics for SLT students 11	2	C	15	45
	Total	**14**			

Course Structure for Physiology/Pharmacology Technology Programme Option at 500 Level

Course Code	Course Title	Units	Status	LH	PH
GLT 501	Laboratory Organization and Management I	3	C	30	45
GLT 502	Laboratory Organization and Management II	3	C	30	45
GLT 508	Photography and illustration	2	C	15	45
SLT 501	Seminar	2	C		
SLT 502	Research Project	6	C	-	270
	Total	**16**			

Course Contents and Learning Outcomes

100 Level Courses for all Programme Options

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. identify possible sound patterns in English Language;
2. list notable Language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English Language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and

Deductive Argument and Reasoning Methods, Analogy, Generalisation and Explanations). Ethical considerations, Copyright Rules and Infringements. Writing Activities: (Pre-writing , Writing, Post writing, Editing and Proofreading; Brainstorming, outlining, Paragraphing, Types of writing, Summary, Essays, Letter, Curriculum Vitae, Report writing, Note making etc. Mechanics of writing). Comprehension Strategies: (Reading and types of Reading, Comprehension Skills, 3RsQ). Information and Communication Technology in modern Language Learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of trade, economic and self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian state towards nation building
6. analyse the role of the judiciary in upholding people's fundamental rights
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian civil war). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justice and national development (law definition and classification. Judiciary and fundamental rights. Individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation; Re-orientation strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption (WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic definition of Set, subset, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers; integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers; algebra of complex numbers; the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of Function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative, as limit of rate of change. Techniques of differentiation. Extreme curve sketching; Integration as an inverse of differentiation. Methods of integration, Definite integrals. Application to areas, volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:

1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the

computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

BIO 101: General Biology I (2 Units C: LH 30)

Learning Outcomes
At the end of lectures, students should be able to:
1. explain cell's structure and organisations;
2. summarise functions of cellular organelles;
3. characterise living organisms and state their general reproduction;
4. describe the interrelationship that exists between organisms;
5. discuss the concept of heredity and evolution; and
6. enumerate habitat types and their characteristics.

Course Contents
Cell structure and organisation. Functions of cellular organelles. characteristics and classification of living things. Chromosomes, genes their relationships and importance. General reproduction. Interrelationships of organisms (competitions, parasitism, predation, symbiosis, commensalisms, mutualism, saprophytism). Heredity and evolution (introduction to Darwinism and Lamarkism. Mendelian laws. Explanation of key genetic terms). Elements of ecology and types of habitats.

BIO 102: General Biology II (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures, students should be able to:
1. list the characteristics, methods of identification and classification of Viruses, bacteria and fungi;
2. state the unique characteristics of plant and animal kingdoms;
3. describe ecological adaptations in the plant and animal kingdoms;
4. explain nutrition, respiration, excretion and reproduction in plants and animals; and
5. describe growth and development in plants and animals.

Course Contents
Basic characteristics, identification and classification of viruses, bacteria and fungi.
A generalized survey of the plant and animal kingdoms based mainly on the study of similarities and differences in the external features. Ecological adaptations. Briefs on physiology to include nutrition, respiration, circulatory systems, excretion, reproduction, growth and development.

BIO 107: General Biology Practical I **(1 Unit C: PH 45)**

Learning Outcomes
At the end of the course, students should be able to:
1. outline common laboratory hazards;
2. provide precautions on laboratory hazards;
3. state the functions of the different parts of microscope;
4. use the microscope and describe its maintenance;
5. draw biological diagrams and illustrations; and
6. apply scaling and proportion to biological diagrams.

Course Contents
Common laboratory hazards. prevention and first aid. Measurements in biology. Uses and care of microscope. compound and dissecting microscope. Biological drawings and illustration. scaling, accuracy and proportion. Use of common laboratory apparatus and laboratory experiments designed to illustrate the topics covered in BIO 101

BIO 108: General Biology Practical II **(1 Unit C: PH 45)**

Learning Outcomes
At the end of the course, students should be able to:
1. describe the anatomy of flowering plants;
2. differentiate types of fruit and seeds;
3. state ways of handling and caring for biological wares;
4. describe the basic histology of animal tissues; and
5. identify various groups in the animal kingdom.

Course Contents
Anatomy of flowering plants, primary vegetative body. stem, leaf and root to show the mature tissues namely parenchyma, collenchyma, sclerenchyma, xylem and phloem. Types of fruits and seeds. Care and use of dissecting kits and other biological wares. Dissection and general histology of animal tissues based on vertebrate forms. Morphology and functions of epithelial, muscular, nervous and connective tissues. Examination of various groups of lower invertebrates under microscopes. identification of various groups of organisms in animal kingdom. And any experiment designed to emphasize the practical aspects of topics in BIO 102

CHM 101: General Chemistry I **(2 Units C: LH 30)**

Learning Outcomes
At the end of this course, the students should be able to:
1. define atom, molecules and chemical reactions;
2. discuss the modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. rationalize the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. draw shapes of simple molecules and hybridized orbitals;

7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using Lechatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents
Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence Forces; Structure of solids. Chemical equations and stoichiometry; Chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry; rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. state rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reaction;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1a, IIA and IVA elements; and
9. describe basic properties of transition metals.

Course Contents
Historical survey of the development and importance of Organic Chemistry. Fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures, nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The Chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. state the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;

3. identify the basic glassware and equipment in the laboratory;
4. identify the differences between primary and secondary standards;
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents
Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM102. These include acid-based titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. state the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify and carry out preliminary tests which includes ignition, boiling point, melting point, test on known and unknown organic compounds;
5. carry out solubility tests on known and unknown organic compounds;
6. carry out elemental tests on known and unknown compounds; and
7. carry out functional group/confirmatory test on known and unknown compounds which could be acidic / basic / neutral organic compounds.

Course Contents
Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

GLT 101: Hazards & Safety in the Laboratory/Laboratory Maintenance & Fittings (2 Units C: LH 15; PH 45)

Learning Outcomes
Students who successfully complete this course should:
1. have the enabling knowledge to bring laboratory accidents to the barest minimum;
2. be able to install, care, and maintain common laboratory equipment and fittings;
3. be able to administer first aid treatment for common laboratory accidents.

Course Contents
Accidents and control measures**.** Common laboratory accidents/injuries and their control measures. Hazards and caution in the use of electricity supplies. Causes of fire in the laboratory. Precautions against fire and explosion. Action in an emergency involving fire, explosion and implosion. Burns and scalds. Types and operation of firefighting equipment. First aid treatment**:** first aid treatment of common injuries encountered in laboratories. Treatment of shock. Dealing with various bleedings. Wounds, burns and poison, eye injuries. First aid box**:** description, construction, location and contents of first aid box.

Maintenance of laboratory equipment**:** installation of common laboratory equipment. Care and maintenance of laboratory equipment. (a) Trouble shooting and fault finding (b) Servicing and repairs of common laboratory equipment.
Laboratory fittings**:** standard laboratory fittings and services; correct use and care. The necessity to clean and tidy benches and floors in the laboratory. Cleaning of different types of bench-tops and flooring materials. Identification and location of master switches and master gas taps. Colour code of compressed gas cylinders, electrical resistors and services lines. Precaution in handling and use of compressed air and liquefied gas cylinders.

GLT 102: Workshop Technology and Practice (2 Units C: LH 15; PH 45)

Learning Outcomes
On completion, the student should be able to:
1. identify the safety rules associated with workshop practice;
2. use common types of equipment used in workshop and technology practice; and
3. carry out simple wood and metal works.

Course Contents
General safety rules and regulations in the workshop with emphasis on the following elements: workers, working tools, machines and working environment.
Introduction to simple woodwork practice**:** Woodwork tools and equipment – types and uses. Woodwork machines and accessories – types and uses. Various types of woodwork joints and uses. Basic types of wood and uses. Wood seasoning and application in the laboratory.
Introduction to simple metal work practice**:** metalwork tools and equipment – types and uses. Metals in use in engineering industry – ferrous and non-ferrous castings, (mode of production and basic applications). Bench-work practice-cutting, chipping, filing and use of taps and dies. Bench drilling machine-parts, operation, and uses. Lathe machine-parts, operation and uses. Arc and gas welding processes.
Scope of practical work**:** woodwork practicals designed by lecturers to test students' dexterity in woodwork joint and wood shaping processes such as Tee square, drawing board, photo frames, saving boxes etc. Metalwork practicals designed by lecturers to test students' dexterity in bench-work, drilling machine, and lathe-machine work practice such as male and female mating of parts.

GLT 104: Glass –Blowing Technology (2 Units C: LH 15; PH 45)

Learning Outcomes
On completion, the student should be able to:
1. explain the chemistry of glass, its various types, composition and applications;
2. identify equipment and tools used in the technology of glass-blowing and their associated hazards; and
3. operate simple glass blowing tools and machines, and carry glass cutting.

Course Contents
The origin and nature of glass; simple analysis of glass composition. Types of glass commonly used in laboratories. Properties of different glasses commonly used in laboratories. Identification of glass by physical, flame and chemical methods. Design of glassblowing workshop. Identification of various tools and equipment used in the glassblowing workshops.

The use of non-return valves and goggles. Hazards of glassblowing; safety measures and regulation. Glass tubing storage.
Construction of simple glass apparatus: Glass cutting and various types of glass cutting techniques. Manipulations of simple glass blowing tools and machines.
Burners: surface and premix burners. "Point-pulling" and various methods of glass manipulations. End deals – for making test tables. Blow bulbs at thaw ends and in the middle of glass tubes. Bends for delivering tubes and manometers. Tee joints and the attendant problems.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes
On completion, the student should be able to:
1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents
Space and time. Units and dimension. Vectors and Scalars. Differentiation of vectors: displacement, velocity and acceleration. Kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). Relative motion. Application of Newtonian mechanics. Equations of motion. Conservation principles in physics. Conservative forces. Conservation of linear momentum. Kinetic energy and work. Potential energy. System of particles. Centre of mass. Rotational motion; Torque, vector product, moment. Rotation of coordinate axes and angular momentum. Polar coordinates. Conservation of angular momentum. Circular motion. Moments of inertia, gyroscopes and precession. Gravitation: Newton's Law of Gravitation, Kepler's laws of planetary motion, gravitational potential energy, escape velocity, satellites motion and orbits.

PHY 102: General Physics II (Behaviour of Matter) (2 Units C: LH 30)

Learning Outcomes
On completion, the student should be able to:
1. explain the concepts of heat and temperature and relate the temperature scales;
2. define, derive, and apply the fundamental thermodynamic relations to thermal systems;
3. describe and explain the first and second laws of thermodynamics, and the concept of entropy;
4. state the assumptions of the kinetic theory and apply techniques of describing macroscopic behaviour;

5. deduce the formalism of thermodynamics and apply it to simple systems in thermal equilibrium; and
6. describe and determine the effect of forces and deformation of materials and surfaces.

Course Contents
Heat and temperature. Temperature scales, Gas laws. General gas equation. Thermal conductivity; First law of thermodynamics; heat, work and internal energy, reversibility. Thermodynamic processes; adiabatic, isothermal, isobaric. Second law of thermodynamics; heat engines and entropy. Zero's law of thermodynamics; kinetic theory of gases. Molecular collisions and mean free path. Elasticity; Hooke's law, Young's, shear and bulk moduli. Hydrostatics; Pressure, buoyancy. Archimedes' principles. Bernoulli's equation and incompressible fluid flow. Surface tension; adhesion, cohesion, viscosity, capillarity, drops and bubbles.

PHY 107: General Practical Physics I (1Unit C: PH 45)

Learning Outcomes
On completion, the students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasizes quantitative measurements, the treatment of measurement errors, and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc., covered in PHY 101, 102, 103 and PHY 104. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

PHY 108: General Practical Physics II (1Unit C: PH 45)

Learning Outcomes
On completion, the students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data; and
6. prepare and present practical reports.

Course Contents
This practical course is a continuation of PHY 107 and is intended to be taught during the second semester of the 100 level to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements, the treatment of

measurement errors, and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction

Level 200 Courses for all Programme Options

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;
2. state the characteristics of an entrepreneur;
3. analyze the importance of micro and small businesses in wealth creation, employment, and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents
Concept of Entrepreneurship (Entrepreneurship, Intrapreneurship/Corporate Entrepreneurship,). Theories, rationale and relevance of Entrepreneurship (Schumpeterian and other perspectives, Risk-taking, Necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of entrepreneurs (Opportunity seeker, Risk taker, Natural and nurtured, Problem solver and change agent, Innovator and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking, and creative thinking). Innovation (Concept of innovation, Dimensions of innovation, Change and innovation, Knowledge and innovation). Enterprise formation, partnership and networking (Basics of business plan, Forms of business ownership, Business registration and forming alliances and joint ventures). Contemporary entrepreneurship issues (Knowledge, Skills and Technology, Intellectual property, Virtual office, Networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, Youth and women entrepreneurship, Entrepreneurship support institutions, Youth enterprise networks and environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

BCH 201: General Biochemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures, students should be able to:
1. explain the structure of different macromolecules in biological system;
2. identify types of chemical reactions involving these macromolecules;
3. explain the various methods of isolation of these macromolecules;
4. estimate the effects of acids and alkalis on the macromolecules;
5. describe purification of macromolecules; and
6. discuss quantification of the various macromolecules.

Course Contents
Introductory chemistry of amino acids; their properties, reactions and biological functions. Classification of amino acids: neutral, basic and acidic; polar and non-polar; essential and non-essential amino acids. Peptides. Introductory chemistry and classification of proteins. Biological functions of proteins. Methods of their isolation, purification and identification. Primary, secondary, tertiary and quaternary structures of proteins. Basic principles of tests for proteins and amino acids. Introductory chemistry of carbohydrates, lipids and nucleic acids. Nomenclature of nucleosides, and nucleotides; effects of acid and alkali on hydrolysis of nucleic acids.

BCH 202: General Biochemistry II (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. identify the structure of the cell including its components;
2. discuss the interrelationship between different organelles of the cell;
3. recognize the differences between plant and animal cells;
4. isolate the various organelles of both plant and animal cells; and
5. explain the influence of hydrogen ion concentration on cellular function.

Course Contents
The cell theory. Structures and functions of major cell components. Cell types, constancy and diversity. Cell organelles of prokaryotes and eukaryotes. Chemical composition of cells. Centrifugation; Methods of cell fractionation. Structure, function and fractionation of extra-cellular organelles. Water, total body water and its distribution. Regulation of water and electrolyte balance. Disorder of water and electrolyte balance. Acidity and alkalinity, pH and pK values and their effects on cellular activities.

BCH 203: General Biochemistry Practical (1 Unit C: PH 45)

Learning Outcome
At the end of the course, students will be able to:
1. explain the various laboratory procedures used in the study of various biochemical processes.

Course Contents
Laboratory experiments designed to reflect the topics covered in BCH 201 and BCH 202. Introduction to laboratory methods and procedures employed in studying biochemical processes.

BIO 201: Genetics I (2 Units C: H 30)

Learning Outcomes
At the end of this course, students should be able to:
1. distinguish between heritable and non-heritable characteristics,
2. explain the likelihood of genetic events (Probability) and how well those events (results) fit into a set of observation;
3. discuss polygenic variations; and
4. describe concepts in population genetics.

Course Contents
Hereditable and non-hereditable characteristics. Probability and tests of goodness of fit. Quantitative inheritance; variation in genome structure, introduction to population genetics.

BIO 202: Introductory Ecology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the lectures in this course, students should be able to:
1. explain various concepts and terminologies associated with the ecosystem;
2. list and explain features of various habitat types;
3. explain natural destruction/disaster, community and natural cycles; and
4. explain and describe factors responsible for changes in population.

Course Contents
Concept and definition of ecosystem. Ecology at community level. Ecological classification of habitat types. Terrestrial and aquatic biomass. Specific features of each, biotic components of habitat. Natural destruction. Factors of communities. Success of community interaction. Natural cycle. Dynamics of population.

BIO 203: General Physiology (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the chemistry of organic compounds and their biological importance;
2. state the general characteristics of enzymes;
3. describe nutrition, digestion and absorption in plants and animals;
4. discuss the cell membrane structure and list its functions;
5. summarize osmoregulation, excretion and transport in animals;
6. enumerate growth hormones in plants and their functions;
7. explain the homeostasis, their coordination and functions in animals;
8. explain the plant water relation, growth and growth regulation.

Course Contents
Chemicals of life: The chemistry of carbohydrates, lipids, proteins and nucleic acids and their biological importance. General characteristics of enzymes; nutrition, digestion, and absorption in plants and animals. Biosynthesis: Photosynthesis and protein synthesis. Cell membrane structure and function.
A general study of osmoregulation, excretion, transport, growth hormones and enzymology, homeostasis and their co-ordination in animals. Plant water relation, growth and growth regulation.

BIO 204: Biological Techniques (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the lectures, students should be able to:
1. list the different parts of a light microscope and state their functions;
2. state and explain the stages involved in preparation of slides;
3. describe the basic principles of spectrophotometry, colorimetry, photometry;
4. describe polarimetry, chromatography, refractometry, melting points and colligative properties;
5. describe the basic collection and preservation processes of plant and animal materials and their preservation in herbarium and museum respectively; and
6. explain the need for experimental design, basis of report writing and presentations.

Course Contents
Microscopy. handling of microscopes. preparation of microscope slides (microtomy) for microscopic examinations. use of hand lens. biological drawings and diagrams. Spectrophotometry. Colorimetry. Photometry. Polarimetry. Chromatography. Refractometry. melting points and colligative properties. Herbarium and museum techniques. Experimental designs, report writing and presentations.

BIO 205: Introductory Developmental / Cell Biology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the lectures in this course, students should be able to:
1. draw the detailed structure of plant and animal cells and state the functions of the organelles;

2. summarise and state the differences and similarities between mitosis and meiosis;
3. describe cell differentiation and its growth; and
4. explain the molecular basis of cell structure and development.

Course Contents
History and present trends in cell biology. Ultra-structure of the plant and animal cells, Organelles and their basic structures and functions. Mitosis and meiosis. Cell differentiation and growth of cells. A brief study of the molecular basis of cell structure and development.

BOT 202: Seedless Plants (2 Units C: LH 30)

Learning Outcomes
The students, at the end of the course, will be able to:
1. recognise the basic structure of fungi, algae, bryophyte and pteridophytes;
2. relate the evolutionary sequences of the seedless plants;
3. identify plants that do not possess seeds; and
4. explain the fossils plants

Course Contents
Morphology and reproduction of fungi. Morphology and reproduction of algae. Morphology and reproduction of bryophytes and pteridophytes. Morphology and reproduction of fossils of fungi, algae, bryophytes and Pteridophytes. Evolutionary sequences of the members of Thallophytes (Bacteria, fungi and bryophytes and pteridophytes)

BTG 204: Practical in Biotechnology (1 Unit C: PH 45)

Learning Outcomes
The successful students will be able to:
1. manipulate the microscope to view different types of cells;
2. estimate the population density of cells in a medium;
3. carry out thin sectioning of cells, stain and view;
4. carryout aseptic protocol, extract DNA from a cell and view after gel electrophoresis; and
5. explain PCR principles, primer design and the concept of cloning.

Course Contents
Microscopic examination of cells. Measurement of cell size using micrometer. Measurement of cell concentrations (microscopic enumeration, fresh weight, dry weight, packed cell volume). Microtome sectioning and microscopy. Aseptic techniques and autoclaving. Different DNA extraction methods, gel electrophoresis, polymerase chain reaction techniques, primer design, overview of DNA cloning. Plasmids and episomes. Cultivation of bacteria and yeast cells under aerobic and anaerobic conditions; cultivation of microalgae (*Chlorella sorokiniana)*. Protoplast isolation and genetic recombination by protoplast fusion.

CHM 210: Physical Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. state the kinetic theory of gases and solve problems related to ideal and real gases;

2. derive the formula for molecular velocity of gases and use the derived formula to solve problems;
3. describe and explain the fundamental concepts of physical chemistry including those of statistical mechanics, chemical kinetics, quantum mechanics and spectroscopy;
4. apply simple models to predict properties of chemical systems;
5. define and state types of solutions; define different concentration terms which include molarity, normality etc. explain vapour pressure lowering of the solvent, boiling point elevation of solutions, freezing point depression of solution and measurement of osmotic pressure;
6. apply numerical or computational methods to calculate physical properties of chemical systems and assess the appropriateness of different computational techniques and numerical approximations for solving chemistry problems;
7. design and plan an investigation by selecting and applying appropriate practical, theoretical, and/or computational techniques or tools; and
8. states ohms law and describe the electrolytic conduction, states the faraday's law and conductance law of solution and calculation on electrical conductance on different electrolyte solution.

Course Contents
Kinetic theory of gases; science of real gases; the laws of thermodynamics; entropy and free energy; reactions and phase equilibria; reaction rates; rate laws; mechanism and theories of elementary processes; photochemical reactions; basic electrochemistry.

CHM 211: Organic Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe and solve problems in chemistry of aromatic compounds;
2. describe the structures of simple sugars, starch and cellulose, peptides and proteins and show the difference in their conformation structure;
3. describe and solve problems in chemistry of bifunctional compounds;
4. explain the mechanisms of substitution, elimination, addition and rearrangement reactions;
5. describe stereochemistry and its application;
6. describe conditions and pathways of the following organic reactions - Grignard reaction, Aldol and related reactions; and
7. describe simple alicyclic carbon compounds and their synthesis.

Course Contents
Chemistry of aromatic compounds. Structures of simple sugars, starch and cellulose, peptides and proteins. Chemistry of bifunctional compounds. Energetics, kinetics and the investigation of reaction mechanisms. Mechanisms of substitution, elimination, addition and rearrangement reactions. Stereochemistry. Examples of various named organic reactions e.g. Grignard reaction, Aldol and related reactions. Simple alicyclic carbon compounds and their synthesis.

CHM 212: Inorganic Chemistry I **(2 Units C: LH 30)**

Learning Outcomes

After completing the course, the students will be able to:

1. list the first-row transition elements and explain their characteristics and properties;
2. explain crystal field theory (CFT) and draw the diagram to illustrate with examples of coordination compounds;
3. state the advantages of CFT over other bonding theories;
4. discuss the comparative Chemistry of the following elements. (I) Ga, In, Tl (II). Ge, Sn, Pb (III). As, Sb, Bi (IV). Se, Te, Po;
5. define organometallic Chemistry;
6. give relevant examples with illustrations;
7. classify organometallic compounds with examples;
8. list the roles of metals in biochemical systems;
9. discuss the concepts of hard and soft acids and bases.
10. list examples of item 9 above;
11. explain oxidation and reduction reaction; and
12. illustrate the above (11) with appropriate reactions.

Course Contents

Chemistry of first row transition metals. Introduction to coordination chemistry including elementary treatment of crystal field theory. Comparative Chemistry of the following elements: (a) Ga, In, TI, (b) Ge, Sn, Pb, (c) As, Sb, Bi (d) Se, Te, Po. Elementary introduction to organometallic chemistry. Role of metals in biochemical systems. Concepts of hard and soft acids and bases. Oxidation and reduction reactions.

CHM 213: Analytical Chemistry I **(2 Units C: LH 15; PH 45)**

Learning Outcomes

At the end of this course, the students should be able to:

1. explain analytical processes which include description of chemist as a problem solver;
2. describe and differentiate forms of error;
3. explain its implication on laboratory analysis;
4. state different statistical tool use in treatment of data;
5. solve practical problems using the statistical tools;
6. define sampling and give reasons for sampling in field work;
7. state and describe different sampling techniques;
8. state different forms of sample collection and processing;
9. describe volumetric method of analysis and solve some practical problems; and
10. describe gravimetric method of analysis and solve some practical problems.

Course Contents

Theory of errors; and statistical treatment of data: Theory of sampling. Chemical methods of analysis including volumetric, gravimetric, data analysis and presentation. Physicochemical methods, Optical methods of analysis; separation methods.

GEY 202: Crystallography and Systematic Mineralogy (2 Units C: LH 15; PH 45)

Learning Outcomes
Students should, at the end of the course, be able to:
1. determine physical properties of minerals;
2. describe and identify some minerals;
3. describe the crystal system; and
4. list and identify various crystal system.

Course Contents
The main morphological properties, classification and mode of occurrence of rock forming minerals. Crystal system and identification.

GEY 203: Introduction to Petrology (2 Units C: LH 15; PH 45)

Learning Outcomes
Students should, at the end of the course, be able to:
1. describe igneous, metamorphic and sedimentary rocks;
2. identify igneous, metamorphic and sedimentary rocks;
3. describe the texture of igneous, metamorphic and sedimentary rocks;
4. classify igneous, metamorphic and sedimentary rocks.

Course Contents
Origin, occurrence, geologic setting and systematic description and classification of igneous rocks. Metamorphism and description of metamorphic rocks, metamorphic minerals and textures of metamorphic rocks and classification. Sediments and description of sedimentary rocks. Textures, mineral composition and classification of sedimentary rocks.

GEY 205: Invertebrate Palaeontology (2 Units C: LH 15; PH 45)

Learning Outcomes
Students should, at the end of the course, be able to:
1. explain and describe the morphology of the fossil groups;
2. classify major invertebrate fossil groups;
3. define and describe the stratigraphic range and ecology of the fossils;
4. explain paleobiologic models
5. draw and label the morphological elements of the fossils; and
6. identify the fossils.

Course Contents
Major invertebrate fossil groups, their morphology, taxonomy, classification, ecology, stratigraphic distribution and evolutionary trends. Paleontological principles and paleobiologic models. Macro- and micro- evolution.

GEY 207: Principles of Stratigraphy (2 Units C: LH 30)

Learning Outcomes
Students, at the end of the course, should be able to:
1. define stratigraphy and classify stratigraphy;
2. list and discuss techniques and parameters of stratigraphic analysis;
3. discuss the geologic time scale and its applications;
4. review the facies concept and application of Walther's law; and
5. explain correlation and correlation criteria.

Course Contents
Basic principles of stratigraphy applied to sedimentary sequences in geologic time. Facies concept and facies changes. Stratigraphy of sedimentary basins in Nigeria. Introduction to facies map, correlation and stratigraphic cross-sections.

GEY 209: Introduction to Surveying (3 Units C: L15; PH 90)

Learning Outcomes
Students, at the end of the course, should be able to:
1. list the surveying instruments and their uses; and
2. state the methods of surveying.

Course Contents
Introduction to surveying instruments and their uses e.g., the chain, steel measuring tape, ranging poles, land chain arrows, dumping levels, theodolite, planimeters. Methodologies and techniques of linear and areal surveying. Geological and mining evaluation.

GEY 210: Introduction to Structural Geology and Geological Map Interpretation (2 Units C: LH 15; PH 45)

Learning Outcomes
Students, at the end of the course, should be able to:
1. define and illustrate geological structures;
2. relate and represent scales of maps;
3. read topographic maps;
4. prepare a base map; and
5. prepare and interpret geological maps.

Course Contents
Basic structural elements; folds, faults, foliations and joints. Contours and contouring. Recognition of basic geological and geographic features. Geological structures. Preparation and interpretation of topographic and base maps. Detailed interpretation of simple geological maps.

GEY 212: Introduction to Geological Field Mapping (2 Units C: PH 90)

Learning Outcomes
At the end of this course students should be able to:
1. use simple geological equipment in the field;
2. prepare a base map;
3. observe and record field geology data;
4. prepare and interpret geological maps; and
5. write geological reports.

Course Contents
Practical – observation and recording of geological and features in particular in sedimentary and crystalline rock terrains. Sampling and labelling of samples. Application of field techniques. Field data management. Base and geological maps interpretation. Report writing.

GLT 201: Instrument Maintenance I (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course students should be able to:
1. identify electrical and electronic components;
2. describe measuring instruments; and
3. Explain measuring instruments, read circuit diagrams; and effect repairs of differential electronic devices, and carry out corrective maintenance power supplies.

Course Contents
Electrical and electronic components – Electrical quantities; Ohm's law in circuitry; resistors, capacitors, semi-conductors; transducers, photo-multipliers and photodiodes.
Measuring Instruments – Analytical, audio-visual, and diagnostics. Care and safety; practical use of measuring instruments. Study of components layout: Circuit training, referring to manufacturer's data. Reading of circuit diagrams; repair differential electronic devices. Maintenance, services, and repair procedures of electric devices, electrical and electronic circuits, circuit diagrams and designs, types of maintenance. Factors affecting maintenance. Corrective maintenance. Power supplies.

MCB 221: General Microbiology (3 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the basic concepts and scope of microbiology;
2. describe the layout of a microbiology laboratory, equipment and reagents in a microbiology laboratory; and
3. discuss the theory behind basic protocols in a microbiology laboratory

Course Contents
History of the Science of Microbiology. Classification of organisms into prokaryotes and eukaryotes; Classification of prokaryotes into archaea and eubacteria. Anatomy and cytochemistry of bacteria and fungi. Shapes, groupings and colonial morphology of bacteria and fungi. Structure of viruses. Sterilization and disinfection; Structure, ecology and reproduction of

representative microbial genera. Culture of micro-organisms. Isolation of micro-organisms; isolation of bacteria, viruses' fungi (yeasts and moulds. Nutrition and biochemical activities of micro-organisms. Antigens and antibodies. Identification and economic importance of selected microbial groups. Microbial variation and heredity. Study of laboratory equipment. Introduction to microbiology of air, food, milk, dairy products, water and soil. Staining techniques, antibiotic sensitivity tests, serological tests, antimicrobial agents.

MCB 231: Basic Techniques in Microbiology (2 Units C: PH 90)

Learning Outcomes
At the end of the course, students will be able:
1. identify techniques used for the isolation of bacteria from soil, water, food and air;
2. explain the process for obtaining pure cultures of bacteria and fungi;
3. discuss the techniques used for the characterization and identification of bacterial isolates; and
4. describe the methods of bacteria enumeration and preservation of isolates and methods for culturing anaerobic bacteria.

Course Contents
Culturing of micro-organisms; preparation of media for microbial growth. Isolation of pure culture; streaking, pour plates etc; subculturing procedures. Staining techniques for differentiation of microorganisms. Enumeration of microorganisms, direct and indirect procedures. Identification of microorganisms to include colonial and cellular morphology and biochemical procedures. Identification of bacteria should also include the use of serological techniques, antibiotic sensitivity discs and agar-in well methods. The use of anaerobic jar for growth of anaerobic organisms. Methods of preservation (agar slants, frequent subculturing, refrigeration and use of deep freezers, lyophilisation, storage in liquid nitrogen) of microbial cultures

PCH 203: Pharmaceutical Organic Chemistry (1 Unit C: LH 15)

Learning Outcomes
At the end of the course, students should be able to:
1. explain chemical structures affect the physicochemical properties of drugs;
2. classify drug into different classes based on their chemical structures; and
3. describe synthetic pathways of drugs.

Course Contents
Characteristics of organic chemistry, its relationship to other branches of chemistry and its relevance to Pharmacy. Physical properties of organic compounds – melting point, boiling point, solubility. General Classes of Organic Compounds. Structural concepts, nomenclature, occurrence, reactions, physical and chemical properties with examples of some pharmaceutical agents. Hydrocarbons – Alkenes, Alkynes, Aromatic and fused aromatic hydrocarbons. Halogenated hydrocarbons. Alcohols and phenols. Aldehydes and ketones. Carboxylic acids and derivatives – Esters, Lactones Amides, Anhydrides, Halides. Nitrogenous compounds – Amines, Amides, Imides, Carbamates derivatives, Nitro and Nitroso compounds.

PCM 204: Petroleum Chemistry Lab I (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. determine density and specific gravity of petroleum;
2. determinate hydrocarbon groups in petroleum fractions by sulphuric acid treatment;
3. estimate percent aromatic hydrocarbons by aniline point method;
4. determine of correlation index of hydrocarbon; and
5. determine wax content of crude oil.

Course Contents
Determination of hydrocarbon groups in Petroleum fractions by sulphuric acid treatment. Determination of hydrocarbon group composition in petroleum fractions by method of fluorescent indicator adsorption technique. Estimation of percent aromatic hydrocarbons by Aniline point method. Determination of density and specific gravity of petroleum. Determination of viscosity of petroleum products by Ostwald viscometer. Determination of correlation index of hydrocarbon. Determination of wax in crude oil.

PCM 205: Petroleum Chemistry Lab II (1 Unit C: PH 45)

Leaning Outcomes
At the end of the course, the students should be able to:
1. estimate sulphur content, calorific value and other characteristic indices of petroleum and petroleum products.

Course Contents
Estimation of sulphur content and calorific value of petroleum fraction by Bomb calorimeter. Estimation of percent C and H contents in petroleum fractions. Study of etherification reactions by using dilute HCl, dilute H_2SO_4 as catalysts. Determination of Bromine Number. Estimation of Molecular Weight. Determination of Density and specific gravity of petroleum products. Determination of Viscosity-Gravity Constant (VGC) of petroleum products. Determination of Universal Oil Product (UOP) characterization factor.

PHY 205: Thermal Physics (3 Units C: LH 45)

Learning Outcomes
On completion, the students should be able to:
1. discuss the concept of heat and temperature;
2. explain and determine thermodynamic processes;
3. explain and evaluate properties of real and ideal gases;
4. evaluate the consequences of the thermodynamic laws;
5. describe the basis of the kinetic theory; and
6. describe the statistical behaviour of gases with applications.

Course Contents
The Foundations of classical thermodynamics including the zeroth and definition of temperature; the first law, work heat and internal energy. Carnot cycles and the second law. Entropy and irreversibility, thermodynamic potentials and the Maxwell relations. Ideal gas

equation and internal energy, including internal molecular modes. Qualitative discussion of phase transitions: Gibbs free energy. Clausius-Clapeyron equation. Examples of phase transitions including Van der Waals gas. Kinetic theory. Mean free path. Equi-partition of energy. Heat transfer. Diffusion rate.

PHY 207/208: Practical Physics III & IV (2 Units C: PH 90)

Learning Outcomes
On completion, the students should be able to:
1. verify some equations, physical laws and theorems;
2. identify apparatus and set up experiments; and
3. investigate relationships between physical quantities numerically and graphically.

Course Contents
The laboratory course consists of a group of experiments drawn from diverse areas of Physics (Optics, Electrical and Electronics, Electromagnetism, Mechanics, Modern Physics, etc.) It is accompanied by seminar studies of standard experimental technique and the analysis of famous and challenging experiments.

PHY 210: Physics of Solid Earth (2 Units C: LH 30)

Learning Outcomes
On completion, the students should be able to:
1. describe the evolution and structure of the earth;
2. explain the dynamics of the earth's atmosphere;
3. state the characteristics of the earth's magnetic field;
4. compare geomagnetic field observations;
5. discuss the effect of sunspots and magnetic storms; and
6. describe the theory of plate tectonics and continental drift

Course Contents
Origin, shape, structure and major divisions of the earth. The Earth's main magnetic field and its distribution. Electrical theory of the earth's core and origin of the magnetic field, seafloor spreading, continental drift and plate tectonics.

PHY 211: Workshop Practice (2 Units C: LH 15; PH 45)

Learning Outcomes
On completion, the students should be able to:
1. identify safety signs for various workshop types and abide by the underlining regulations while working in the workshop;
2. handle workshop tools and machineries;
3. illustrate simple metal processing methods;
4. describe the criteria for selection of construction materials;
5. identify electrical and electronic devices and explain some instrumentation techniques for measuring parameters; and
6. explain types and methods of wood and plastic processing.

Course Contents

Workshop layout and safety. Basic hand tools and bench work practices. Measurement and gauging. Sheet metal operations: Casting, cutting, drilling, turning, milling, metal joining devices and adhesives in common use. Soldering techniques and wrap joints. Plain and cylindrical generation of smooth surface using power operated machines. Criteria for selection of materials used for construction – metallic and non-metallic. Instrumentation and measuring techniques. Multi-meters and oscilloscopes; Extension of instrument range. A survey of the use of electronic circuit devices e.g., diodes, transistors including FET, integrated circuits, photocells. Basic circuit development and analysis. Wood logging. Wood types and processing. Plastic types and working, plastic moulding, bending, and encapsulation.

PIO 201: Introductory Physiology and Blood (2 Units C: LH 30)

Learning Outcomes

On successful completion of this course, the students should be able to:

1. describe the composition of a cell membrane;
2. explain how a potential difference across a membrane will influence the distribution of cation and anion;
3. describe how transport rates of certain molecules and ions are accelerated by specific membrane transport proteins;
4. distinguish between active (primary and secondary) transport, facilitated diffusion and passive diffusion based on energy source and carrier protein involvement;
5. identify the mechanisms and role of selective transporters for amino acids, neurotransmitters, nutrients, etc.;
6. explain the general concepts of homeostasis and the principles of positive and negative feedback in physiological systems;
7. identify the site of erythropoietin production, the stimulus for its release, and the target tissue for erythropoietin action;
8. discuss the normal balance of red blood cell synthesis and destruction ,including how imbalances in each lead to anemia or polycythemia;
9. list and differentiate the various types of leukocytes;
10. describe the role of thrombocytes in haemostasias; and
11. list clotting factors and discuss the mechanism of anti-coagulants.

Course Contents

Introduction and history of physiology. Structure and functions of cell membranes. Transport process. Special transport mechanism in amphibian bladder, kidney, gall bladder, intestine, astrocytes and exocrine glands. Biophysical principles. Homeostasis and control systems including temperature regulation. Biological rhythms. Composition and functions of blood haemopoiesis. WBC and differential count. Plasma proteins, coagulation fibrinolysis and platelet functions. Blood groups –ABO system – Rh system – blood transfusion – indication for collection and storage of blood, hazards of blood transfusions. Reticulo- endothelial system. Immunity and Immunodeficiency disease and HIV.

PIO 212: Renal and Body Fluids Physiology (2 Units C: LH 30)

Learning Outcomes

On successful completion of this course, the student should be able to:

1. sketch across section of a kidney; identify the renal cortex, renal medulla, renal calycies, medullary pyramids, renal pelvic space, renal artery, renal vein and ureter;
2. describe renal blood flow, renal plasma flow, glomerular filtration rate, and filtration fraction and list typical values;
3. explain the concept of renal clearance. Use the clearance equation and an appropriate compound to estimate the glomerular filtration rate, renal plasma flow and renal blood flow;
4. describe the effects of reductions in GFR on plasma creatinine concentrations and plot the relationship;
5. discuss the role of the ascending limb of the loop of Henle in producing a high renal interstitial fluid osmolality from the loop of Henle, contrast the tubular fluid and interstitial fluid osmolality changes that allow either a dilute or a concentrated urine to be produced and excreted;
6. describe processes that lead to acid-base disturbances and list the common causes; and
7. identify major routes and normal ranges for water intake and loss and predict how these affect the distribution of total body water.

Course Contents

Macroscopic, microscopic and ultra-structure of the kidney. Elements of renal functions. Glomerular filtration, Concept of clearance, tubular reabsorption and secretion. Renal blood flow. Body fluid and electrolyte balance. Buffer mechanism and pH regulation. Counter-current system. Micturition. Abnormalities of renal functions. Composition and estimation of body fluid compartments. Concept of water and electrolyte balance. Role of kidney in body fluid homeostasis.

PIO 214: Introduction to Cardiovascular and Respiratory Physiology (3 Units C: LH 45)

Learning Outcomes

On successful completion of this course, the students should be able to:

1. state Starling's law of the Heart and describe the application of the law in keeping the output of the left and right ventricles equal;
2. describe how ionic currents contribute to the four phases of the cardiac action potential;
3. explain the ionic mechanism of pacemaker automaticity and rhythmicity, and identify cardiac cells that have pacemaker potential and its spontaneous rate. Identify neural and humoral factors that influence their rates;
4. describe the various phases of ventricular systole and ventricular diastole;
5. describe the timing and causes of the four heart sounds;
6. explain why the ECG tracing looks different in each of the12 leads;
7. explain the principles underlying cardiac output measurements using the Fick principle, dye dilution and thermodilution methods;
8. list the factors that shift laminar flow to turbulent flow;
9. describe the relationship between velocity, viscosity and audible events, such as murmurs and bruits;

10. describe how arterial systolic, diastolic, mean, and pulse pressure are affected by changes in: a) stroke volume, b) heart rate, c) arterial compliance, and d) total peripheral resistance;
11. define the Starling equation and discuss how each component influences fluid movement across the capillary wall;
12. list the anatomical components of the baro receptor reflex;
13. explain three positive feedback mechanisms activated during severe haemorrhage that may lead to circulatory collapse and death;
14. define compliance and identify two common clinical conditions in which lung compliance is higher or lower than normal;
15. list the factors that determine total lung capacity, functional residual capacity and residual volume;
16. define surface tension and describe how it applies to lung mechanics, including the effects of alveolar size and the role of surfactants;
17. explain how the shape of the oxyhemoglobin dissociation curve influences the uptake and delivery of oxygen;
18. list the forms in which carbon dioxide is carried in the blood; and
19. identify the regions in the central nervous system that play important roles in the generation and control of normal respiration.

Course Contents

The heart; events of the cardiac cycle cardiac output and control of cardiac contractility. Cardiac electrophysiology. Properties of cardiac muscle. Cardiac cycle. Cardiac output - measurement and control. Haemodynamics of circulation. Arterial blood pressure and its regulation; Cardiovascular reflexes. Peripheral resistance and local control of the circulation; Regional blood flow; Cardiovascular changes in exercise, haemorrhage and shock. Respiratory Physiology – Functions of upper respiratory tract. Mechanics of respiration including compliance, surfactant, lung volume and capacities; pulmonary gas exchange. Blood gas transport. Pulmonary function tests; Nervous and chemical control of respiration. Response to hypoxia, high altitude and exercise. Artificial respiration.

PIO 216: Gastrointestinal Physiology (2 Units C: LH 30)

Learning Outcomes

On successful completion of this course, the students should be able to:

1. compare and contrast the regulation of gut function by nerves, hormones and paracrine regulators;
2. identify the cell type and anatomical location of the endocrine cells secreting major GI hormones, such as gastrin, secretin, cholecystokinin (CCK), GLP-1, GLP-2, leptin and motilin;
3. list the physiological functions of the components of saliva;
4. describe the role of HCl in the gastric digestion of carbohydrates and protein and how pepsinogen is activated;
5. list the mechanisms contributing to gastric mucosal defense and how they can be compromised by drugs or pathogens;
6. list the stimuli that release secretin and CCK and explain the route by which these regulatory peptides stimulate the pancreas;

7. describe the cellular mechanisms for the hepatic uptake, conjugation, and secretion of bile salts and bilirubin;
8. describe the sequential digestion of ingested starch by enzymes of the salivary glands, pancreas and the intestinal apical membrane;
9. describe the mechanisms and molecules mediating the solubilization and digestion of lipids in the small intestine; and
10. describe the disorders of motility that can lead to gastroparesis, achalasia, diarrhea, constipation, megacolon and irritable bowel syndrome.

Course Contents
Physiologic anatomy of the gastrointestinal tract. Review of smooth muscle function. Secretions in the G.I.T. and their control. Movements of the gastrointestinal tract. Digestion and absorption of various food substances. Physiologic anatomy of the liver And biliary system including their functions. Disorders of G.I.T. The Gut as an endocrine organ. Nutrition: Energy and other dietary requirements. Basal metabolic rate. Nitrogen balance. Amino acid deficiency and hormonal control of nutritional needs. Vitamins. Mineral mechanisms. Food value of local foodstuffs. Diet sheets. Nutritional deficiency states.

PIO 218: Introduction to Laboratory Physiology I (1Unit C: PH 45)

Learning Outcomes
On successful completion of this course, the students should be able to:
1. explain the proper handling of laboratory equipment.
2. dissect laboratory animals and mount an isolated organs for a specific experiment.
3. use human subjects for some of the experiments like blood grouping, etc.
4. take recordings of an experiment and interpret the results accordingly.

Course Contents
Laboratory sessions on basic physiology experiments, especially those related to the frog sciatic nerve, smooth muscles and blood physiology.

SLT 204: Biological Laboratory Techniques I (2 Units C: LH 15; PH 45)

Learning Outcomes
On successful completion of this course, the students should be able to:
1. describe microscopes, fixatives, tissue processing and microtome, adhesive, principles and methods for histochemistry, haematology and serological techniques; and
2. exhibit skills in the use of microscopes, fixatives, tissue processing and microtome.

Course Contents
Microscopes: Types – simple and compound microscopes. Range, setting and illumination. Care, maintenance and storage of microscopes. Use of stage and ocular micrometer. Care and use of dissecting lens and microscopes. Collection, preparation, transportation, maintenance and preservation of biological specimens (animal and plant materials). Fixatives: Types and function of fixatives for plant and animal tissues: Tissue Processing and Microtomy: Types, use and care of microtomes. Honing, stropping and storage of microtome knives. Cutting of paraffin sections, frozen sections and Cryostat section. Adhesive: Types and preparation; methods of attachment of section to slides. Stains and staining techniques and Histochemistry methods.

The theory and application of stains. The functions of dyes and impregnation. Principal stains including natural, and synthetic stains. Principles of methods for histochemistry. Haematological and serological techniques: Blood: Types of blood cells, structures, characteristics and formation; plasma and serum, immunoglobins (anti-bodies), antigen-antibody reactions. Collection of blood samples and labelling. Making of smears and staining. Counting of blood cells. Haemoglobin estimation. Packed cell volume estimation, and the significance of blood groups.

STA 202: Statistics for Physical Sciences and Engineering (3 Units C: LH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. explain the scope for statistical methods in physical sciences and engineering;
2. define the measures of location, partition and dispersion;
3. explain the elements of probability, probability distribution: binomial Poisson, geometric, hypergeometric, negative-binomial, normal Poisson, geometric, hypergeometric, negative-binomial, normal, student's t and chi-square distributions;
4. differentiate point from internal estimation and could be able to test for hypotheses concerning population means proportions and variances;
5. compute for regression and correlation as well as conduct some non–parametric tests with reference to Contingency table analysis; and
6. explain the elements of design of experiments and Analysis of variance.

Course Contents
Scope for statistical methods in physical sciences and engineering. Measures of location, partition and dispersion. Elements of probability. Probability distribution: binomial Poisson, geometric, hypergeometric, negative-binomial, normal Poisson, geometric, student's t and chi-square distributions. Estimation (point and internal) and tests of hypotheses concerning population means proportions and variances. Regression and correlation. Non-parametric tests. Contingency table analysis. Introduction to design of experiments. Analysis of variance.

Level 300 Courses for all Programme Options

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents
Concepts of peace, conflict and security in a multi-ethnic nation. Types and theories of conflicts: ethnic, religious, economic, geo-political conflicts; Structural conflict theory, Realist theory of conflict, frustration-aggression conflict theory. Root causes of conflict and violence in Africa:

Indigene and settlers phenomenon; Boundaries/boarder disputes; Political disputes; Ethnic disputes and rivalries; Economic inequalities; Social disputes; Nationalist movements and agitations; Selected conflict case studies – Tiv-Junkun; Zango Kataf, Chieftaincy and land disputes etc. Peace building, Management of conflicts and security: Peace &human development. Approaches to peace &conflict management --- (religious, government, community leaders etc.). Elements of peace studies and conflict resolution: Conflict dynamics assessment scales: Constructive &destructive. Justice and legal framework: Concepts of social justice; The Nigeria legal system. Insurgency and terrorism. Peace mediation and peace keeping. Peace &security council (international, national and local levels) agents of conflict resolution – conventions, treaties community policing: Evolution and imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of international organisations in conflict resolution. (a). The United Nations, UN and its conflict resolution organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping. Media and traditional institutions in peace building. Managing post-conflict situations/crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in post-conflict situations/crisis.

ENT 312: Venture Creation (2 Units C: LH15; PH 45)

Learning Outcomes

At the end of this course, students, through case study and practical approaches, should be able to:

1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/market research, Unutilised resources, Social and climate conditions and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (venture capital, Equity finance, Micro finance, Personal savings, small business investment organisations and business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, Customer acquisition &retention, B2B, C2C and B2C models of e-commerce, First Mover Advantage, E-commerce business models and successful E-Commerce companies,). Small business management/family business: Leadership &management, Basic book keeping, Nature of family business and Family business growth model. Negotiation and business communication (strategy and tactics of negotiation/bargaining, Traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, Business idea contest, brainstorming sessions, idea pitching). Technological solutions (the concept of market/customer solution, Customer solution and emerging

technologies, Business applications of new technologies - Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud computing, Renewable energy etc. Digital business and E-commerce strategies).

BCH 306: Analytical Methods in Biochemistry (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the principles of instrumentation in biochemistry;
2. describe how the level of precision attained in analysis is dependent on the method employed;
3. elucidate why a method is preferred in a particular biochemical investigation;
4. explain the theoretical basis of major instruments used in biochemical analyses; and
5. perform some specific analytical investigations.

Course Contents
Tissue and cell culture techniques, immunoassays, blotting, and isotopic techniques. Principles, methodologies, instrumentation and applications of electrophoresis, manometry and centrifugation techniques. Chromatographic techniques including paper, thin layer, column, gas, and high-performance chromatographic techniques. Spectroscopic techniques including uv-visible, infra-red, nuclear magnetic resonance and mass spectrometry. Fluorimetry, polarographic including potentiometric and electrometric measurements. State-of-the-art equipment: Gas chromatography-mass spectrometry, thermocycler, high performance liquid chromatography, nuclear magnetic resonance, Fourier-transform infrared spectroscopy. This course includes laboratory practical classes which will provide students opportunity to practice the various techniques and familiarise themselves with the types of equipment used for the techniques.

BIO 301: Genetics II (2 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. summarize various aspects of human genetics and pedigree analysis;
2. discuss various aspects of gene interactions, biochemical mutants;
3. describe the types and functions of nucleic acids and nucleotides;
4. explain DNA replication and mutation;
5. discuss proteins and regulation of gene expression; and
6. describe the importance and processes involved in DNA technology and how it influences genetic engineering.

Course Contents
Aspects of human genetics; pedigree analysis. Further consideration of various deviations from basic principles. Gene interactions, including biochemical mutants, nucleic acids and nucleotides, DNA replication, mutation of DNA, proteins and regulation of gene expression. DNA technology and genetic engineering.

BIO 307: Field Course I **(1 Unit C: PH 45)**

Learning Outcomes
At the end of this field trip, students should be able to:
1. conduct basic field sampling techniques in terrestrial, aquatic and aerial environment;
2. collect plant and animal materials for identification, classification and preservation in the herbarium and Museum respectively; and
3. explain the importance of the institutes and industries visited to Biology

Course Contents
Sampling techniques in local habitats (i.e., not more than 20 km radius of the university). Also involve visits to research institutes, industries, etc. This should cover several areas of specialisation in Biology. Assessment by examination (objectives, short answer questions, fill in the gaps) in addition to group report.

BTG 305: Techniques in Biotechnology **(2 Units C: LH 30; PH 45)**

Learning Outcomes
At the end of this course, students should be able to:
1. demonstrate in-depth knowledge of analytical techniques including PCR, southern, northern and western blot and the applications; and
2. demonstrate skills in the use of modern analytical tools/equipment and ability to solve problems in various areas of biotechnology

Course Contents
Principles of instrumentation. Principles and techniques of radioisotope techniques, chromatographic methods, electrophoresis, centrifugation techniques, ultracentrifugation, dialysis and ultrafiltration, spectroscopic techniques, polymerase chain reaction (PCR), DNA sequencing techniques, ELISA; Southern, Northern, and Western blot methods of protein and DNA extraction and identifications. SDS-PADE, DGGE. Physical methods of gene transfer, Optical microscopy; Review of modern analytical techniques (radiochemical methods); Fluorimetric instrumentation types-GLC, NMR, X-ray diffraction, FTIR. In-situ hybridization, RELP, Micro array

CHM 301: Physical Chemistry II **(2 Units C: LH 30)**

Learning Outcomes
At the end of this course, the students will be able to:
1. describe the general knowledge of Gibbs function;
2. explain the concept of thermodynamics compare to kinetics; and
3. explain the concept of statistical thermodynamics and use statistical equation to solve problems in ideal and non-ideal solution.

Course Contents
A review of Gibbs function. Chemical thermodynamics. Introduction to statistical thermodynamics. Ideal solutions and non-Ideal solutions. Properties of electrolytes. Colligative properties. Studies on biochemical systems

CHM 302: Inorganic Chemistry II (2 Units C : LH 30)

Learning Outcomes

After completing the course, the students will be able to:

1. analyse inorganic chemistry information;
2. demonstrate and apply knowledge of inorganic chemistry;
3. explain the electronic structure and general properties of group 1A and Group IIA elements;
4. compare Group IA and Group IIA in terms of the parameters mentioned in 3 above;
5. explain the chemistry of Boron; carbon and Silicon; Nitrogen and phosphorus; Oxygen and sulphur;
6. explain the halogen chemistry;
7. explain the periodic properties of the transition metals and to use these to predict and/or rationalise the chemistry of these metal ions and their complexes;
8. use crystal field Theory to explain and understand some of the key features of complexes of the first-row transition metals including their shapes, colours, and magnetic properties;
9. synthesize and characterise a metal coordination compound using practical inorganic chemistry techniques;
10. describe ligand and crystal field theories;
11. draw the diagram showing crystal and ligand field theories with specific examples;
12. list advantages and limitations of these bonding theories;
13. define radioactive decay processes and nuclear radiation;
14. explain the principles of utilizing radioactivity applied to chemistry, chemical processes and adjacent fields where chemistry is an integral part;
15. discuss the principles of radiation hygiene and the interaction of radiation and matter;
16. explain current methods in radiochemistry;
17. define radioactivity;
18. define and describe all three types of radioactivity (alpha, beta, and gamma radiation); and
19. explain the roles of metals in living systems.

Course Contents

The Noble gases. Hydrogen. Electronic structure and general properties and comparative study of Group IA and Group IIA elements. Chemistry of Boron; Carbon and Silicon; Nitrogen and Phosphorus; Oxygen and Sulphur. The halogens. Transition elements. Separation of metals. Introduction to co-ordination chemistry. Introductory organo-metallic chemistry. Ligand and crystal field theories. Introduction to radiochemistry. Radioactivity and the periodic table. Role of metals in living systems.

CHM 303 Organic Chemistry II (2 Units C: LH 30)

Learning Outcomes

After completing the course, the students will be able to:

1. recognize and distinguish between aromatic and Alicyclic compounds by their structures;
2. identify the properties of aromatic and Alicyclic compounds, and the chemical consequences of aromaticity;
3. recognise and be able to write the mechanism of electrophilic aromatic and Alicyclic substitution;
4. outline the completed electrophilic aromatic substitution reactions of the

following types: halogenation, nitration, sulfonation, and Friedel-Crafts acylation & alkylation;
5. expain the chemistry of heterocyclic Chemistry (3,4,5 and 6-membered ring of O, N, S heterocyclic compounds);
6. describe the Reactive intermediates – carbocations, carbanions, carbenes, nitrenes;
7. express the rearrangement reactions e.g., Beckmann, Baeyer-Villiger etc.;
8. illustrate with various reaction mechanisms and types; and
9. organise Forensic analysis of biological samples, pharmaceutical samples, organic analytes and macromolecular samples.

Course Contents
Aromatic and Alicyclic chemistry. Survey of representative polycyclic compounds. Heterocyclic chemistry (3,4,5 and 6-membered ring of O, N, S heterocyclic compounds). Reactive intermediates – carbocations, carbanions, carbenes, nitrenes etc. Selected rearrangement reactions e.g. Beckmann, Baeyer-Villiger etc to illustrate various reaction mechanisms and types. Forensic analysis of biological samples, pharmaceutical samples, organic analytes and macromolecular samples.

CHM 304: Atomic and Molecular Structure and Symmetry (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. illustrate the Schrodinger wave equation for the hydrogen molecule and ion;
2. define the terms in the time-independent Schrodinger wave equation;
3. express equation for the 3D Schrodinger wave equation;
4. define Pauli Exclusion Principle and the Hund's rule;
5. illustrate electron configurations for atoms in either the subshell or orbital box notations;
6. illustrate electron configurations of ions;
7. explain how molecular orbital are formed;
8. draw molecular orbital diagrams for diatomic molecules;
9. define modern valence theory;
10. explain the concept of resonance and configuration interaction;
11. explain Huckel theory;
12. outline Walsh rules;
13. illustrate Walsh rules with specific examples;
14. explain the theory of electronic spectroscopy;
15. explain Franck-Condon Principle;
16. use Franck-Condon Principle to account for the vibrational structure of electronic transitions; and
17. explain Russel- Saunders coupling, orbital and spin angular momentum; Use of symmetry in chemistry.

Course Contents
Schrödinger equation. Helium atom, ground and excited states, Spin and Pauli exclusion principle. Hydrogen molecule; Comparison of molecular orbital and valence bond theory, concept of resonance and configuration interaction. Coulson Fischer function. Molecular orbitals for diatomic molecules. Simple pi electron theory, Huckel theory. Walsh rules. Rotational, vibrational and electronic spectra. Applications for determining bond lengths and angles. Atomic

spectra, Russell Saunders coupling, orbital and spin angular momentum. Use of symmetry in chemistry.

CHM 305: Petroleum Chemistry (2 Units C: LH 30)

Learning Outcomes
After completing the course, the students will be able to:
1. give an overview of the chemical composition and physical properties of petroleum, petroleum products and renewable motor fuels;
2. specify quality criteria for petroleum products and renewable motor fuels;
3. present the chemistry of the most important refinery processes;
4. give an overview of the resource base for petroleum and renewable alternatives;
5. find information and perform individual evaluations of questions pertaining to production and use of petroleum from different sources and renewable motor fuels;
6. use geophysical and geological knowledge to interpret and map data for identification of potential prospects;
7. contribute to development of geo-based technology for exploration and improved recovery of petroleum resources;
8. explain the theory of hydraulics applied to fuels in pump-pipeline systems;
9. explain the fundamentals of electricity with emphases on electrical safety in petroleum; and
10. list lubrication and wear with importance attached to physical and chemical properties of lubricants.

Course Contents
Petroleum in the contemporary energy scene. Nature, classification and composition of crude petroleum and natural gases. Natural product chemical markers of petroleum and geological sediments. Distribution of petroleum and natural gas resources (the global and Nigerian situations). Petroleum technology, survey of refinery products and process. Petrochemicals in industrial raw materials. Prospects for the petrochemical industry in Nigeria. Aviation fuels; present and future; formulation of lubricants; Theory of hydraulics, as applied to fuels in pump-pipeline systems. Fundamentals of electricity with emphases on electrical safety in petroleum lubrication and wear, with importance attached to the physical and chemical properties of lubricants.

CHM 312: Analytical Atomic Spectroscopy (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. explain the concept of interaction of atoms with electromagnetic radiation;
2. explain the principles of atomic absorption spectrometry; atomic fluorescence spectrometry; X-ray fluorescence;
3. explain the procedure and use of these instruments in analytical chemistry and industries; and
4. discuss the preparations of standard solution for these instruments.

Course Contents
Introduction of concept of interaction of atoms with electromagnetic radiation. Atomic absorption spectrometry; Atomic emission spectrometry. Atomic fluorescence spectrometry and X-ray fluorescence spectrometry.

CHM 316: Applied Spectroscopy (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. study and characterise spectroscopic molecules and materials with the infrared; UV; NMR and mass spectrometry;
2. discuss the general principles of the analytical instruments listed above;
3. describe the applications of spectroscopy, such as the study of the atmosphere, cultural heritage, astrophysics, and materials;
4. describe the theoretical principle of GC-MS; LC-MS; LC-NMR;
5. study and characterise molecules and materials with the listed instruments in (4) above; and
6. list the application of these instruments in industry and medicine.

Course Contents
Principles and applications of UV, IR, NMR and Mass spectroscopy in the determination and elucidation of structures of organic compounds. Brief mention of hyphenated systems: GC-MS, LC-MS and LC-NMR, and diagnostic use of NMR in medicine.

CHM 317: Industrial Raw Materials Resource Inventory (1 Unit C: LH 15)

Learning Outcomes
At the end of this course, the students should be able to:
1. explain the industrial raw materials and resource inventory;
2. describe the types of inventory costs;
3. survey industries in Nigeria and their raw material requirements;
4. describe the chemistry of minerals, fossils and their uses;
5. describe plants and animal products;
6. define the followings: nuclear; aerodynamic; wind and hydrodynamic sources of energy;
7. explain the listed items in 5 above;
8. explain the potentials and applications of locally available raw materials as industrial feed stock; and
9. describe how service firms apply inventory management methods to their operations.

Course Contents
Survey of Nigeria's industries and their raw material requirements. Mineral chemistry. Fossils and their uses. Plant and animal products. Nuclear, solar, aerodynamic/wind and hydrodynamic sources of energy. Potentials and applications of locally available raw materials as industrial feed stocks.

CHM 319: Environmental Chemistry (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. explain the elementary circle of the following element oxygen, nitrogen, sulphur etc.;
2. describe the stratification of the earth atmosphere and state characteristics of each strata;
3. state and describe different sources of environmental pollution;
4. state and describe different types of environmental pollution and their effect on the environment;
5. describe water and state qualities that define the uses of water;
6. describe and explain different sources of water contamination and its impact on agricultural land crops etc.;
7. state and describe different methods used in treatment of waste water – chemical, biological and physical methods;
8. state and justify chemical and physical instrumentation in environmental chemistry;
9. describe environmental impact assessment; and
10. state and describe twelve principles of green chemistry and its practical applications.

Course Contents
Concepts of elementary cycles. Characteristics of the atmosphere. Sources, types and effects of environmental pollution. Wastewater treatment. Composition of domestic/industrial wastes and waste management. Water chemistry and analysis. Chemical and physical instrumentation in environmental sciences. Introduction to Environmental Impact Assessment. Twelve principles of green chemistry.

GEY 301: Geochronology & Precambrian Geology of Africa (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. discuss evolution of Precambrian rocks;
2. determine chronology of rocks; and
3. list and explain the techniques of dating rocks.

Course Contents
Principles of geochronology. Radiometric age determination. Rb/Sr, and K/Ar, U/Pb dating methods. Stable isotopes. Geology and evolution of Precambrian domains and rocks in Nigeria. Precambrian stratigraphy and application to major shield areas of Africa. Regional tectonic structures of Africa:- nappes; transcurrent faults with special reference to Africa.

GEY 305: Sedimentary Depositional Environments & Basins of Africa (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. differentiate type of flows;
2. classify depositional environments;
3. determine and understand various controls on sedimentation;
4. evaluate the criteria for recognising or interpreting depositional environments;

5. review economic resources associated with each depositional settings; and
6. illustrate the stratigraphy and geological evolution of some sedimentary basins in Africa.

Course Contents
Properties of flows and bed forms. Walthers law of facies. Sedimentary facies. Physical, chemical and biological influence on marine and continental depositional environments and their sedimentation patterns. Classification of environments. Alluvial fans, braided and meandering rivers deposits. Coastal environments. Marine and deep marine system. Criteria for paleoenvironmental analysis. Analysis of the African sedimentary basins.

GEY 310: Independent Geological Mapping (3 Units C: LH 15; PH 90)

Learning Outcomes
At the end of the course, students should be able to:
1. carry out an independent field mapping of an area;
2. produce geological maps;
3. interpret geological maps; and
4. write and present geological report.

Course Contents
Independent field study of specific areas. Production of geological maps and reports. Study and interpretation of geological maps. Writing of field geology report.

GEY 313: Structural Geology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. identify and describe various geological structural elements; fault, fold, shears;
2. evaluate earth dynamics that control the deformational structures;
3. describe preparation and interpretation of structural maps.

Course Contents
Dynamics of rock. Stress-strain relationships. Faults, folds, ring dykes. Introduction to crustal tectonics. Major deformational structures of the earth. Study and interpretation of geological maps. Problems concerning geological maps. Structures and stereographic projection in Structural Geology. Structural Mapping Practice.

MCB 307: Immunology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. explain the basic concepts of immunology and diagnostic immunology;
2. describe types of immunity**,** structure of antibodies(immunoglobulins) and antigens;
3. discuss the origin of the B and T cells, the role of immunity in protection against diseases;
4. explain the harmful effects of immunological responses; and
5. identify types of vaccines and animal and human vaccine production.

Course Contents
Introduction. Historical background. Innate and acquired immunity. Antigens, antibodies, cellular immunity. Immunological tolerance and suppression. Surgical grafting. Complement system. Hypersensitivity. Immunological anomalies. Diagnostic immunology, Vaccines, effector systems of parasite killing and nature of resistance in plants. Animal and human vaccine production.

PCM 304: Petroleum Chemistry Lab II (1 Unit C: LH 45)

Learning Outcomes
1. At the end of this course, the students would be conversant with the equipment and procedures for determining the different indices used for evaluating crude oil and petroleum products.

Course Contents
Determination of: Correlation Index, Density, Specific Gravity and API Gravity and Volatility. Distillation Curve. Pour Point& Cloud point. Flash Point: Open cup and Close cup, Fire Point, Aniline Point & diesel index. Ash Content. Heat of Combustion. Salt Content. Viscosity, Viscosity Index and Viscosity-Gravity Constant (V.G.C), n.d.M (n: Refractive index, d: Density, M: Freezing point), Water content, Total acid number (TAN). Total base number (TBN), and Sulphur content. [At least ten practical's per semester]

PCM 305: Petroleum Refining (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students will be able to:
1. explain the chemistry and technology of separation and conversion processes;
2. describe catalytic reforming, catalytic cracking, and hydrotreating processes; and
3. discuss crude oil pre-treatments

Course Contents
Crude oil pre-treatments: Crude oil impurities (water, salt and solids); Dehydration; Variables affecting crude oil dehydration; Desalting: Main problems of salty crude oil, Oil desalting principles, Electrostatic theory; Separation processes: atmospheric distillation, vacuum distillation, azeotrophic and extractive distillation; Conversion processes: thermal conversion processes (coking processes, delayed coking, fluid coking, vis-breaking) and catalytic conversion processes (catalytic reforming, catalytic cracking, hydrotreating Process); Emphasis should be given to feeds, process conditions, product distribution and chemistry & technology of each process.

PCM 306: Instrumental Method of Analysis (2 Units C: LH 30)

Learning Outcomes
1. understand the basic principles and applications of instrumental methods of analysis.

Course Contents
Theory, principles and applications of; UV/Visible spectrometry, IR spectrometry. Flame emission and atomic absorption spectrometry. Fluorescence and phosphorescence

spectrometry, Nuclear magnetic resonance and electron spin resonance. Introduction to electro analytical techniques. X-ray and radiochemical methods of analysis. Other instrumental methods: refractometry and, polarimetry, polarography, calorimetry.

PHA 301: **General Principles of Pharmacology (2 Units C: LH 30)**

Learning Outcomes
At the end of the course, the students should be able to:
1. list sources of drugs;
2. explain the various routes of drug administration and how they influence onset of drug action;
3. explain the factors that affect drug absorption, distribution, metabolism and excretion;
4. identify the role of receptors as targets for drug action;
5. explain the fundamental differences between agonists and antagonists; and
6. discuss the common system parameters in pharmacokinetics and their measurements.

Course Contents
Introduction: History of Pharmacology and relationship of Pharmacology to other pharmaceutical and clinical subjects. Definition and sources of drugs. Routes of drug administration. Drug absorption, distribution, elimination and factors affecting them. Enzyme induction and enzyme inhibition. Mechanisms of drug action – Receptor and non-receptor theory. Drug dosage and dose response curves. Measurement of some pharmacokinetic parameters.

PHA 302: Pharmacogenetics and Pharmacokinetics (2 Unit C: LH 30)

Learning Outcomes
At the end of the course, the students should be able to:
1. explain the concept of genetic variation (continuous and discontinuous) among the general population;
2. discuss the significance of genetic polymorphism in the development, progression and treatment of human disease;
3. describe the models of drug distribution and elimination;
4. explain how dose, bioavailability, rate of absorption, apparent volume of distribution, total clearance and elimination half-life affect the plasma concentrations of a drug after administration of a single dose;
5. describe the factors which determine the time-course of systemic accumulation of a drug administered by infusion or multiple doses;
6. use the pharmacokinetic parameters to determine loading and maintenance doses of specific drug regimens; and
7. identify the factors that affect hepatic and renal clearance (blood flow, protein binding, intrinsic clearance etc).

Course Contents
Pattern of transmission of single gene trait. Hardy-Weinberg law conditions for its validity, application. On concepts of continuous and discontinuous variation. Pharmacogenetics (drug metabolism, tissue metabolism and receptor alterations). Compartment models (one and two)

kinetics after intravenous and oral dosing. Bioavailability, Drug distribution, Protein binding. Renal excretion of drugs. Urinary excretion data in Pharmacokinetic analysis.

PHA 304: Autonomic Pharmacology II (2 Units C: LH 30)

Learning Outcomes

At the end of the course, the students should be able to:

1. explain synthesis and metabolic fate of adrenergic neurotransmitters and the clinical importance of vanillyl mandelic acid (VMA) level measurement;
2. discuss the structural and functional differences between adrenergic receptor types and subtypes, their locations in the body and mechanisms of pharmacological action; and
3. describe the synthesis, pharmacological actions, mechanisms of action, clinical indications, side effects and structure-activity relationship of drugs acting as agonists (direct and indirect) and antagonists on the sympathetic nervous system.

Course Contents

Introduction: Chemical neurotransmitters – Evidence for Noradrenaline as an adrenergic neurotransmitter, Synthesis, storage, release, metabolism, and uptake of catecholamines. Detection and bioassay of adrenaline and Nor-adrenaline. Adrenergic receptors – Types of adrenoceptors. Concept of agonists and antagonists. Sympathomimetic amines – Catecholamines, properties and uses. Sympatholytic drugs (Aadrenergic blockers) properties and uses. Structure – activity relationships among the sympathomimetic amines and beta-adrenergic blockers.

PHA 305: Neuropharmacology: CNS Depressants and Stimulants
(2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of the course, the students should be able to:

1. explain neurotransmission in the Central Nervous System;
2. discuss pathologies and treatment modalities of Parkinson's disease, Alzheimer's disease,
3. epilepsy, schizophrenia and depression;
4. describe the pharmacology of hypnotics and sedatives including alcohols, barbiturates, benzodiazepines and other non-barbiturates;
5. elucidate prostaglandin synthesis and consequences of its blockade by NSAIDS to produce anti-inflammation, analgesia and antipyresis; and
6. explain the mechanisms of action, chemistry, clinical uses and adverse effects of local and general anaesthetic drugs and contrast between local and general anaesthetics.

Course Contents

Introduction: Review of functional organisation of CNS Pharmacology of drugs used as hypnotics, sedatives, antipsychotics, mood stabilizing drugs, anticonvulsants and related disorders. Anxiolytic drugs. Tricyclic antidepressants and other CNS stimulants and analeptics. Drugs used in Parkinson and other neurodegenerative diseases. Centrally-acting appetite

suppressants. Theories of general anaesthesia, General anaesthetics, Local anaesthetics and pre-anaesthetic medications. Opioid analgesics and antagonists, non-steroidal anti-inflammatory analgesics.
Practical: Animal models of analgesia (hot plate and tail clip methods), Epilepsy (Pentylenetetrazole PTZ, Strychnine, 4-aminopyridine and maximal electroshock test MEST-induced models of epilepsy). Induction of sleep with barbiturates, sedative-hypnotics, Induction of Parkinson disease in animals using 6-hydroxydopamine and MPTP and induction of psychosis in animals with amphetamine and treatment with anti-psychotic agents.

PHA 306: Cardiovascular and Respiratory Pharmacology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. explain the pharmacology (mechanisms of action, clinical effects, indications, adverse effects and contraindications) of major drug classes acting on the cardiovascular and respiratory disorders and the principles of therapy; and
2. describe the pharmacology of major classes of drugs used in the treatment of obesity.

Course Contents
Introduction to cardiovascular system physiology. Pathophysiology and drugs used as antihypertensives., Cardiac glycosides, Anti arrhythmics, Anti-angina. Drug treatment of shock. Anti-obesity drugs. Anti-lipidaemic drugs. Asthma and anti-asthmatic drugs. COPD, Bronchitis and pneumonia. Cough and pharmacology of drugs used in the treatment of cough (Anti-tussives, expectorants and mucolytics). Practical: Demonstration experiments with drugs acting on the CVS (Finkleman and isolated perfused rabbit heart (Lagendroff) preparation), cat blood pressure and respiratory system (Tracheal Chain Preparation).

PHY 301: Analytical Mechanics I (3 Units C: LH 45)

Learning Outcomes
On completion, the students should be able to:
1. explain particle motion in one, two, and three dimensions;
2. describe the two body problem and many body systems;
3. define and solve problems of conservative forces;
4. explain newton theory of gravitation;
5. describe the nature of generalized motion;
6. explain the theory of relativity;
7. choose an appropriate set of generalized coordinates to describe a dynamical system and obtain its Lagrangian in terms of those coordinates and the associated 'velocities'; and
8. derive and solve the corresponding equations of motion. treat small oscillations as an eigenvalue problem.

Course Contents
Review of Newtonian mechanics; motion of a particle in one, two and three dimensions; Internal forces, external forces, forces of constraint; Systems of particles and collision theory; Newtonian gravitation; conservative forces and potentials, oscillations, central force problems; accelerated frames of reference; Rigid body dynamics; Rotational problems and polar

coordinates; Mechanics of continuous media; Galilean relativity; Relativistic kinematics and dynamics; Applications of relativistic kinematics.

PHY 307/308: Experimental Physics V & VI (2 Units C: PH 90)

Learning Outcomes
On completion, the students should be able to:
1. verify some equations, physical laws and theorems;
2. identify apparatus, design and set up experiments;
3. investigate relationships between physical quantities numerically and graphically; and
4. prepare and present laboratory reports.

Course Contents
A year-long series of mini courses on important experimental techniques. Topics covered include electronics, optics, electricity, atomic, molecular nuclear and low temperature physics, statistics and data handling and scientific writing.

PHY 311 Complex Variable and Vector Space (2 Units C: LH 30)

Learning Outcomes
On completion, the students should be able to:
1. determine whether or not a given function of a complex variable is differentiable;
2. use conformal mappings of the complex plane to solve problems in 2d electrostatics fluid flow and heat flow;
3. construct the Taylor-Laurent series for functions that are analytic in an annular region of the complex plane;
4. determine the location and nature of the singularities of a function and determine the order of a pole and its residue;
5. use the residue theorem to evaluate integrals of functions of a complex variable, and identify appropriate contours to assist in the summation of series and the evaluation of real integrals;
6. find an orthonormal basis for a given vector space;
7. define the adjoint of a linear operator and determine whether a given operator in Hermitian and/or unitary; and
8. employ methods from this and prerequisite units to solve previously unseen problems in linear algebra, using Dirac's notation where appropriate.

Course Contents
Complex numbers: Functions of complex variable. Functions as mappings; Differentiation, analytic functions and the Cauchy-Riemann equations. Conformal mappings. Solutions of 2D Laplace equation in Physics. Integration in the complex plane. **Contour integration:** Cauchy's theorem, Cauchy's integral formulae, Taylor and Laurent Series, Cauchy's Residue Theorem, Real integrals and series. **Vector Spaces:** Abstract vector spaces; Linear independence, basis and dimensions, representations, Inner products, Linear operators, Hermitian and unitary operators, Eigenvalues and eigenvectors.

PHY 314 Solid State Physics I (3 Units C: LH 45)

Learning Outcomes

On completion, the students should be able to:

1. explain crystal binding, structure and dynamics;
2. describe models of the free electron and transport properties of conduction electron;
3. describe band structure;
4. determine reciprocal lattices of simple crystal structure, and relate them to x-ray diffraction data;
5. calculate band structures for simple 2D and 3D tight-binding models and construct nearly-free electron approximations;
6. use the nearly-free-electron approximation to calculate equilibrium properties;
7. apply the semi-classical dynamics of electrons in solids to interpret magneto- conductance data and its relation with the Fermi surface; and
8. describe and make use of the relationship between bonding and electronic structure of semiconductors, metals and insulators.

Course Contents

Crystal structure and binding. Reciprocal lattice. Basic concepts of the quantum theory in solids. The free electron model. Weak and tight binding approximations. Energy band structures in metal, semiconductors and insulators. Electrons in solids. Density of states. Fermi surface. Fermi-Dirac distribution. Weidemann-Franz law. Interaction of electron with crystal lattice. Scattering of electrons. Crystal defects. Physics of surfaces. Schottky devices. Use of photo-electric emission in the study of solids. Elastic properties. Lattice vibrations. Super-conductivity. Graphene: Band structure and properties.

PHY 316: Electronics II (3 Units C: LH 30; PH 45)

Learning Outcomes

On completion, the students should be able to:

1. describe the physics of semiconductor devices and the junction characteristics
2. explain signal generation and amplification;
3. explain the principles of power switching and control with applications;
4. describe the general properties of feedback amplifiers and amplifier circuits;
5. identify the types, design and functions of integrated circuits; and
6. construct truth tables, design logic circuits and simplify logic gates.

Course Contents

Semiconductor device characteristics. Transistor amplifier. Bipolar. JFET. MOSFET. Operational amplifiers. Microprocessor. Feedback circuits and signal generators. Digital systems: Logic functions. Truth tables. Logic gates. Combinatorial logic. Logic counters and timers. Integrated circuits. Switching circuits. Power supply and power control.

PIO 309: Physiology Practical II (1 Unit C: PH 45)

Learning Outcomes
On successful completion of this course, the students should be able to:
1. acquire the skills needed in the proper handling of laboratory equipment;
2. dissect laboratory animals and mount an isolated organs for a specific experiment;
3. use human subjects for some of the experiments like ECG, etc.; and
4. take recordings of an experiment and interpret the results accordingly.

Course Contents
Laboratory sessions on Physiology experiments related to cardiovascular physiology, gastric secretions, respiratory, renal and neurological functions.

SLT 301: Entrepreneurship and Management of Science Laboratory Technology Business Venture (3 units C: LH 30; PH 45)

Learning Outcomes
On successful completion of this course, the student should be able to:
1. design and create business ideas;
2. apply their professional skills to offer actionable answers in the development of entrepreneurial ventures;
3. have a greater entrepreneurial flair; innovation and agility in putting ideas into business ventures;
4. acquire the skill to identify business opportunities and challenges associated with their ideas as a business venture; and
5. acquire the technical knowhow and the managerial skills to manage their venture in the competitive world of today.

Course Contents
Introduction to various types of Science Laboratory Technology (SLT) associated businesses. How to develop science related business ideas. Technology and equipment required for common SLT business ventures. Design and execution of business plans. Identification of common sources of raw materials for common SLT related businesses preservation, handling, packaging and marketing of finished products where applicable. Challenges associated with managing SLT related business ventures in a developing country.

SLT 304: Biological Laboratory Techniques II (2 Units C: LH 15; PH 45)

Learning Outcomes
On successful completion of this course, the students should be able to:
1. identify the basic techniques used in microbiological work;
2. explain common microbiological equipment, their care, use and maintenance;
3. describe the various methods used in the preparation of culture media and their application in the culture and isolation of microorganisms;
4. identify the hazards associated with the handling of live culture of microorganisms;
5. list methods of disposing pathogenic materials;
6. explain the preparation of materials for sterilization;
7. describe culture maintenance; and

8. explain the importance and applications of aseptic techniques, sterile areas and room.

Course Contents
Microbiological technique**:** Equipment: Types, use, care and maintenance. Preparation of culture media and the methods used in the culture of micro-organisms: agar; broth etc. Dangers of infection in handling live culture of micro-organisms. Correct methods of disposal of pathogenic materials. Preparation of materials for sterilization. Culture maintenance. Sterile areas and rooms. Aseptic techniques.

MCB 309 Food Microbiology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of this course students will be able to:
1. explain the factors responsible for food spoilage and food quality enhancement;
2. identify microorganisms involved in food spoilage;
3. list microbial indices of food quality;
4. describe methods for food quality assessment;
5. explain international microbiological standards for food quality assessment;
6. discuss traditional and rapid methods for estimating microbial populations in foods and quality; and
7. explain novel food production processes.

Course Contents
The distribution, role and significance of micro-organisms in food; Examples of international and national fermented foods. Intrinsic and extrinsic parameters of foods that affect microbial growth, food spoilage and food borne diseases. Microbial indices of food sanitary quality. International and national microbiology standards for food quality. Diseases of animal transmittable to man via food products. Rapid methods for assessing microbiological quality of foods, Traditional and modern methods for food preservation. Ecology, taxonomy, biochemistry and analytical technology of bacteria, yeasts, fungi and viruses associated with food spoilage, food-borne diseases and fermentations. Emphasis on new developments in Food Microbiology; Economic consequences of micro-organisms in food; exploitation of micro-organisms in novel processes for the production of food ingredients.

BIO 307 Field Course I (1 Unit C: PH 45)

Learning Outcomes
At the end of this field trip, students should be able to:
1. conduct basic field sampling techniques in terrestrial, aquatic and aerial environment;
2. collect plant and animal materials for identification, classification and preservation in the herbarium and Museum respectively;
3. explain the importance of the institutes and industries visited to Biology.

Course Contents
Sampling techniques in local habitats (i.e., not more than 20 km radius of the university). Also involves visits to research institutes, industries, etc. This should cover several areas of specialisation in Biology. Assessment by examination (objectives, short answer questions, fill in the gaps) in addition to group report.

SLT 331: Bioinformatics for Science Laboratory Technology Students 1
(2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, each successful student should be able to:
1. explain the use of bioinformatics in addressing questions in biochemistry; biotechnology, microbiology, medicine, molecular biology and pharmacology;
2. access and retrieve sequence data for particular genes/proteins from various databases (e.g., Genbank, UniProt, etc.) and interpret the data files returned;
3. prove a considerate understanding of the principles of pairwise sequence alignment using a various bioinformatics tools (e.g. BLAST);
4. discuss the principles and practice of multiple sequence alignment (MSA) (e.g. using Clustal, Pfam, etc.) and its relevance in identifying key structural/functional elements in proteins;
5. navigate a number of different tools for modelling both protein structure and protein-ligand interactions (e.g. Swiss-model, RaptorX, AUTODOCK, etc.);
6. exhibit knowledge of designing primers using primer3, primer bank etc.; and
7. describe the basic principles underlying the use of sequences in predicting phylogenetic relationships and use web-based tools to construct and interpret phylogenetic trees.

Course Contents
Introduction to bioinformatics. Bioinformatics databases. Pairwise sequence alignment. Protein structure and function. Multiple sequence alignment. Protein modelling. Designing of oligonucleotide primers and construction of phylogenetic trees.

Level 400 Courses for all Programme Options

BCH 402: Molecular Biochemistry (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
explain how genes can be sequenced to determine the structure of DNA contained therein;
2. illustrate the mechanism of replication of DNA in both procaryotic and eucaryotic organisms;
3. describe how genes can be influenced to obtain a pre-determined outcome;
4. discuss the mechanism of action of gene- specific chemical compounds; and
5. explain the bias of human genome project.

Course Contents
Gene structure and function. Nucleic acid function and biological function. DNA sequencing and restriction endonucleases. DNA repair mechanisms. Nucleic acid replication. Regulation of nucleic acid synthesis. Genetic code and gene-protein relationship. Eukaryotic transcription. Control of gene expression. Functional analysis of the replicator structure of bacteriophage DNA. Drug-nucleic acid interactions. Initiation factor for viral DNA replication. Genetic control of viral replication. Model systems used for studying embryology at the molecular level. Model systems in differentiation studies. Cell cycle, Control of cell proliferation. Genetic engineering and recombinant DNA technology. Polymerase chain reaction, Human genome project, Gene therapy.

BIO 404: Nigerian Plants and Animals in Prophylactics and Therapeutics (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures in this course, students should be able to:
1. explain the historical development of plants and animals in prophylactics and therapeutics (Pharmacognosy);
2. define some terminologies used in pharmacognosy;
3. appreciate the classification and uses of plants and animals in prophylactics and therapeutics in Nigeria;
4. discuss crude traditional methods of preparation and uses;
5. identify and describe modern methods of preparation and uses of plants and animals as prophylactics and therapeutics; and
6. account for the evaluation and adulteration of crude drugs, and the need for quality control.

Course Contents
Historical development and scope of plants and animals in prophylatics and therapeutics (Phamacognosy). Some terminologies used in pharmacognosy. Classification and uses of plants and animals in prophylatics and therapeutics in Nigeria. Crude traditional methods of preparation and uses. Modern methods of preparation and uses of plants and animals as prophylatics and therapeautics. Evaluation and adulteration of crude drugs (extraction methods, identification of phytochemicals, proximate analysis, minerals, organoleptic, microscopic, physical, chemical and biological). Deterioration and adulteration of crude drugs. Quality control.

BIO 414: Molecular Biology (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures in this course, students shall be able to:
1. describe the structure and roles of DNA and RNA;
2. discuss Gene regulation, DNA replication, genetic transformation and recombinant DNA technology;
3. summarise the roles of Nucleic acids and proteins in the cell division, growth and development,
4. list the importance and application of Molecular Biology in food production, medicine and genetic engineering.

Course Contents
Structure and role of DNA. Structure and role of RNA. Describe gene regulation, DNA replication, genetic transformation and recombinant DNA technology. Describe biological systems at the molecular level. Nucleic acids and proteins, and how they interactively regulate cell division, growth and development. Evolution of genomes. Practical applications of the knowledge of molecular Biology (in alleviation of food shortages, plant breeding, disease resistant crops, animal breeding, marriage, medicine, genetic engineering, etc.).

CHM 406: Reaction Kinetics (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:

1. identify the first, second and third order rate equations;
2. use the coefficients of a balanced chemical equation to express the rate of reaction in terms of the change in concentration of a reactant or product over time;
3. distinguish between instantaneous rates and average rates from a graph;
4. determine the rate law from initial rate data;
5. recognise the integrated rate laws;
6. use Collision theory to explain how reactions occur at the molecular level;
7. explain how enzymes act as biological catalysts and how they interact with specific substrate;
8. explain why enzymatic reactions respond differently to temperature changes compared to nonenzymatic processes;
9. explain NavApp: chemical warfare;
10. explain the mechanism by which sarin inhibits acetylcholinesterase; and
11. identify photochemical reaction mechanism.

Course Contents
Review of first, second and third order rate equations. Rate constants and equilibrium constants. Collision theory, transition state theory, reaction co-ordinates. Unimolecular reaction mechanisms, bimolecular reaction mechanisms, chain reaction mechanisms; catalysis and heterogeneous reactions. Photochemical reaction mechanisms.

CHM 410: Analytical Chemistry II (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe different thermal methods of analyses: TG, DTG, DTA, DSC;
2. describe the potentiometric method of analysis using pH;
3. describe the conductometric method analysis;
4. describe the colorimetric method analysis;
5. describe the polarography methods analysis;
6. explain and perform calculation using chromatography principles;
7. explain principles of different chromatographic technique; and
8. explain the principle of radiochemical method in environmental analysis.

Course Contents
Potentiometric and pH methods. Conductometric, electroanalytical, amperometric, colorimetric methods of analysis. Coupled methods of analysis e.g. GC-MS, LC-MS. Radio-chemical methods, chromatography.

CHM 422: Physical Organic Chemistry (2 Units C: LH 30)

Learning outcomes
At the end of this course, the students should be able to:
1. describe reactions of different stereoisomers;
2. explain preparations and reactions of stereoisomers, stereoselectivity;
3. explain the effect of neighboring groups on isomers;
4. explain the term conformational analysis.

Course Contents
Preparation and reactions of stereoisomers, stereoselectivity, neighbouring group effects, and a few special topics in Physical Organic Chemistry. Conformational Analysis.

CHM 423: Organometallic Chemistry (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify the classifications of organometallic compounds by bonding and ligands;
2. explain preparation, structure and reactions including abnormal science of organometallic compounds;
3. identify electron rule, bonding, chemistry of ferrocene and related compounds; and
4. explain the roles of organometallic compounds in some catalytic reaction.

Course Contents
Classification of organometallic compounds. Preparation, structure and reactions including abnormal science of organometallic compounds. Synthetic utility of organometallics. Introduction to organometallic compounds of the transition elements. Classification of ligands, electron rule, bonding, preparation of organic transition metal compounds. Reaction and structures of organometallic compounds of transition elements. The organic chemistry of ferrocene and related compounds. The role of organometallic compounds in some catalytic reaction.

GEY 406: Micropalaeontology and Palynology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students would be able to:
1. describe the morphology of major groups of microfossils;
2. identify and classify the microfossils;
3. evaluate the stratigraphic range and significance of the microfossils; and
4. discuss the paleoecologic significance of the fossils.

Course Contents
Morphology and classification of foraminifera, coccoliths, diatoms. Morphology and classification of pollen, spores, dinoflagellates and achritarchs. Distribution, classification and stratigraphical application of major groups of microfossils. Palaeoecological interpretations of the microfossils and models. Biofacies analysis. Preparation of rock samples for biostratigraphic analysis. Photomicrography.

GEY 408: Petroleum Geology (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. state the characteristics of hydrocarbons;
2. discuss the concept of source rocks;
3. explain how source rocks are formed and different types of sources;
4. list the various methods of evaluating source rock potential;
5. discuss the reservoir properties;

6. recognise and describe various types of traps and understand the trapping mechanism;
7. explain principles and application of well logs;
8. prepare various subsurface maps and calculate reserves.

Course Contents
Forms of petroleum: - solid, liquid and gaseous forms; surface and subsurface occurrence. Accumulation of organic matter and concept of source rock. Transformation of organic matter and hydrocarbon generation. Migration of hydrocarbon. Properties of petroleum reservoir, traps and seals. Hydrocarbon traps, abnormal pressure. Exploration methods. Reserves and basin classification. Subsurface maps. Well-logging and interpretation. Examples of major oil deposits. Bitumen and conventional oil deposits in Nigeria: stages in licensing, exploration and production. Introduction to the use of relevant computer packages for data analyses and graphical presentation. Origin, occurrence and distribution of hydrocarbon deposits and fields.

GEY 409: Applied Geophysics (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. carry out geophysical investigations;
2. discuss the fundamentals of geophysics;
3. apply the principles of geophysics; and
4. interpret geophysical data.

Course Contents
Fundamentals of seismic method. Gravity method. electrical methods. interpretation of geophysical data. Application the geophysical to solving geological problems. Introduction to geophysical interpretation using workstation applications and other geophysical software applications.

GEY 410 Engineering Geology (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students would be able to:
1. explain the principles and applications of soil mechanics;
2. outline and describe the geotechnical techniques;
3. carry out site investigations;
4. interpret geotechnical reports; and
5. write and present geological report

Course Contents
Geotechnique and application in engineering geology. Terrain classification principles and application of soil mechanics. Water retaining structures, dams, highways, foundation, slope stability, settlement, design of structures. Site investigations. Principles and methods-tunnelling, drilling and sampling techniques, engineering-geological maps. Erosion problems and material quality control. Application of geology to engineering problems in roads, bridge and dam construction.

GEY 411: Hydrogeology (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students would be able to:
1. relate the hydrological cycle;
2. describe groundwater hydraulics;
3. define the hydrodynamic laws; and
4. evaluate groundwater potential of an area.

Course Contents
Hydrogeology and hydrology-definition and scope. Hydrological cycle. hydrological properties of rocks. Origin, Ooccurrence and movement of groundwater. Groundwater and well hydraulics. Fundamental hydrodynamics laws. Hydrometereology- rainfall, overland flow, through flows interception etc. Hydrographs; unit hydrograph, theory and application. Explanation of the basic hydrological equation. Regional groundwater resource evaluation.

GEY 415: Geology of Nigeria (2 Units C: PH 90)

Learning Outcomes
At the end of the course, students should be able to:
1. locate and describe strategic geologic sequences in Nigeria;
2. discuss the Cretaceous and Tertiary sequences;
3. describe the location of various Precambrian rock belts and provinces; Older granites, younger granites, Schist belts;
4. recognise the location of some mineralised zones, mines and quarries; and
5. recognise and field characteristics of the geological exposures

Course Contents
Field study through 2-week excursion to major geological features and type localities within the basement complex and sedimentary domain of Nigeria.

MCB 403: Pharmaceutical Microbiology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. explain syntheses of chemotherapeutic and prophylactic agents by microorganisms;
2. describe chemistry of chemotherapeutic and prophylactic agents synthesized by microorganisms, mode of action of antimicrobial agents; and
3. discuss mechanisms of drug susceptibility and resistance by microorganisms and assay, purification and quality control of antimicrobial agents and antiseptics.

Course Contents
Concepts of growth and death in micro-organisms. The chemistry of synthetic chemotherapeutic agents and antibiotics. Production and synthesis of antibiotics and antiseptics. Industrial and biotechnological(molecular) techniques in the large-scale syntheses of chemotherapeutic agents. Relationship of antimicrobial agents to different microbial groups: Gram positives, Gram negatives, spore-formers etc. The mode of action and assay and

purification of antibiotics and antiseptics. Sensitivity and resistance as related to microbial physiology. Microbiological quality control in the pharmaceutical industry.

MCB 405 Principles of Epidemiology & Public Health Microbiology (3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of the course, students will be able to:

1. explain epidemiological concepts (distribution, frequency, determinants, population, pattern) indices;
2. discuss herd immunity and its importance;
3. describe epidemiological field investigation methodologies;
4. identify mode of viral replication;
5. describe episomes;
6. explain viral latency (episomal latency and proviral latency) immunization;
7. discuss transmission of diseases by direct and indirect methods and schedules and Zoonotic infections.

Course Contents

Epidemiology and epidemiological concepts. Types of epidemiology. Statistical applications to epidemiology. Nature of epidemiological investigations. Spectrum of infections. Herd immunity. Latency of infections. Multifactorial systems in epidemics. Zoonoses. Antigenic drifts. Biological products for immunization. Schedules for international control of infectious diseases. Transmission routes and infectious doses (airborne, waterborne, urogenital transmissions, arthropod borne, direct contact). Controlling epidemics (reducing or eliminating reservoirs, breaking transmission routes, reducing number of susceptible individuals, quarantine). Epidemiological investigations and surveillance. Disease surveillance, Emergency preparedness and global early warning system.

MCB 407: Pathogenic Microbiology (3 Units C: LH 30: PH 45)

Learning Outcomes

1. Students will learn and be able to describe the pathogenesis (virulence factors) of common bacterial and viral pathogens, epidemiology, mode of infections, laboratory diagnosis and treatment of specific bacterial and viral pathogens.

Course Contents

Study of some bacterial and viral pathogens of plants, animals and man with emphasis on those prevalent in Nigeria. The geographical distribution, isolation, identification, morphology, life cycle, source of infection, transmission and the host. Ecology, clinical manifestations and treatment of specific bacterial, viral and fungal pathogens of man.

MCB 412: Microbial Genetics (3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of the course, students will be able to:

1. describe mutations and mutagens;
2. explain DNA transfer in bacteria, fungi and viruses;
3. describe Plasmids, Phages, Cosmids; and

4. list procedure for the transfer of the gene in Recombinant DNA Technology and procedures for recognition of transformed cell.

Course Contents
Principles of genetic analysis. Plasmids (conjugative and non-conjugative plasmids). Plasmid nomenclature and transposable genetic elements, mutagenesis and DNA repairs, bacteriophages genetics and genetics of Nitrogen fixation. Mechanism and nature of mutation, induction, isolation and characterization of mutants and Mutagens. Genetic recombination in prokaryotes including transformation, transduction, conjugation, protoplast fusion, site directed mutation, genetic engineering (recombinant DNA technology). DNA splicing. Restriction endonucleases and methylases. DNA ligases, their nomenclature phage conversion (cosmids) and transfection. Recent techniques in microbial genetics. Chemical coding and expression of genetic information. Fungal genetics. Principles and applications of genetic engineering.

MCB 423: Industrial Microbiology (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course students will be able to:
1. discuss the scope of industrial microbiology and biotechnology;
2. explain industrial media composition;
3. illustrate preparation and sources, commonly used microorganisms in industrial microbiology, primary and secondary metabolites production and gene regulation, sources and methods of strain improvements;
4. explain culture collection centres and preservation methods; and
5. describe fermentor design and operation.

Course Contents
Microorganisms used in industrial microbiology, screening for productive strains, strain improvement. Fermentation systems; design and use of fermenters. Micro-organisms of industrial importance. Patent and Intellectual Property rights; Classification of microbial products by use. Relationship between primary and secondary metabolism; characteristics, sources and strain improvement of industrial micro-organisms. Microbial preservation of industrial organisms. Culture collections. Microbial growth and product formation in industrial processes. Media for industrial fermentations. Foaming. Major products of Industrial Microbiology: enzyme production and immobilization. Production of vitamins, amino acids, antibiotics, organic acids, beer and wine.

MCB 424: Microbial Physiology & Metabolism (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. identify growth dynamics of bacterial cultures;
2. explain effect of physical and chemical factors affecting bacterial growth;
3. describe the energy and carbon sources for autotrophic and heterotrophic bacteria;
4. describe the metabolic pathways for biosynthesis of industrial microbiology some products;

5. identify anabolic and catabolic reactions;
6. explain Gibbs free energy, entropy, enthalpy and their relationships; and
7. describe energy of catabolic reactions and anabolic reactions and enzymes and activation energy.

Course Contents
Review of bacterial anatomy and cytochemistry, Dynamics of growth (batch and continuous culture). Nutrition and energy metabolism of micro-organisms. Effect of physical and chemical factors on growth. Biochemistry of various microbial processes such as transport, regulation and respiration. Biosynthesis of microbial products. Bioenergetics, Autotrophic (Photoautotrophs and chemoautotrophs) metabolism, Catabolism and anabolic reactions, Activation energy and enzyme action and control buffer preparation and standardisation. Basic separation techniques in microbiology, dialysis, salting out, gel filtration, electrophoresis etc. Assay techniques for various metabolites including microbial enzymes, acids etc.

MCB 482: Virology & Tissue Culture (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students will be able to:
1. list virus classification;
2. identify replication and cytopathic effects;
3. describe isolation, cultivation, purification and assay of viruses;
4. explain culture of viruses in egg yolk, egg white, chicken embryo; and
5. discuss monoclonal antibodies and maintenance of plant and animal cells *in-vivo.*

Course Contents
Structure, properties and classification of viruses. Principles of isolation, cultivation and maintenance of plant and animal cells *in vivo.* Application of cell culture technique in virology. Viruses as agents of diseases in animals. General characteristics of plant, animal and bacterial viruses; viral replication, spread and cytopathic effects. Virus classification, purification and assay. Regulation of lytic development and maintenance of the lysogenic state in bacteriophages lambda, P2 and 14 single stranded DNA and RNA phageviroids as pathogens.

PCM 403: Introduction to Catalysis (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students will be able to:
1. identify types, properties of catalysts and methods for characterizing them;
2. describe factors that determine industrial use catalysts; and
3. identify industrial applications of catalysts.

Course Contents
Definition of terms; the concept of catalysis; mechanism of catalysis. Role of catalysis in the chemical industry. types of catalysis; properties of catalysts. Methods for characterisation of catalysts; factors that determine industrial use of catalysts; catalyst deactivation; catalyst recycling and management. Examples of industrial applications of catalysts: Wacker process, catalytic cracking with zeolites, catalytic reforming, Fischer-Tropsch process, Harber process, Contact process, Ziegler-type catalysts in polymerisation.

PCM 404: Petrochemicals I **(2 Units C: LH 30)**

Learning Outcomes
At the end of the course, students will be able to:
1. identify downstream technology and investment options;
2. describe chemistry and technology of production of lower alkenes;
3. discuss chemistry and technology of production of chemicals and polymers; and
4. explain the environmental perspectives of petrochemicals.

Course Contents
Introduction to petrochemicals and petrochemical industries. Primary feedstock for the petrochemical industry. Primary and secondary products of the petrochemical industry. Chemistry & technology of production of lower alkenes (ethylene and propylene) from petroleum fractions. Chemistry & technology of production of chemicals and polymers from (a) ethylene, and (b) propylene. Environmental impact of petrochemicals.

PCM 405: Petrochemicals II **(2 Units C: LH 30)**

Learning Outcomes
At the end of the course, students will be able to:
1. explain the basic chemical reactions of hydrocarbons: oxidation, halogenations, sulphonation and nitration;
2. identify polymers from C_4-C_5 and BTX streams; and
3. describe potential non-petroleum sources of petrochemicals.

Course Contents
The prospects of petrochemical industry in Nigeria. Basic reactions of hydrocarbons: oxidation, halogenations, sulphonation and nitration. Chemistry & technology of production of C_4-C_5 and BTX streams from petroleum fractions. Chemistry & technology of production of chemicals and polymers from (a) C_4-C_5 streams, and (b) BTX stream. Potential non-petroleum sources of petrochemicals.

PCM 408: Corrosion Chemistry **(2 Units C: LH 30)**

Learning Outcomes
At the end of the course, students will be able to:
1. explain the chemistry of corrosion as well as corrosion inhibition, control and management;
2. describe the economic implications ofcorrosion;
3. discuss corrosion in chemical industries
4. explain corrosion in transport, storage and refining operations; and
5. describe corrosion in offshore production.

Course Contents
Definitions. Economic implications of corrosion. Corrosion principles: electrochemical aspects. Corrosion mechanism: Basic corrosion cells, Polarisation, Passivity, Theories of corrosion. Factors affecting corrosion. Uniform attack, Galvanic corrosion, Pitting corrosion, Erosion corrosion, and stress corrosion. Corrosion in chemical industries: petroleum production.

Corrosion in transport and storage, Corrosion in refining operations. Corrosion in offshore production. Corrosion testing techniques. Corrosion control and management.

PHA 405: Ethnopharmacology (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of the course, the students will be able to:

1. explain the key definitions/terms used in ethnopharmacology and historical perspective of ethnopharmacology;
2. describe the process (various stages) of drug discovery using ethnopharmacology approach;
3. identify the values and challenges/issues of drug discovery from natural products; and
4. explain the WHO traditional medicine strategy to address the challenges/issues.

Course Contents

Definitions, historical and religious basis of ethnomedicine – The medicine of Avicena, Esculapius and Galen. Key events in the development of modern Pharmacy including examples of important drugs developed from ethnopharmacology (the Calabar bean, South American arrow poison, Coca chewing and opium poppy smoking of the American Indians etc.). Race and cultural influence of traditional medicine. Herbal medicine and orthodox medicine – Homeopath; Naturopaths, Chinese acupuncture, African medicine. Socio-economic, politico-religious and technological influence on drug development and medical practice. Process of drug discovery using ethnopharmacology (information sources, extraction (solvent consideration and process), scientific investigation (tests for biological activity, bioassay, clinical trial). Challenges/issues of drug discovery from natural products (in collection, extraction and preparation, biological variation, loss of species, loss of knowledge, issues of Intellectual Property Rights) and desirability or not of merging orthodox and traditional medical practices. WHO strategy to address the challenges. The African pharmacopoeia.

PHA 409 : Quantitative Pharmacology (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of the course, the students will be able to:

1. explain the most commonly used quantitative models in pharmacology; and
2. describe the application of biostatistics in the design, collection, summarization, analysis and interpretation of data in pharmacology experiments.

Course Contents

Introduction: Drug – Receptor interaction. Affinity and intrinsic activity. Occupancy theory. Rate theory. Drug receptor interactions. Law of mass action. Enzyme. Substrate interaction. Dose-response relationship – Graphical. Law of mass action and derivation of affinity PD_2; Competitive antagonism. The Gaddum-Schild equation for affinity constant of competitive antagonists; Non-competitive antagonism, Partial agonist. Competitive non-competitive antagonism. Pharmacodynamic prediction from pharmacokinetic data (one compartment model). Receptor desensitization, Mechanisms of Post-receptor transduction. Introduction to biostatistics, Normal distribution, Mean probit transformation standard deviation and standard error. T-tests paired and unpaired chi-square test, Analysis of variance, Poison distribution.

PHY 401: Quantum Mechanics I **(3 Units C: LH 45)**

Learning Outcomes
On completion, the students would be able to:
1. state the postulates of quantum mechanics;
2. explain the basics of vectors and tensor operators;
3. solve a variety of physical problems using the Schrodinger equation;
4. work with angular momentum operators and their eigenvalues both qualitatively and quantitatively;
5. explain electron spin and the Pauli principle; and
6. apply perturbation theory and other methods to find approximate solutions to problems in quantum mechanics, including the fine-structure of energy levels of hydrogen.

Course Contents
The formulation of quantum mechanics in terms of state vectors and linear operators. Time evolution of the Schrodinger equation. The theory of angular momentum and spin. Electron spin and the Stern-Gerlach experiment. Identical particles and the Pauli exclusion principle. Multi-electron atoms. Approximation methods. Variational methods and WKB approximation for bound states and tunnelling. Time-independent Perturbation theory. The fine structure of hydrogen. Harmonic oscillator. Creation and annihilation operators. External fields: Zeeman and Stark effects in hydrogen.

PHY 407: Computational Physics **(3 Units C: LH 45)**

Learning Outcomes
On completion, the students would be able to:
1. write programmes using dynamic high-level scripting programming languages and carry out data analysis in them;
2. use classical numerical methods (euler and higher order) to find solutions of ordinary differential equations;
3. apply the Monte Carlo techniques and associated statistical methods;
4. use numerical solutions to analyse the behaviour of a physical system (such as a driven oscillator);
5. apply the approximation methods;
6. employ statistical tools in data analysis; and
7. apply methods of least square and curve fitting.

Course Contents
High level scripting language for data analysis; Definition of variables and arrays; scalar and array operations; Built in and user defined functions; Working with data sets: file input/output; Data visualisation and plotting; Error analysis: Least squares and curve fitting; X2 analysis; Errors on fitting coefficients; propagation of errors; Comparison of high level languages; Methods of numerical integration, and differentiation; Numerical methods and the solution of differential equations; Euler's method, higher order methods; Symmetric methods; Implementation of numerical methods; Statistical analysis of experimental data; Numerical solution of non-linear algebraic equations; polynomials; Numerical solution of systems of linear algebraic equations; interpolation; Monte Carlo method and its application; Pseudorandom sampling methods of generating samples with given probability.

PIO 414: Cardiopulmonary Physiology (2 Units C: LH 30)

Learning Outcomes
On successful completion of this course, the students should be able to:
1. describe the historical developments in Cardiovascular and Respiratory physiology;
2. discuss the progressive changes in maternal blood volume, cardiac output, and peripheral resistance during pregnancy and at delivery;
3. list the functions in utero of the fetal ductus venosus, foramen ovale and ductus arteriosus;
4. explain the mechanisms causing closure of these structures at birth;
5. describe the redistribution of cardiac output during the various degrees of CNS, coronary, splanchnic, cutaneous and skeletal muscle vascular beds sustained during exercise (distance running);
6. explain the relative importance of neural and local control in each vascular bed;
7. list the various causes of hypertension and discuss the underlying mechanisms;
8. discuss the direct cardiovascular consequences of the loss of 30% of the circulating blood volume on cardiac output, central venous pressure and arterial pressure;
9. describe the compensatory mechanisms activated by these changes;
10. list the factors that determine total lung capacity, functional residual capacity, and residual volume;
11. describe the mechanisms responsible for the changes in those volumes that occur in patients with emphysema and pulmonary fibrosis;
12. differentiate between the two broad categories of restrictive and obstructive lung disease, including the spirometric abnormalities associated with each category;
13. discuss the physiology of jet lag; and
14. describe the mechanism of Nitrogen narcosis in deep sea diving.

Course Contents
Developmental milestones in cardiovascular and respiratory physiology. Cardiopulmonary function in the fetus and in old age. Cardiopulmonary responses at rest and in moderate to severe stress conditions. Pathophysiology of hypertension, Obstructive and restrictive lung diseases. Principles of servomechanism as applied to cardiopulmonary physiology. Aviation, space and deep-sea physiology.

MCB 412: Microbial Genetics (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course students will be able to:
1. explain mutations and mutagens;
2. describe DNA transfer in bacteria, fungi and viruses;
3. identify plasmids, Phages and cosmids;
4. explain the procedure for the transfer of the gene in recombinant DNA technology; and
5. highlight the procedures for recognition of transformed cells.

Course Contents
Principles of genetic analysis. Plasmids (conjugative and non-conjugative plasmids), Plasmid nomenclature and transposable genetic elements, mutagenesis and DNA repairs,

bacteriophages genetics and genetics of Nitrogen fixation. Mechanism and nature of mutation, induction, isolation and characterisation of mutants and Mutagens. Genetic recombination in prokaryotes including transformation, transduction, conjugation, proptoplast fusion, site directed mutation, genetic engineering (recombinant DNA technology), DNA splicing, restriction endonucleases and methylases DNA ligases, their nomenclature phage conversion (cosmids) and transfection. Recent techniques in microbial genetics. Chemical coding and expression of genetic information. Fungal genetics. Principles and applications of genetic engineering.

SLT 402: Students' Industrial Work Experience Scheme (6 Units C: 24 weeks)

Learning Outcomes
Students who successfully complete the six months long practical exposure will:
1. acquire hands-on experience in a work place setting;
2. acquire practical skills related to their study programme;
3. exhibit interpersonal skills;
4. demonstrate knowledge of workplace expectations and professional ethics;
5. be equipped to face the rudiments associated with his chosen profession.

Course Contents
This SIWES programme shall be undertaken in an establishment with practical working facilities relevant to the student area of specialisation (e.g., suitable laboratories in medical/public, industrial laboratories, research etc). Assessment is based on written report, seminar presentation, and assessment by supervisors.

SLT 431: Bioinformatics for SLT Students 11 (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, student will be able to:
1. identify currently accessible genomic and proteomic databases;
2. search and retrieve information from genomic and proteomic databases and analyse their search results using software accessible on the Internet;
3. compare and analyse biological sequences and how to interpret the results of their analyses;
4. locate consensus sequences, genes and open reading frames within biological sequences;
5. explain the principles and applications of microarrays;
6. perform elementary predictions of protein structure and function;
7. describe how to perform elementary comparative genomic analysis;
8. explain how to construct character based phylogenetic trees; and
9. design primers using primerbank and other useful software.

Course Contents
Introduction and navigation of the NCBI. Online Mendelian Inheritance In Man (OMIM), NCBI Genome, and Swiss-Prot Databases. Sequence retrieval from genomic databases, Restriction endonuclease mapping. Comparison of sequences using BLAST, Interpretation of BLAST search results; Global Alignment using MatGAT, Multiple Alignment using ClustalW; Determination of consensus sequences, locating genes (gene prediction) and open reading frames in DNA sequences. Prediction of protein structure and function and comparative genomics; Microarray

analysis and applications of microarrays. Comparison and analysis of whole genomes. Construction of character based phylogenetic trees and designing and construction of specific primers using PrimerBank and other software

Level 500 Courses for all Study Options

GLT 501: Laboratory Organisation and Management I (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of this course students will be able to:
1. recognise the special features required for teaching, industrial, research and hospital laboratories and the ways of acquiring laboratory accommodation;
2. plan and design various types of laboratories;
3. plan and design laboratory stores;
4. explain laboratory store policy as it affects the storage of chemicals, hazardous materials, storage of equipment and apparatus and their documentation;
5. maintain laboratory premises and equipment;
6. carry out inspection of laboratory premises and equipment; and
7. explain laboratory administration and management.

Course Contents
Planning and designs of laboratories. Ways of acquiring laboratory accommodation. Flexibility in laboratory design. Special features of teaching, industrial, research and hospital laboratories. General space requirements; laboratory layout, provision of services; floors, windows, doors, benches; cupboards and drawer units, mechanical services – heating and ventilating, fume-cupboards, lighting, electrical supplies, water supplies, piped gases; safety in design and decoration. Allocation of floors in multi-storey buildings.
Management of Stores**:** Stores policy; stores design and planning – storage of chemicals, hazardous materials, storage of apparatus; documentation.
Laboratory Administration: Technical information – filling systems, indexing systems, laboratory records and record-keeping, office facilities and equipment, decision-making – seeking advice, staff meetings, advisory committee, meetings, formal committee meetings.
Maintenance of Laboratory Premises and Equipment**:** Planned maintenance – inspection of premises and equipment. Service Departments and Special **–** Purpose Rooms**:** Glassware washing and sterilizing facilities; radioisotope laboratories; photographic units, cold-rooms, hot-rooms; animal houses; reprographic units, laboratory workshops, audio-visual aids – audio-aids, visual aids; glassblowing workshops.

GLT 502: Laboratory Organisation and Management II (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of this course students will be able to:
1. highlight the procedures for purchasing laboratory materials;
2. prepare purchasing orders, receipt and effect storage of ordered materials;
3. explain and apply laid down standard operating procedures for issuing of materials from laboratory stores;
4. describe stock control management;
5. explain record keeping in the laboratory;

6. carry out literature search and retrieval;
7. design and execute scientific experiments and projects;
8. carry out scientific measurements and data collections;
9. identify the factors that can affect the accuracy of experimental measurements;
10. prepare and present experimental data;
11. design and present seminars and technical reports;
12. discuss planning; organizing; forecasting; motivating, coordination controlling and communication as applied to laboratory management and services;
13. explain the concept and relevance of management to laboratory practice;
14. recognize the rudiments and procedures for the selection and management of laboratory staff, organisation of laboratory practice and how to ensure health and safety in the laboratory;
15. discuss the health and safety at work etc Act of 1974 as it affects organisation of laboratory safety;
16. explain the Legislation regulating the science laboratory practice in Nigeria (NISLT Act No. 12 of 2003);
17. identify the legal and professional responsibilities of technologists; and
18. explain the modus operandi and organisation of public and private laboratory services in Nigeria –have an understanding of the professional code of ethics.

Course Contents

Management techniques and functions**:** The concept and relevance of management to laboratory practice. Meeting of organisation; Supervisory skills and management functions; Planning; organising; forecasting; motivating, coordination, controlling and communicating etc. Purchasing of laboratory materials; sources of funds and different methods of purchasing. Preparation of purchasing orders. Receipt and storage of ordered materials. Issuing of materials. Stock control management. Record keeping in the laboratory. Design and execution of scientific experiments and projects. Different types of scientific experiments. Scientific measurements and data collections. Literature search and retrieval. Factors affecting accuracy of experimental measurements. Preparation and presentation of experimental data – thesis/dissertation. Ways of presenting seminars.

Selection and management of staff**:** Job description; the advertisement; application forms – references; interview and selection – final selection; contracts and conditions of service; induction; training and further education – motivation in technical education. Recent developments in technical training and education; laboratory discipline; termination of employment.

Organisation of laboratory practice**:** Elements of law. Common and statutory laws and relevance to laboratory practice such as health and safety; welfare of employees, and cruelty to animals. Import and exercise duties. Nature of contract. Elements of contract. Contract in relation to purchasing of laboratory materials, employment etc. Legislation regulating the science laboratory practice in Nigeria (NISLT Act No. 12 of 2003). Structure of NISLT and functions. Legal and professional responsibilities of technologists. Organisation of laboratory services in Nigeria – public and private laboratories. Professional code of ethics. Types of business organisation. Small business management. Production; entrepreneurship and business development. Industrial relations.

Health and safety**:** The basic approach – The health and safety at work, etc Act of 1974. Organisation of laboratory safety – line management, safety officers, safety committees, codes of practice, general attitude to laboratory safety, accident books and records, notable accidents, hazards – fire, fire prevention, fire-fighting equipment, fire drills, fire escapes, fire prevention advice, electrical and electronic equipment, radiation and the use of radioactive substances, cylinders of compressed gas, centrifuges, cryogenic substances, physical injuries, chemical occupational hygiene, dermatitis and skin reactions, toxic substances and threshold limit values, carcinogens; bacterial, viral and other biohazards.

GLT 508: Photography and Illustrations (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students will be able to:
1. explain the working of cameras and it various types;
2. describe the concepts and fundamentals of photography, photomicrograph, dark-room management, lighting system;
3. carry out video camera splicing and editing of commercially processed films;
4. recognise photomicrography, its techniques and application; and
5. identify the hazards associated with photographic reagents.

Course Contents
Concepts and fundamentals of photography*:* Cameras: The general principles, manipulation and care of different types of cameras in common use, their advantages and disadvantages. Photomicrography**:** Techniques and application; Lighting system**:** Daylight, "Photoflood", exposure meters, depth of field, background. Printing process**:** Projection and contact printing, choice and grades of paper, local control, finishing. Colour photography**:** Colour photography principles of reversal and of negative-positive processes. Types of materials; colour temperature, filters, exposure. Cine Photography: Cine photography, use of 8mm cameras, video camera splicing and editing of commercially processed film. *Safety***:** Hazards in the use of photographic reagents. Dark-room management.

SLT 501: Seminar (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students will be able to:
1. carry out literature search;
2. elucidate the various reference methods for writing and presenting seminar papers;
3. exhibit presentation, discussion, listening and questioning skills, in addition to argumentative and critical thinking skills; and
4. demonstrate the foundation for engaging with big questions and studying major works.

Course Contents
Students will research topics and organise presentations for the department and other students. The topics may be any aspect of their areas of study options and must be approved by their supervisor and/or Head of Department.

SLT 502: Research Project (6 Units C: PH 270)

Learning Outcomes
At the end of this course, students will be able to:
1. demonstrate practical laboratory research work experience;
2. exhibit critical thinking ability;
3. display foundational research skills to address research questions; and
4. exhibit planning, time and change management skills.

Course Contents
Research project on a topic of interest in the student's area of specialisation. The project should involve literature review, experimental work and written report.

SLT 504 Biological Laboratory Techniques III (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students will be able to:
1. demonstrate knowledge of the Cruelty to Animals Act of 1876, and its amendment and how it applies to the practice of the SLT profession;
2. explain the theoretical and the practical knowledge of handling and care of laboratory animals; and
3. process histological specimens, including dissection and embalmment.

Course Contents
Laboratory animal technology and aquarium/vivarium management: The Cruelty to Animals Acts. 1876; An understanding of the legal requirements covering the management of experimental animals. Licenses and certification. The conditions attached to every license. Administration of the Act: Inspectors: Recording of experiments, visitors to experimental areas. Routine care of common species and of the Rhesus monkey. Methods of feeding and watering. Bedding and nesting materials. Cleaning of cages, equipment and premises. Environmental temperature and humidity and the option recommended for various species. Inspection for injuries: Teeth and claws. Normal body temperatures. Ill-health in the common species. An elementary knowledge of the causes of ill-health. Recognition of the signs of ill-health. e.g., loss of condition; respiratory infections; infestations. Breeding of the common species. Recognition of good breeding animals. Elementary knowledge of oestrous cycles. Gestation periods. Average litter sizes. Average birth, weaning and adult body weights. Duration of economic breeding life. Breeding system; mating at post-partum oestrous; monogamous. Pairs and colonies; inbreeding and random breeding.
Practicals:
1. Handling and sexing of laboratory animals;
2. Determination of age and body weight;
3. Principles of spring, beam and torsion balances;
4. The use and care of animal and food balances;

Sources of specimens. Fixing preservation and embalming of bodies. The techniques of dissection and finishing. Injection techniques. Demonstrating lymphatic vessels and maceration.

Minimum Academic Standards

Staffing

Academic Staff

The guidelines on academic staff/student ratio of 1:20 for Science Programmes shall apply. To start any programme in Science, there should be a minimum of six academic staff. There is need to have a reasonable number of staff with PhD degrees accounting for at least 70% of the total number and having adequate teaching experience for every programme in the Discipline.

Administrative Support Staff

The services of the administrative support staff are indispensable in the proper administration of the Department. It is important to recruit very competent, computer literate senior staff.

Technical Support Personnel

The services of technical support staff, which are indispensable in the proper running of laboratories are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

Library

1. All SLT departments must have its own dedicated library/resource room in addition to the Institutions general university library.
2. The library/resource room must be large enough to accommodate at least 15% of the student population in the department.
3. Its stock of books, journals and resource materials must be broad and relevant to the available learning options.
4. Its stock should include relevant current journals and internet linked computers that allow access to journals globally.

Classrooms, Laboratories, Workshops and Office Space

The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

Classrooms
There should be at least three dedicated classrooms of about 0.7m^2 per student.
Workshops
There should at least be one workshop for glass-blowing. The size of the workshop should not be less than 40.0m^2. The workshop should provide modern facility for glassblowing operation and design. Its facilities should include safety, storage cabinets, desk/work stations and furniture arranged in a manner to block easy access to the hot zones or working areas of the shop.

Hot zone areas
The hot zone areas should include glass working workbench and student benches where the hot working or forming of glass takes place.
Work surfaces should be a fibre/cement composition that can withstand exposure to gas/hydrogen oxygen flames and hot glass. It should be painted flat black, to aid in determining subtle differences in flame and glass colour during the glassblowing process.

Storage facility should be provided for glass working tools and related equipment.

Compressed gases, vacuum, and electricity
Compressed gas(es), vacuum, electricity should be delivered to the glassblower's lathe. This preferably should be delivered through an overhead feed. A metal housing with removable back panel should be provided to enclose and protect the piping, as well as serve as a mounting platform for regulators and hose cocks.

The Sink area
The sink area should be a 1.5 metres stainless steel sink that can accommodate the 1.2 metres lengths of tubing commonly used by glassblowers. The faucet and drain should be at the end of the sink to maximize their usefulness.

Sources for hot, cold, and distilled (DI) water should be available and sources of compressed air and vacuum are nearby.

The following are minimum equipment/ tools that should be in the workshop;
1. Furnace/Glory Hole
2. Benches
3. Yokes
4. Annealer
5. Wooden Blocks
6. Blowpipe
7. Torches
8. Jacks
9. Shears
10. Paddles
11. Molds
12. Crimps
13. Marvers
14. Parchoffi

15. Punty
16. Pyrometer
17. Safety Glasses
18. Soffietta
19. Taglia
20. Tweezers

Laboratory Facilities

Good laboratory facilities are major core requirements for any science laboratory department. However, the number and types of laboratories will depend on the study options available in the university. For example, a university with two study options such as Biology, Microbiology should have a minimum of three dedicated laboratories with relevant facilities, water and power supply. This is in addition to other shared laboratory facilities. Two laboratories for routine and practical's classes and another exclusively for research work. Each should be at least $7.5m^2$ per student.

Equipment

These should be relevant to the study options available in the university. There must be functional and enough for all students to have a hands-on the bench experience during practical exercises. It should be an addition to the general facilities that should be provided in laboratories required for basic science courses such as Biology, Chemistry and Physics. In addition, each laboratory must have a preparatory room.

Minimum equipment/apparatus needed for a Microbiology laboratory

1. Autoclave
2. Incubator
3. Hot air oven
4. Inoculating loop
5. Vortex mixer / shaker
6. Water bath
7. Heating mantle
8. Hot plate with magnetic stirrer
9. UV chamber
10. Inoculation chamber
11. pH meter
12. Colony counter
13. Microscope
14. Refrigerator
15. Bunsen burner
16. Micrometer (stage and ocular)
17. Balance (Digital and 4-beam)
18. Thermometer
19. Membrane filter set
20. Safety goggles and safety equipment.
21. Beakers
22. Erlenmeyer flasks, AKA conical flasks.
23. Test tubes, tongs, and racks

24. Funnels.

Minimum equipment/apparatus required for a Geology/Mining technology laboratory

1. Jaw crusher and pulverizer
2. Petrographic microscopes
3. Scanning electron microscope
4. Rock saw blades
5. Rock saws
6. Sample splitters &riffler
7. Sieve shakers &accessories
8. Testing sieves
9. Water swivels.

Minimum equipment/apparatus required for a Physics/Electronics Technology laboratory

In addition to the normal needs for B.Sc. Physics laboratory requirement, the SLT requirements for a Physics/Electronics Technology laboratory includes:

1. Oscilloscope.
2. Laboratory power supply unit.
3. Functional generator.
4. Multimeter.
5. Component tester for semiconductors.
6. LCR meter.
7. Variable isolation transformer.
8. Soldering station
9. Oscilloscope.
10. Laboratory power supply unit.
11. Functional generator.
12. Multimeter.
13. Component tester for semiconductors.
14. LCR meter.
15. Variable isolation transformer.
16. Soldering station

Minimum equipment/apparatus required for a Physiology/Pharmacology Technology laboratory

1. Respiratory belt transducer.
2. Grip Force transducer (DIN)
3. Cardio microphone.
4. Sphygmomanometer with 3 Cuffs.
5. Blood pressure systems/blood pressure monitor
6. Capnograph/capnography monitor
7. Lab animal exercise / walking system
8. Laboratory animal anaesthesia system
9. Physiological monitor
10. Laboratory refrigerator freezer
11. Liquid nitrogen canister / liquid nitrogen dewar

12. Liquid nitrogen freezer / LN2 freezers
13. Minus 20 freezer (-20C to -40C Freezers)
14. Laboratory animal monitoring chamber
15. Forensic workstation / forensic hood
16. Laboratory freeze dryer
17. Laboratory hoods
18. Cage changing hoods

Minimum equipment/apparatus for a Biochemistry Laboratory.

1. Spectrometer.
2. High-performance liquid chromatography apparatus.
3. Centrifuge machine
4. Gel electrophoresis equipment
5. Incubator
6. Orbital shaker
7. Shaker water bath
8. Water baths
9. Thermocyclers
10. Forceps
11. Colorimeter
12. Weighing balance
13. Spatula
14. Tongs
15. Wash bottles
16. pH meters
17. Electrical balance
18. Oven hot air
19. Water distillation apparatus steel
20. Stop watches

List of glassware of Biochemistry laboratory

S. No	GLASSWARES	Size
1	Beakers	1000ml
2	Beakers	500ml
3	Beakers	250ml
4	Beakers	200ml
5	Reagent Bottle	1000ml
6	Reagent Bottle	500ml
7	Reagent Bottle	250ml
8	Reagent Bottle	125ml
9	Reagent Bottle	60ml
10	Burettes	50ml
11	Conical Flask	1000ml
12	Conical Flask	500ml
13	Conical Flask	250ml
14	Conical Flask	100ml
15	Conical Flask	50ml
16	Volumetric Flask	1000ml
17	Volumetric Flask	500ml
18	Volumetric Flask	250ml
19	Volumetric Flask	100ml
20	Graduated Cylinder	1000cc
21	Graduated Cylinder	500cc
22	Graduated Cylinder	250cc
23	Graduated Cylinder	100cc
24	Graduated Cylinder	25cc
25	Disposable Syringes	5cc
26	Filter Paper	
27	Glass Funnel	75ml
28	Glass Rod	
29	Pipette	10ml
30	Pipette	5ml
31	Pipette	2ml
32	Pipette	1ml
33	Pipette	0.5ml
34	Pipette	0.2ml
35	Test tube	Various
36	Test tube	Various
37	Test tube brushes	
38	Test tube holder	
39	Pastel mortar	
40	Spatula	
41	Spirit lamps	

S. No	GLASSWARES	Size
42	Wash bottles	
43	Pipette sucker	
44	Test tube racks	
45	Glass slides	
46	Glass slide cover slip	

Special requirements for laboratories

All laboratories for teaching, research or for student's practical work must meet the following requirements:

1. must be spacious enough for the number of students it is expected to hold;
2. be properly ventilated;
3. it must fulfil all safety regulations, including electrical, emergency escapes routes, availability of standard fire extinguishers and sand buckets;
4. if it generates hazardous materials (e.g. microbiological laboratories, chemistry, pharmacology, biochemistry) then the lab must have all support spaces such as: instrument and preparation rooms, sample stores, sterilization facilities, waste storage facilities;
5. administration and office accommodation should not be within the laboratory boundary but should ideally be in close physical proximity to the laboratories they serve; and
6. must conform to hazardous substances advisory standard.

B.Sc. Statistics

Overview
Statistics programme is designed to enable students acquire far-reaching knowledge in the management of data, including ways to gather, review, analyse, and draw conclusions from data. Throughout the course, students will gain experience in working as part of a team, and learn how to use specialized computer software.

Students are given intensive exposure to probability and introductory statistical methods, introducing the ideas of likelihood and regression modelling. Other statistics topics that will be covered include experimental design, inference, computational inference, sampling and databases.

Statistics facilitates the decision-making process by quantifying the element of chance or uncertainties. The course is designed to develop concepts, from basic level to increasingly complex topics or skills. Graduates of the programme will acquire sufficient theoretical and practical knowledge to enhance sustainability of a better development and can compete favourably in any place.

Philosophy
The philosophy of the Statistics programme is to provide broad based education in the use of a limited sample to make intelligent and accurate conclusions about a greater population. The use of tables, graphs, and charts will also play a vital role in presenting data being used to draw these conclusions.

Objectives
The objectives of the Program are to:

1. develop in students a sense of enthusiasm for Statistics, an appreciation of its application in different areas and to involve them in an intellectually stimulating and satisfying experience of learning and studying;
2. provide students a broad and balanced foundation in Statistics knowledge and practical skills in Statistics;
3. develop in students, the ability to apply their Statistics knowledge and skills to the solution of theoretical and practical problems in Statistics;
4. develop in students, through an education in Statistics, a range of transferable skills of values in Statistics related and non-Statistics related employment; and
5. provide students with knowledge and skills- base from which they can proceed to further studies in specialized areas of Statistics or multi-disciplinary areas involving Statistics.

Unique Features of the Programme
The unique features of the programme include:
1. more practical hours are dedicated to the use of statistical software in understanding of complex data in graphical form, tabular form and in diagrammatic representation;
2. Designing effective and proper planning of statistical inquiry and research in any field;
3. independent student research projects allow students to explore topics of interest in great depth, and with the guidance of a faculty mentor; and

4. entrepreneurship skill for the students and the industrial attachment which provides hands-on experience on industrial workflow and ethics and thereby enhancing employability

Employability Skills

1. Graduates from the programme will be able to demonstrate: practical skills relating to solution of statistics problems express themselves in writing for professional and academic audience; analytical skills appraise key issues in both the descriptive and statistical inference.
2. Students will also be able to synthesis concepts; ability to plan and execute, design and conduct surveys, construct and mange various criteria's in decision making. Graduates of the program will be employable in schools, ministries, departments and agencies. They may also be self-employed or even employers of labour.

The 21st Century Skills

1. Data analysis
2. Information literacy
3. Productivity
4. Collaboration
5. Innovation
6. Technology Literacy
7. Critical Thinking
8. Creativity

Admission and Graduation Requirements

Admission Requirements

There are two different pathways by which candidates can be admitted into the programmes in the discipline; the indirect-entry mode and the direct entry.

Indirect-entry mode (100 level)

The entry requirements shall be at least credit level passes in five (5) subjects and in not more than two (2) sittings. These subjects including English language, mathematics and physics to form the core subjects and any other two (2) relevant science subjects (chemistry, biology/agricultural science, geography/economics or further mathematics) at the senior secondary certificate (SSC) or its equivalent. In addition, an acceptable pass in the unified tertiary matriculation examination (UTME) with the appropriate subject combination is required for admission into 100- Level.

Direct entry

Candidates with at least two A level passes (graded A-E) at the GCE/IJMB Advanced Level in relevant subjects (Mathematics, Physics and Further-Mathematics) may be admitted into 200-Level.

Graduation Requirement

To be eligible for graduation, UTME students must pass and obtain a minimum of 120 credit units, while direct entry students must pass and obtain a minimum of 90 credit units.

Global Course Structure

100 Level

Course Code	Course Title	Units	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	
CSC 101	Introduction to Computer Science	3	C	30	45
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
STA 111	Descriptive Statistics	3	C	45	-
STA 112	Probability I	3	C	45	-
STA 121	Statistical Inference I	3	C	45	-
STA 122	Statistical Computing I	3	C	15	90
	Total	**23**			

200 Level

Course Code	Course Title	Units	Status	LH	PH
GST 212	Philosophy, Logic, and Human Existence	2	C	30	
ENT 211	Entrepreneurship and Innovation	2	C	15	45
STA 202	Statistics for Physical Sciences & Engineering	3	C	45	-
STA 211	Probability II	3	C	45	-
STA 212	Introduction to Social & Economic Statistics	3	C	45	-
STA 221	Statistical Inference II	3	C	45	-
STA 231	Statistical Computing II	2	C	-	90
STA 299	Industrial Attachment I (12 Weeks)	3	C		
	Total	**21**			

300 Level

Course Code	Course Title	Units	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	
ENT 312	Venture Creation	2	C	15	45
STA 311	Probability III	3	C	45	-
STA 312	Distribution theory I	3	C	45	-
STA 321	Statistical Inference III	3	C	45	-
STA 322	Regression and Analysis of Variance I	2	C	30	-
STA 324	Survey methods and sampling theory	3	C	45	-
STA 399	Industrial Attachment II (12 Weeks)	3	C		
	Total	**21**			

400 Level

Course Code	Course title	Units	Status	LH	PH
STA 411	Probability IV	3	C	45	-
STA 412	Distribution Theory II	3	C	45	-
STA 413	Statistical Inference IV	3	C	45	-
STA 415	Regression and Analysis of Variance II	3	C	45	-
STA 422	Logical Background of Statistics & Decision Theory	3	C	45	-
STA 499	Research Project	6	C		
	Total	**21**			

Course Contents and Learning Outcomes

100 level

GST 111: Communication in English (2units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. identify possible sound patterns in English language.
2. list notable language skills.
3. classify word formation processes.
4. construct simple and fairly complex sentences in English.
5. apply logical and critical reasoning skills for meaningful presentations.

6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents

Sound patterns in English language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex); grammar and usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and critical thinking and reasoning methods (logic and syllogism, inductive and deductive argument and reasoning methods, analogy, generalisation and explanations); ethical considerations; copyright rules and infringements; writing activities: (pre-writing , writing, post writing, editing and proofreading; brainstorming, outlining, Paragraphing, types of writing, summary, essays, letter, curriculum vitae, report writing, note making etc. mechanics of writing). Comprehension Strategies: (reading and types of reading, comprehension Skills, 3RsQ); information and communication technology in modern language learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening; report writing.

GST 112: Nigerian Peoples and Culture (2 units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of Trade, Economic and Self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building;
6. analyse the role of the Judiciary in upholding people's fundamental rights;
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture and art up to 1800 (yoruba, hausa and igbo peoples and culture. Peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria. Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification. judiciary and fundamental rights; individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts. cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – reconstruction, rehabilitation and

re-orientation; re-orientation strategies: operation feed the nation (OFN); green revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and corruption (WAIC), Mass Mobilization for self-reliance, social justice and economic recovery (MAMSER), national orientation agency (NOA); current socio-political and cultural developments in Nigeria.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents

Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. explain basic definition of set, subsets, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers, integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers, algebra of complex numbers, the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Function of a real variable, graphs, limits and idea of continuity. The derivative as limit of rate of change. Techniques of differentiation. Extreme curve sketching. Integration as an inverse of differentiation. Methods of integration. Definite integrals. Application to areas, volumes.

STA 111: Descriptive Statistics (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the basic concepts of descriptive statistics;
2. present data in graphs and charts;
3. differentiate between measures of location, dispersion and partition;
4. describe the basic concepts of Skewness and Kurtosis as well as their utility function in a given data set;
5. differentiate rates from ratio and how they are use; and
6. compute the different types of index number from a given data set and interpret the output.

Course Contents
Statistical data. Types, sources and methods of collection. Presentation of data. Tables chart and graph. Errors and approximations. Frequency and cumulative distributions. Measures of location, partition, dispersion, skewness and Kurtosis. Rates, ratios and index numbers.

STA 112: Probability 1 (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the differences between permutation and combination;
2. explain the concept of random variables and relate it to probability and distribution functions;
3. describe the basic distribution functions; and
4. explain the concept exploratory data analysis.

Course Contents
Permutation and combination. Concepts and principles of probability. Random variables. Probability and distribution functions. Basic distributions: Binomial, geometric, Poisson, normal and sampling distributions; exploratory data analysis.

STA 121: Statistical Inference I (3 Units C: LH 45)

Learning Outcome
At the end of the course, students should be able to:
1. differentiate population from sample as well as point from interval estimate;
2. test for hypothesis concerning population mean and proportions for large and small samples;
3. compute regression and obtain the fitted line. Likewise, the computation for correlation coefficient well understood; and
4. describe the fundamentals of time series analysis.

Course Contents
Population and samples. Random sampling distributions. Estimation (point and interval) and tests of hypotheses concerning population mean and proportion (one and two large sample cases). Regression and correlation. Elementary time series analysis.

STA 122: Statistical Computing I (3 Units C: LH 15; PH 90)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the fundamentals of computer;
2. acquire knowledge of the applications and use of computers and calculators in relation to computing the measures of locations and dispersions;
3. explain the organizations of computations to access, transform, explore, analyse data and produce results; and
4. demonstrate the use of Microsoft excel and the installation of the analysis tool pack.

Course Contents
Introduction to computer: structure, type, uses and applications; computations (using computers and calculators), involving topics in STA111 and 121; organizations of computations to access, transform, explore, analyze data and produce results. Concepts and vocabulary of statistical computing. Microsoft excel and specifically the installation and the utility function of the analysis tool pack.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;

3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk-taking state the characteristics of an entrepreneur
2. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence engage in entrepreneurial thinking;
3. identify key elements in innovation; describe stages in enterprise formation, partnership and networking including business planning;
4. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
5. state the basic principles of e-commerce.

Course Contents
Concept of entrepreneurship (entrepreneurship, intrapreneurship/corporate entrepreneurship,). Theories, rationale and relevance of entrepreneurship (Schumpeterian and other perspectives, risk-taking, necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of entrepreneurs (opportunity seeker, risk taker, natural and nurtured, problem solver and change agent, innovator and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking, and creative thinking). innovation (concept of innovation, dimensions of innovation, change and innovation, knowledge and innovation); enterprise formation, partnership and networking (basics of business plan, forms of business ownership, business registration and forming alliances and join ventures). Contemporary entrepreneurship Issues (knowledge, skills and technology, intellectual property, virtual office, networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, youth and women entrepreneurship, entrepreneurship support institutions, youth enterprise networks and environmental and cultural barriers to entrepreneurship); basic principles of e-commerce.

STA 201: Statistics for Agriculture and Biological Sciences (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the scope for statistical methods in biology and agriculture;
2. define the measures of location, partition and dispersion;
3. explain the elements of probability; probability distributions: binomial, poisson, geometric, hypergeometric, negative binomial and normal, Student's t and chi-square distributions;
4. differentiate point from interval estimation and could be able to tests for hypotheses concerning population means, proportions and variances;
5. compute for regression and correlation as well as conduct some Non–parametric tests with reference to Contingency table analysis; and
6. explain the elements of design of experiments and Analysis of variance.

Course Contents
Scope for statistical method in biology and agriculture; measures of location, partition and dispersion. elements of probability. probability distributions; binomial, Poisson, geometric, hypergeometric, negative binomial and normal, Student's t and chi-square distributions. Estimation (point and interval) and tests of hypotheses concerning population means, proportions and variances. regression and correlation. Non–parametric tests. contingency table analysis. Introduction to design of experiments. analysis of variance.

STA 202: Statistics for Physical Sciences and Engineering (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. highlight the scope for statistical methods in physical sciences and engineering;
2. define the measures of location, partition and dispersion;
3. explain the elements of probability; probability distribution: binomial Poisson, geometric, hypergeometric, negative-binomial, normal poisson, geometric, hypergeometric, negative-binomial, normal, Student's t and chi-square distribution;
4. differentiate point from internal estimation and could be able to tests for hypotheses concerning population means proportions and variances;
5. compute for regression and correlation as well as conduct some non–parametric tests with reference to contingency table analysis; and
6. explain the elements of design of experiments and analysis of variance.

Course Contents
Scope for statistical methods in physical sciences and engineering. Measures of location, partition and dispersion. Elements of probability. Probability distribution: binomial Poisson, geometric, hypergeometric, negative-binomial, normal poisson, geometric, hypergeometric, negative-binomial, normal, Student's t and chi-square distributions. Estimation (point and internal) and tests of hypotheses concerning population means proportions and variances. regression and correlation. non-parametric tests. contingency table analysis. introduction to design of experiments. analysis of variance.

STA 211: Probability II (3 Units C: LH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. explain further permutation and combination;
2. define probability laws, conditional probability, and independence;
3. describe Bayes' theorem and explain some of the basic probability distribution for discrete and continuous random variables;
4. compute expectations and moments of random variables;
5. explain Chebyshev's inequality and apply it to real life situations;
6. explain joint marginal and conditional distributions and moments as well as Limiting distributions;
7. describe standard distributions, moments and moment-generating functions; and
8. explain laws of large numbers and the central limit theorem.

Course Contents

Further permutation and combination. probability laws. conditional probability, independence. Bayes' theorem. probability distribution of discrete and continuous random variables: binomial, Poisson, geometric, hypergeometric, rectangular (uniform), negative exponential, binomial. Expectations and moments of random variables. Chebyshev's inequality. joint marginal and conditional distributions and moments. limiting distributions. discrete and continuous random variables, standard distributions, moments and moment-generating functions. laws of large numbers and the central limit theorem.

STA 212: Introduction to Social and Economic Statistics (3 Units C: LH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. highlight the statistics systems and explain the nature, types, sources, methods of collection and problem of official statistics;
2. compute index numbers using the different types;
3. describe descriptive statistics and Basic principles of probability;
4. differentiate discrete from continuous random variables considering binomial, normal, t, chi-square, Poisson, other univariate distributions;
5. explain joint distributions and sampling distributions;
6. demonstrate central limit theorem;
7. explain the properties of an estimators and linear combinations of random variables;
8. explain the basic concept of testing of hypotheses;
9. identify the socio-economic indicators: nature, types, uses and computation; and
10. explain the nature, sources, contents and problems of official statistics in selected sectors.

Course Contents

Statistics systems. nature, types, sources, methods of collection and problem of official statistics. index numbers, theory, construction and problems. descriptive statistics. Basic principles of probability. discrete and continuous random variables (binomial, normal, t, chi-square, Poisson, other univariate distributions). joint distributions. sampling distributions. central limit theorem. properties of estimators. linear combinations of random variables. testing and estimation.

maximum likelihood principle, basics of hypotheses testing. Socio-economic indicators: nature, types, uses and computation. Nature, sources, contents and problems of official statistics in selected sectors.

STA 221: Statistical Inference II (3 Units C: LH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. explain sampling and sampling distribution;
2. differentiate point from interval estimation;
3. outline the principles of hypotheses testing; test hypotheses concerning population means, proportions and variances; of large and small samples, large and small sample cases; and
4. conduct a goodness fit tests using the analysis of variance.

Course Contents

Sampling and sampling distribution. point and interval estimation. principles of hypotheses testing. tests of hypotheses concerning population means, proportions and variances of large and small samples, large and small sample cases. Goodness –fit tests. analysis of variance

STA 231: Statistical Computing II (2 Units C: PH 90)

Learning Outcomes

At the end of the course, students should be able to:

1. explain the uses of computers in statistical computing;
2. demonstrate various statistical package;
3. use some statistical packages in solving problems in statistical methodology;
4. to demonstrate the use of spread sheet in application software; and
5. use packages such as SPSS, STATA, MINITAB etc, to demonstrate their abilities in statistical methodology.

Course Contents

Uses of computers in statistical computing. introduction to various statistical packages. use of statistical packages in solving problems in statistics. spread sheet applications. Such as SPSS, STATA, MINITAB etc.

STA 299: Industrial Attachment I (12 Weeks) (3 Units C)

Learning Outcomes

At the end of the course, students should be able to:

1. exhibit laboratory and field knowledge of subjects taught;
2. demonstrate knowledge of technical report writing and presentation; and
3. carryout research on specific topic, collect and evaluate information on specific subject matter while at the attachment.

Course Contents
Students should be attached to some relevant organizations for 12 Weeks at the 200 Level preferably during the long vacation for industrial experience. Students are to be assessed based on seminar presentation, their reports and assessment by supervisors

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building

Course Contents
Concepts of peace, conflict and security in a multi-ethnic nation; types and theories of Conflicts: ethnic, religious, economic, geo-political conflicts; structural conflict theory, realist theory of conflict, frustration-aggression conflict theory. Root causes of conflict and violence in Africa: Indigene and settlers phenomenon; boundaries/boarder disputes; political

disputes; ethnic disputes and rivalries; economic inequalities; social disputes; nationalist movements and agitations; selected conflict case studies – Tiv-Junkun; Zango Kartaf, chieftaincy and land disputes etc. Peace building, management of conflicts and security; peace & human development. Approaches to peace & conflict management --- (religious, government, community leaders etc.). Elements of peace studies and conflict resolution; conflict dynamics assessment Scales: constructive & destructive. Justice and legal framework: Concepts of social justice; The Nigeria legal system. Insurgency and terrorism; peace mediation and peace keeping; Peace & security Council (international, national and local levels) Agents of conflict resolution – conventions, treaties community policing; evolution and imperatives. Alternative dispute resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of international Organizations in conflict resolution. (a). The United Nations, UN and its conflict resolution organs. (b). The African Union & Peace Security Council (c). ECOWAS in peace keeping. Media and traditional institutions in peace building. Managing post-conflict situations/crisis: Refugees. Internally displaced persons, IDPs. The role of NGOs in Post-conflict situations/crisis

ENT 312: Venture Creation (2Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students, through case study and practical approaches, should be able to:
1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;

3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity identification (sources of business opportunities in Nigeria, environmental scanning, demand and supply gap/unmet needs/market gaps/market research, unutilised resources, social and climate conditions and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (venture capital, equity finance, Micro finance, Personal savings, small business investment organizations and business plan competition). Entrepreneurial marketing and e-commerce (principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first mover advantage, E-commerce business models and successful E-commerce companies,). Small business management/family business; leadership & management, basic book keeping, nature of family business and family business growth model; negotiation and business communication (Strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, Idea pitching); technological solutions (the concept of market/customer solution, customer solution and emerging technologies, business applications of new technologies - Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of hings (IoTs), blockchain, cloud computing, renewable energy etc. Digital Business and E-commerce strategies).

STA 311: Probability III (3 Units C: LH 45)

Learning Outcomes

At the end of the course, students should be able to:
1. define discrete sample spaces and provide rules of probability;
2. explain independence Bayes' theorem and Um models;
3. determine sampling with and without replacement;
4. explain inclusion-exclusion theorem;
5. explain allocation and matching problems;
6. explain probability generating function; and
7. outline the properties of Bernoulli trials, binomial, Poisson, Hypergeometric negative binomial and multinomial distribution, Poisson process.

Course Contents

Discrete sample spaces. definitions and rules of probability. Independence Bayes' theorem. Um models; sampling with and without replacement. inclusion-exclusion theorem. allocation and matching problems; probability generating function; Bernoulli trials, binomial, Poisson, Hypergeometric negative binomial and multinomial distribution, Poisson process.

STA 312: Distribution Theory I **(3 Units C: LH 45)**

Learning Outcomes
At the end of the course, the students should be able to:
1. identify and/or find distributions using any of the transformation techniques;
2. explain cumulants and their generating functions as well as some special univariate distribution;
3. explain the central limit theorem;
4. illustrate bivariate moment generating functions of random variable and bivariate distribution;
5. explain bivariate moment generating functions; and
6. explain bivariate normal distributions associated with the normal, X^2, t and F distribution.

Course Contents
Transformation techniques, probability integral transformation, order statistics and their functions. cumulants and their generating functions. some special univariate distribution. central limit theorem. Bivariate moment generating functions of random variable. bivariate distribution. bivariate normal distributions. distribution associated with the normal, X^2, t and F distribution.

STA 321: Statistical Inference III **(3 Units C: LH 45)**

Learning Outcomes
At the end of the course, the students should be able to:
1. outline the properties of a good estimator consistency unbiasedness, efficiency, minimum variance and sufficiency;
2. describe the methods of estimation; using maximum likelihood, least squares and method of moments; and
3. determine confidence intervals for simple and composite hypotheses to compute the likelihood ratio test as well as inferences about means and variance.

Course Contents
Criteria of estimating consistency unbiasedness, efficiency, minimum variance and sufficiency. methods of estimation. maximum likelihood, least squares and method of moments. confidence intervals. simple and composite hypotheses. likelihood ratio test. inferences about means and variance.

STA 322: Regression and Analysis of Variance I **(2 Units C: LH 30)**

Learning Outcomes
At the end of the course, the students should be able to:
1. explain total, partial and multiple correlation ratio;
2. demonstrate simple and multiple linear regression using the variable selection techniques, stepwise regression;
3. determine the analysis of covariance, influence measures, polynomial regression and orthogonal polynomials;
4. explain simple non-linear way classification;

5. demonstrate two-way classification; three-way classification; balanced and unbalanced two factor nested (hierarchical) classifications;
6. explain multiple comparisons component or variance estimates and tests; and
7. demonstrate these techniques in computing packages.

Course Contents
Total, partial and multiple correlation ratio. simple and multiple linear regression. variable selection techniques. stepwise regression, analysis of covariance, influence measures, polynomial regression. Orthogonal polynomials. simple non-linear way classification. two-way classification. Three-way classification. balanced and unbalanced two factor nested (hierarchical) classifications. multiple comparisons component or variance estimates and tests. computing packages.

STA 324: Survey Methods and Sampling Theory (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain survey design, planning and programming;
2. identify the methods of data collection;
3. design questionnaires and collect data so that meaning conclusion can determine.
4. explain errors and biases;
5. differentiate probabilities from non-probability sampling and outline the selection procedure;
6. explain the estimation of mean, totals, ratios and proportions in all the sampling techniques;
7. identify probability proportion-to-size sampling; and
8. demonstrate Nigeria's experience in sampling survey.

Course Contents
Survey design, planning and programming. methods of data collection. design of form and questionnaires. data processing, analysis and interpretation. errors and biases. Probabilities and non-probability sampling: selection procedure. estimation of mean, totals, ratios and proportions in simple random, systematic, stratified cluster and two-stage sampling. Probability proportion-to-size sampling; Nigeria's experience in sampling survey.

STA 331: Statistical Computing III (2 Units C: PH 90)

Learning Outcomes
At the end of the of the course, students should be able to:
1. install the R or SAS package;
2. load data into R package;
3. gain more experience and confidence in statistics applications;
4. learn something of the structure of the R statistical software;
5. obtain practical computation skills through application of statistical theories; and
6. interface computers to their environment through statistical applications

Course Contents
Use of advanced statistical computing packages. Analysis of statistical and numerical algorithms. Analysis of statistical and numerical algorithms. Introduction to Monte Carlo Methods e.g. SAS, R. Etc.

STA 399: Industrial Attachment II (12 Weeks) (3 Units C)

Learning Outcomes
At the end of the course, students should be able to:
1. exhibit laboratory and field knowledge of subjects thought while at the attachment;
2. demonstrate knowledge of technical report writing and presentation; and
3. carryout research on specific topic, collect and evaluate information on specific subject matter while at the attachment.

400 Level

STA 411: Probability IV (3 Units C: LH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. explain the probability spaces measures and distribution;
   describe distribution of random variables as measurable functions, product spaces; products of measurable spaces, product probabilities;
2. explain independence and expectation of random variable;
3. identify convergence of random variables; Weak convergence almost everywhere, convergence in path mean;
4. describe central limit theorem, laws of large numbers; and
5. explain characteristic function and inversion formula.

Course Contents
Probability spaces measures and distribution; distribution of random variables as measurable functions; product spaces; products of measurable spaces, product probabilities; independence and expectation of random variable; convergence of random variables; weak convergence almost everywhere, convergence in path mean. Central limit theorem, laws of large numbers; characteristic function and Inversion formula.

STA 412: Distribution theory II (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to;
1. identify the distribution of quadratic forms; Fisher – Cochran theorem, Multivariate normal distributions;
2. explain the distribution of order statistics from continuous populations;
3. differentiate characteristic from moment generating functions; and
4. to identify uniqueness and inversion theorems and limit theorems.

Course Contents
Distribution of quadratic forms. Fisher – Cochran theorem, Multivariate normal distributions. Distribution of order Statistics from continuous populations. Characteristic and moment generating functions. Uniqueness and inversion theorems. Limit theorems.

STA 413: Statistical Inference IV (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the general linear hypothesis and analysis of linear models;
2. gain further treatment of estimation and hypothesis testing extension of uniparameter results to multiparameter situation; and
3. describe the basic ideas of distribution – free test; Bayesian Inference.

Course Contents
General linear hypothesis and analysis of linear models. further treatment of estimation and hypothesis testing extension of uniparameter results to multiparameter situation. basic ideas of distribution – free test. Bayesian Inference.

STA 415: Regression and Analysis of Variance II (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain multicollinearity, autocorrelation and heteroscedasticity;
2. perform the residual analysis;
3. describe the transformations;
4. compare intercepts and slopes;
5. explain simple non – linear regression and Logistic regression;
6. use dummy variables;
7. familiarise with the departures from ANOVA assumptions;
8. estimate missing values; and
9. determine the analysis of covariance in one-way, two-way, three-way and nested (hierarchical) classifications as well as analysis of covariance with two concomitant variables.

Course Contents
Multicollinearity, autocorrelation and heteroscedasticity; residual analysis; transformations. comparison of intercepts and slopes; Simple non – linear regression; Logistic regression; Use of dummy variables. Departures from ANOVA assumptions. Transformations. Missing values; analysis of covariance in one-way, two-way, three-way and nested (hierarchical) classifications; analysis of covariance with two concomitant variables.

STA 422: Logical Background of Statistics and Decision Theory
(3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. describe empirical sources of knowledge-hypothesis, observation and experiment;
2. explain deductive sources of knowledge and scientific attitude;
3. explain the concept of causation; probability, a brief historical treatment and to show conflicting definitions;
4. explain Bayesian statistics and the notion in inverse probability;

5. identify the place of statistical methods in science;
6. define the principles of decision making, utility functions and their properties;
7. explain the role of uncertainty; Bayes Strategies; problems of prior and posterior distributions: value of prior information minimax strategies; statistical inference; and
8. describe the theory of games.

Course Contents
Empirical sources of knowledge: hypothesis, observation and experiment. Causation: probability. Bayesian statistics and notion in inverse probability. Principles of decision making, utility functions and properties. Bayes strategies, prior and posterior distributions, statistical interference, minimax strategies. Theory of games.

STA 499: Research Project (6 Units C: PH 270)

Learning Outcomes
At the end of the course, students should be able to:
1. exhibit laboratory and field knowledge of subjects taught while at the attachment;
2. demonstrate knowledge of technical report writing and presentation; and
3. carryout research on specific topic, collect and evaluate information on specific subject matter while at the attachment.

Course Contents
Research finding into selected topics in statistics, each student will be expected to carry out independent research into an assigned or selected topic and produce a report. Student should be subjected to oral examination on the project.

Minimum Academic Standards

Equipment

PC having CPU with minimum of 2 GB of main memory, 250 GB HD with DVD drive (ideally there should be a minimum of one PC per every five students).

Multifunctional laser printers (minimum of two) to be networked with the PCs.

Statistical Computer Software packages such as STATISTICA, STATA, GENSTAT, TSP, S-PLUS, R, SAS, Python and Eview.

Staffing

Academic Staff

For a program such as Statistics to be floated there is need to have at least six (6) members of the academic staff. This will be in the ratio of, **1: 2: 3** which is translated into one coming from the Professorial cadre, two from the Senior Lecturer cadre and three from others (which comprises of Lecturer I, Lecturer II and Assistant Lecturer). This ratio can further be extended to percentages base on the available number of staff for the program. The minimum standard of staff is therefore Professorial Cadre should be 20%, Senior Lecturer Cadre should be 35% and other categories of Lecturers should be 45% respectively.

Administrative Support Staff

The services of the administrative support staff are indispensable in the proper administration of the Department. It is important to recruit very competent, computer literate senior staff.

Technical Support Personnel

The services of technical support staff, which are indispensable in the proper running of laboratories are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

Library

The University Library Service should provide access to a wide range of resources, services and study spaces as well as professional expertise to help students to be successful in their studies and research. There should be an adequate number of recent books, subscription to journals and provides access to more e-books in the program under review.

Library Search can be used to locate books, journal articles and a lot more information using a single search. The Library's Subject Guides bring together tailored, subject-specific information, resources and databases and are the best place to start your exploration of the Library's resources for your specific discipline. Online subject guides should be provided and published to bring together all the key resources for the subject together with a variety of guides on topics such as referencing.

Online Library help should be made available 24/7. Staff can help students to find the information they need as well as help them improve their academic and research skills.

Classrooms, Laboratories, Workshops and Office Space
The NUC recommends the following physical space requirements:

Description		**Size m^2**
Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50
Conference Room	-	37.0

B.Sc. Zoology

Overview
The Bachelor of Zoology degree has evolved in an exciting new way to take account of critical developments with new discoveries and the application of cutting-edge technologies in cell biology, genetics, evolution, ecology, physiology, molecular biology, immunology, and space technology. Zoology has evolved from its tradition of just the study of animals' phyla, to include all aspects of animal existence, survival, adaptation, interaction with one another from lowest to highest level of cellular and organismic specialization.

This current programme spans all levels, from molecules to ecosystems and tackles fundamental problems in disease biology, animal physiology, arthropod diversity, and animal development. Every critical component of this programme gives the students both traditional and modern zoological thoughts, with the ability and skills to solving theoretical and practical problems in zoology and related disciplines such as public health, medical and veterinary sciences, vector and pest control, agriculture, and environmental biology.

Philosophy
The philosophy of the zoology programme is to provide a sound understanding of the concepts and methodologies of traditional and modern zoology in key areas that meet the needs of society and equip the students with academic and practical skills to excel in zoology or in animal and environmental biology.

Objectives
Zoology programme is specifically designed to:
1. provide graduates with a broad understanding of animal biology and to identify, characterize different communities and ecosystems supporting the biological organism together with a more detailed and critical understanding of selected areas in zoology to prepare them for higher studies in different disciplines of zoology;
2. provide graduates with a range of subject-specific and generic skills appropriate to employment both within zoology and outside like fisheries, disease control, laboratories, teaching, and forensic science;
3. produce graduates with essential knowledge and skills for postgraduate work and a professional career in zoology and help them to work in a group and communicate effectively with others;
4. develop in students the ability to apply their scientific knowledge and skills to solve practical problems related to zoology and design, conduct, and interpret data of practical investigations in laboratories or fields;
5. cultivate an interest in zoology, particularly at the organismal level, to know, understand, assess, evaluate, and recognize different levels of organisation in biological systems: cells, tissues, and organs of the organisms and to acquire the modern subjects and techniques and molecular biology;
6. encourage students to emphasize the importance of acquiring general and transferable skills such as written and oral communication, presentation and the skills required for a lifelong learning process; and

7. develop in students the ability to critique, postulate solutions, develops scientific thoughts and help them to acquire basics numeric and computational tools.

Unique Features of the Programme

The unique features of the programme include:

1. development of scientific literacy, combining traditional and modern zoological techniques for understanding the nature of zoology;
2. development of basic skills and competencies to contribute to human wealth, health, and disease control;
3. production of graduates with resources and skills for the next generation animal science industries;
4. development of knowledge in specialized areas (parasitology, physiology, and entomology), necessary for societal needs and development; and
5. development of graduates in the entrepreneurial skills.

Employability Skills

Zoologists work in a variety of natural settings or laboratory facilities studying the interaction between different animal species and between animals and people, therefore all graduates in Zoology are expected to develop the following abilities and skills:

1 Observation and Critical Thinking

Ability to observe, take notes and critically assess animal species and their environment. Provide a reasonable scientific explanation for such observations.

2 Written Communication Skills

Good verbal communication skills to interact with colleagues, make presentations, teach, and publish articles and prepare lectures for students.

3 Analytical Skills

Ability to provide expert analysis of scientific observations in the field and laboratory for decision making, provide expert opinion on zoological matters.

4 Organizational Skills

Ability to plan, organise and execute a project, meeting timelines. Manage expenditure and keeping of records.

21st Century Skills

1. Productivity
2. Creativity
3. Innovation
4. Critical thinking
5. Teamwork
6. Information literacy
7. Collaboration

Admission and Graduation Requirements

Admission Requirements

Indirect Entry
The entry requirements shall be at least credit level passes in five subjects including English Language, Mathematics, Biology and Chemistry to form the core subjects with credit in one other relevant science subject (preferably Physics) at the Senior Secondary Certificate (SSC) or its equivalent. In addition, an acceptable pass in the Unified Tertiary Matriculation Examination (UTME) is required for admission into 100-Level

Direct Entry
Five SSC (or equivalent) credit passes in relevant subjects, two of which are at the Advanced Level.

Graduation Requirements
Students are required to pass a minimum of 120 units for graduation for UTME students and 90 credit units for direct entry students. Students must spend a minimum of 3 or 4 years on the programme depending on the year of entry

Global Course Structure

100 level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
BIO 101	General Biology I	2	C	30	-
BIO 107	General Biology Practical I	1	C	-	45
CHM 101	General Chemistry I	2	C	30	-
CHM 107	General Chemistry Practical I	1	C	-	45
PHY 101	General Physics I	2	C	30	-
PHY 107	General Physics Practical I	1	C	-	45
BIO 102	General Biology II	2	C	30	-
BIO 108	General Biology Practical II	1	C	-	45
CHM 102	General Chemistry II	2	C	30	-

Course Code	Course Title	Unit(s)	Status	LH	PH
CHM 108	General Chemistry Practical II	1	C	-	45
PHY 102	General Physics II	2	C	30	-
PHY 108	General Physics Practical II	1	C	-	45
ZOO 101	The Mammalian Body	2	C	15	45
ZOO 102	Animal Diversity	2	C	15	45
	Total	**33**			

200 Level

Course Code	Course Title	Units	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 201	Entrepreneurship and Innovation	2	C	30	
BIO 201	Genetics I	2	C	30	
BIO 203	General Physiology	2	C	30	-
STA 201	Statistics for Agricultural & Biological Sciences	3	C	45	-
ZOO 211	Invertebrate Zoology I	2	C	15	45
ZOO 212	Invertebrate Zoology II	2	C	15	45
	Total	**15**			

300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
BIO 307	Field Course I	1	C	-	45
ZOO 301	Vertebrate Zoology	2	C	15	45
ZOO 311	Comparative Animal Physiology	2	C	15	45
ZOO 313	Arthropod Diversity	2	C	15	45
ZOO 318	Principles of Animal Development	2	C	15	45
ZOO 312	The Biology of Tropical Parasites	2	C	15	45
ZOO 316	Histology	2	C	15	45
ZOO 398	Industrial Attachment II (12 Weeks)	3	C	-	
	Total	**20**			

400 Level

Course Code	Course Title	Units	Status	LH	PH
BIO 407	Field Course II	2	C	-	90
ZOO 411	Entomology	2	C	15	45
ZOO 419	Essay topic in Zoology/seminar	2	C	-	90
ZOO 499	Project	6	C	-	270
ZOO 412	Parasitology	2	C	15	45
ZOO 422	Entrepreneurship	2	C	30	-
	Total	**16**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. identify possible sound patterns in English Language;
2. list notable language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents
Sound patterns in English Language (vowels and consonants, phonetics, and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple, and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and critical thinking and reasoning methods (logic and syllogism, inductive and deductive argument and reasoning methods, analogy, generalisation and explanations). Ethical considerations, copyright rules, and infringements. Writing activities: (pre-writing, writing, post writing, editing and proofreading; brainstorming, outlining, paragraphing). Types of writing: summary, essays, letter, curriculum vitae, report writing, note making etc. Mechanics of writing. Comprehension Strategies: (reading and types of reading, comprehension skills, 3RsQ). Information and Communication Technology in modern Language Learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of trade, economic and self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian state towards nation building;
6. analyse the role of the judiciary in upholding people's fundamental rights;
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture, and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; nationalist movements and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian civil war). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigerian people; trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification. Judiciary and fundamental rights. Individual, norms and values (basic Nigerian norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage, and development; negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation; Re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, austerity measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption (WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry)
(2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. explain basic definition of set, subset, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents
Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers; integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers; algebra of complex numbers; the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition, and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. identify the types of rules in differentiation and integration;
2. describe the meaning of function of a real variable, graphs, limits, and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents
Functions of a real variable, graphs, limits, and idea of continuity. The derivative, as limit of rate of change. Techniques of differentiation. Extreme curve sketching; integration as an inverse of differentiation. Methods of integration, Definite integrals. Application to areas, volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

CHM 101: General Chemistry I **(2 Units C: LH 30)**

Learning Outcomes
At the end of this course, the students should be able to:
1. define atom, molecules, and chemical reactions;
2. discuss the Modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems;
6. illustrate shapes of simple molecules and hybridized orbitals;
7. identify the characteristics of acids, bases, and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using Le Chatelier's principle to predict the effect of concentration, pressure, and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy, and free energy; and
10. determine rates of reactions and its dependence on concentration, time, and temperature.

Course Contents
Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence forces; structure of solids. Chemical equations and stoichiometry; Chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry; rates of reaction, equilibrium, and thermodynamics. Acids, bases, and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II **(2 Units C: LH 30)**

Learning Outcomes
At the end of this course, students should be able to:
1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. describe rules guiding nomenclature and functional group classes of organic chemistry;
6. determine rate of reaction to predict mechanisms of reaction;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. describe basic properties of transition metals.

Course Contents
Historical survey of the development and importance of organic chemistry; Fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures, nano chemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures

of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids, and derivatives. The chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carry out chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify the differences between primary and secondary standards.
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents
Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify the general laboratory rules and safety procedures;
2. collect scientific data and correctly carry out chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify and carry out preliminary tests which include ignition, boiling point, melting point, test on known and unknown organic compounds;
5. execute solubility tests on known and unknown organic compounds;
6. execute elemental tests on known and unknown compounds; and
7. conduct functional group/confirmatory test on known and unknown compounds which could be acidic / basic / neutral organic compounds.

Course Contents
Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes
On completion, the students should be able to:
1. identify and deduce the physical quantities and their units;

2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents

Space and time; units and dimension, Vectors and Scalars, Differentiation of vectors: displacement, velocity and acceleration; kinematics; Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation); Relative motion; Application of Newtonian mechanics; Equations of motion; Conservation principles in physics, Conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass; Rotational motion; Torque, vector product, moment, rotation of coordinate axes and angular momentum. Polar coordinates; conservation of angular momentum; Circular motion; Moments of inertia, gyroscopes, and precession; Gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General Physics II (Electricity & Magnetism) (2 Units C: LH 30)

Learning Outcomes

On completion, the students should be able to:

1. describe the electric field and potential, and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law, and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;
5. describe electromagnetic induction and related concepts and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters; and
8. determine the characteristics of AC voltages and currents in resistors, capacitors, and inductors.

Course Contents

Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and resistance. Ohm's law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's

laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

PHY 107: General Practical Physics I (1 Unit C: PH 45)

Learning Outcomes
On completion, the students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents
This introductory course emphasises quantitative measurements, the treatment of measurement errors, and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc., covered in PHY 101, 102, 103 and PHY 104. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis, and deduction.

PHY 108: General Practical Physics II (1 Unit C: PH 45)

Learning Outcomes
On completion, the students should be able to:
1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data; and
6. prepare and present practical reports

Course Contents
This practical course is a continuation of PHY 107 and is intended to be taught during the second semester of the 100 level to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements, the treatment of measurement errors, and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis, and deduction.

BIO 101: General Biology I (2 Units C: LH 30)

Learning Outcomes
At the end of lectures, students should be able to:
1. explain cell structure and organizations;
2. summarize functions of cellular organelles;
3. characterize living organisms and state their general reproduction;
4. describe the interrelationship that exists between organisms;

5. discuss the concept of heredity and evolution; and
6. enumerate habitat types and their characteristics.

Course Contents
Cell structure and organisation, functions of cellular organelles. characteristics and classification of living things. chromosomes, genes; their relationships and importance. general reproduction. interrelationships of organisms (competitions, parasitism, predation, symbiosis, commensalisms, mutualism, saprophytism). heredity and evolution (introduction to Darwinism and Lamarkism, Mendelian laws, explanation of key genetic terms). elements of ecology and types of habitat.

BIO 102: General Biology II (2 Units C: LH 30)

Learning Outcomes
At the end of the lectures, students should be able to:
1. list the characteristics, methods of identification and classification of Viruses, bacteria and fungi;
2. state the unique characteristics of plant and animal kingdoms;
3. describe ecological adaptations in the plant and animal kingdoms;
4. explain nutrition, respiration, excretion and reproduction in plants and animals; and
5. describe growth and development in plants and animals.

Course Contents
Basic characteristics, identification and classification of viruses, bacteria and fungi.
A generalized survey of the plant and animal kingdoms based mainly on the study of similarities and differences in the external features. Ecological adaptations. Briefs on physiology to include nutrition, respiration, circulatory systems, excretion, reproduction, growth and development.

BIO 107: General Biology Practical I (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. outline common laboratory hazards;
2. provide precautions on laboratory hazards;
3. state the functions of the different parts of microscope;
4. use the microscope and describe its maintenance;
5. draw biological diagrams and illustrations; and
6. apply scaling and proportion to biological diagrams.

Course Contents
Common laboratory hazards. prevention and first aid. measurements in biology. uses and care of microscope. compound and dissecting microscope. Biological drawings and illustration, scaling, accuracy and proportion. use of common laboratory apparatus and laboratory experiments designed to illustrate the topics covered in **BIO 101.**

BIO 108: General Biology Practical II (1 Unit C: PH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. describe the anatomy of flowering plants;
2. differentiate types of fruit and seeds;
3. state ways of handling and caring for biological wares;
4. describe the basic histology of animal tissues; and
5. identify various groups in the animal kingdom.

Course Contents
Anatomy of flowering plants, primary vegetative body. stem, leaf and root to show the mature tissues namely parenchyma, collenchyma, sclerenchyma, xylem and phloem. Types of fruits and seeds. Care and use of dissecting kits and other biological wares. Dissection and general histology of animal tissues based on vertebrate forms. Morphology and functions of epithelial, muscular, nervous and connective tissues. Examination of various groups of lower invertebrates under microscopes, identification of various groups of organisms in Animal Kingdom. Andany experiment designed to emphasize the practical aspects of topics in BIO 102.

ZOO 101: The Mammalian Body (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, the students will be able to:
1. describe the basic anatomy and physiology of the mammalian body;
2. describe the external feature, muscular, digestive, circulatory and other organ systems of a mammalian body;
3. develop introductory knowledge about the role of zoology in human development by understanding relationships between organisms through systematics and cell biology;
4. describe eugenics and evolution; and
5. elaborate ecology.

Course Contents
The anatomy and physiology of the mammal and adaptation to the environment. External features, skin, skeletal and muscular systems. Digestion and absorption of food; nutrition. Gas exchange and transport. The blood and circulatory system. The kidney and homeostasis. Nervous and chemical coordination. Maturation, sexuality, and reproduction in man.

ZOO 104: Animal Diversity (2 Units C: LH 15; PH 45)

Learning Outcomes
The students, at the end of the course, will be able to:
1. identify the animal diversity around us;
2. describe the underlying principles of the classification of animals and the terminology needed in classification;
3. compare the differences and similarities in the various aspects of classification; and
4. classify animals up to order using the six levels of classification.

Course Contents
Diversity of animal forms, structures, and functions. Multicellularity and development of embryonic layers; history of animal diversity, basis of categorization of the diversity of animals (symmetry, organization of tissues, body cavity, developmental mode, fate of blastopore); major feature of animal phylogenetics tree; introduction to animal systematic; geographical distribution of animal life and issues in the conservation of biodiversity with emphasis on Nigerian species. General classification of animal kingdom. - binomial nomenclature; international rules of zoological nomenclature (brief account); new trends in systematics: numerical taxonomy (Phenetics), cladistics (phylogenetic systematics), molecular systematics.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
A student who has successfully gone through this course should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;

6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa, and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents
Concept of entrepreneurship (entrepreneurship, intrapreneurship/corporate entrepreneurship,). Theories, rationale, and relevance of entrepreneurship (Schumpeterian and other perspectives, risk-taking, necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of entrepreneurs (opportunity seeker, risk-taker, natural and nurtured, problem-solver and change agent, innovator, and creative thinker). Entrepreneurial thinking (critical thinking, reflective thinking, and creative thinking). Innovation (Concept of innovation, dimensions of innovation, change and innovation, Knowledge, and innovation). Enterprise formation, partnership, and networking (basics of business plan, forms of business ownership, business registration and forming alliances and joint ventures). Contemporary entrepreneurship issues (knowledge, skills and technology, intellectual property, virtual office, networking). Entrepreneurship in Nigeria (Biography of inspirational entrepreneurs, youth and women entrepreneurship, entrepreneurship support institutions. Youth enterprise networks and environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

BIO 201: Genetics I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. distinguish between heritable and non-heritable characteristics;
2. explain the likelihood of genetic events (probability) and how well those events (results) fit into a set of observation;
3. discuss polygenic variations; and
4. describe concepts in population genetics.

Course Contents
Hereditable and non-hereditable characteristics. Probability and tests of goodness of fit. Quantitative inheritance. variation in genome structure. introduction to population genetics.

BIO 203: General Physiology (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the chemistry of organic compounds and their biological importance;
2. state the general characteristics of enzymes;
3. describe nutrition, digestion and absorption in plants and animals;
4. discuss the cell membrane structure and list its functions;
5. summarize osmoregulation, excretion, and transport in animals;
6. enumerate growth hormones in plants and their functions;
7. explain the homeostasis, their coordination, and functions in animals; and
8. explain the plant water relation, growth, and growth regulation.

Course Contents
Chemicals of life: the chemistry of carbohydrates, lipids, proteins and nucleic acids and their biological importance. General characteristics of enzymes. Nutrition. digestion and absorption in plants and animals. Biosynthesis, photosynthesis and protein synthesis. Cell membrane structure and function. A general study of osmoregulation, excretion, transport. growth hormones and enzymology. homeostasis and their co-ordination in animals. Plant water relation. growth and growth regulation.

STA 201: Statistics for Agricultural and Biological Sciences
(3 Units C: LH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the scope for statistical methods in Biology and Agriculture;
2. define the measures of location, partition, and dispersion;
3. explain the elements of probability. probability distributions: binomial, Poisson, geometric, hypergeometric, negative binomial and normal, student's t and chi-square distributions;
4. differentiate point from interval estimation and could be able to test for hypotheses concerning population means, proportions and variances;
5. compute for regression and correlation as well as conduct some non–parametric tests with reference to contingency table analysis; and
6. explain the elements of design of experiments and analysis of variance.

Course Contents
Scope for statistical method in Biology and Agriculture. Measures of location, partition, and dispersion. Elements of probability. Probability distributions: binomial, Poisson, geometric, hypergeometric, negative binomial and normal, Student's t and chi-square distributions. Estimation (point and interval) and tests of hypotheses concerning population means, proportions and variances. Regression and correlation. Non–parametric tests. Contingency table analysis. Introduction to design of experiments. Analysis of variance.

ZOO 211: Invertebrate Zoology I (2 Units C: LH 15; PH 45)

Learning Outcomes
The students, at the end of the course, will be able to:
1. describe the variety of lower invertebrate animals and explain their evolutionary origin and diversity;
2. compare and contrast the morphology, life cycle and physiology of different lower invertebrates' groups;
3. have practical experiences in laboratory and field conditions, to identify lower invertebrate taxonomic groups; and
4. communicate the role of invertebrates in the evolution of animal life to specialist and non-specialist audiences.

Course Contents
The systematics, inter-relationship, and basic organization of the lower invertebrates, of the Phylum Protozoa, Porifera, Coelenterate, Platyhelminths, Nematoda, Entoprocta, Nemertinea, Acanthocephala, and Rotifera

ZOO 212: Invertebrate Zoology II (2 Units C: LH 15; PH 45)

Learning Outcomes
The students, at the end of the course, will be able to:
1. describe the variety of higher invertebrate animals and explain their evolutionary origin and diversity;
2. compare and contrast the morphology, life cycle and physiology of different higher invertebrates' groups;
3. have practical experiences in laboratory and field conditions, to identify higher invertebrate taxonomic groups; and
4. communicate the role of invertebrates in the evolution of animal life to specialist and non-specialist audiences.

Course Contents
The systematics, inter-relationship, and basic organisation of the higher (coelomate) invertebrates, of the Phylum Ectoprocta (Bryozoa), Brachiopoda, Phoronida, Annelida, Mollusca, Arthropoda, and Echinodermata.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict, and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media, and traditional institutions in peace building

Course Contents
Concepts of Peace, Conflict and Security in a multi-ethnic nation. Types and theories of conflicts: ethnic, religious, economic, geo-political conflicts; structural conflict theory, realist theory of conflict, frustration-aggression conflict theory. Root causes of conflict and violence in Africa: indigene and settlers phenomenon. Boundaries/boarder disputes; political disputes; ethnic disputes and rivalries; economic inequalities; social disputes. Nationalist movements and agitations; selected conflict case studies – Tiv-Junkun; Zango Kataf, chieftaincy and land disputes etc. Peace building, management of conflicts and security: peace & human development. Approaches to peace & conflict management (religious, government, community leaders etc.). Elements of peace studies and conflict resolution: Conflict dynamics assessment scales: constructive & destructive. Justice and legal framework: Concepts of social justice; The Nigeria legal system. Insurgency and terrorism. Peace mediation and peace keeping. Peace & security council (international, national and local levels) Agents of conflict resolution – conventions, treaties community policing: evolution and imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d). Collaboration etc. Roles of international organisations in conflict resolution. (a). The United Nations, UN, and its conflict resolution organs. (b). The African Union & peace security council (c). ECOWAS in peace keeping. Media and

traditional institutions in peace building. Managing post-conflict situations/crisis: refugees. Internally Displaced Persons, IDPs. The role of NGOs in post-conflict situations/crisis.

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students, through case study and practical approaches, should be able to:
1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed.
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents
Opportunity identification (sources of business opportunities in Nigeria. Environmental scanning, demand and supply gap/unmet needs/market gaps/market research, unutilised resources. Social and climate conditions, and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (venture capital, equity finance, micro finance, personal savings, small business investment organisations and business plan competition). Entrepreneurial marketing and e-commerce (principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first mover advantage, E-commerce business models and successful E-Commerce companies,). Small business management/family business: leadership & management, basic bookkeeping, nature of family business and family business growth model. Negotiation and business communication (strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological solutions (the concept of market/customer solution, customer solution and emerging technologies. Business applications of new technologies - *Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy, etc. Digital business and E-Commerce strategies).*

BIO 307: Field Course I (1 Unit C: PH 45)

Learning Outcomes
At the end of this field trip, students should be able to:
1. conduct basic field sampling techniques in terrestrial, aquatic, and aerial environment;
2. collect plant and animal materials for identification, classification and preservation in the herbarium and museum respectively; and
3. explain the importance of the institutes and industries visited to biology.

Course Contents
Sampling techniques in local habitats (i.e., not more than 20 km radius of the university). Also involves visits to research institutes, industries, etc. This should cover several areas of specialisation in biology. Assessment by examination (objectives, short answer questions, fill in the gaps) in addition to group report.

ZOO 301: Vertebrate Zoology (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, the students will be able to:
1. demonstrate an understanding of, and be able to identify in detail, the anatomical characteristics of members of the phylum chordata. Beginning with protochordate to complex mammals;
2. demonstrate an understanding of the ontogeny and phylogeny relationships of the three chordate subphyla and several vertebrate classes;
3. have practical experiences in laboratory and field conditions, to identify major vertebrate taxonomic groups;
4. discuss the basic life processes of vertebrates, including movement, body support, homeostatic, circulation, gas exchange, reproduction, development, digestion, excretion, sensory perception, cognition, and the immune system;
5. describe the evolutionary history of the vertebrate and the important transition between major taxa and clade;
6. interpret the relationship between the form and function of vertebrates and the selection pressures that have influenced their evolution; and
7. discuss the ecology, behaviour, and diversity of the Nigerian vertebrate fauna.

Course Contents
Ostracoderms and the origin of chordates; The systematic inter-relations of the chordate groups; protochordates – urochordates (tunicates), cephalochordates (amphioxus); hemichordates; basic organization of the vertebrates; ammocoete larva (genetic ties between protochordate and vertebrates) vertebrate systematics, evolution, and geographical distribution of recent vertebrates; the Nigeria vertebrate fauna. Comparative anatomy of the vertebrates - viviparity, germ layer and extraembryonic membranes; skin, skeleton, muscles, digestive system, respiratory system, circulatory system, urinogenital system, nervous system, sense organs, endocrine organs

ZOO 311: Comparative Animal Physiology (2 Units C: LH 15; PH 45)

Learning Outcomes
The students, at the end of the course, will be able to:
1. compare the function of key physiological systems within, and between, animal groups;
2. explain the fundamental concepts of physiology of digestion, blood vascular system, respiration, excretion, and musculature;
3. explain the endocrine system and its interactions with other systems; and
4. have practical experiences in the laboratory, on different physiology of major animal groups.

Course Contents
Homeostasis as a central concept in physiology; osmoregulation and balanced excretion among animal groups. Nutrition and digestion; respiration; blood and circulation in animals. The integrating system (nervous coordination, sense organs and endocrine system). The physiology of movement.

ZOO 312: The Biology of Tropical Parasites (2 Units C: LH 15; PH 45)

Learning Outcomes
The students, at the end of the course, will be able to:
1. explain the biology of tropical parasites within the major parasitic phyla from protozoan to nematodes, including arthropod vectors;
2. describe both external and internal features of body modification and adaptation to a parasitic mode of life; and
3. demonstrate practical experience on skills relevant to the study of parasites.

Course Contents
Classification, adaptation, morphology, anatomy, life cycle of parasitic protozoans, platyhelminths, nematodes, and parasitic arthropods; drawing particular attention to various adaptations to the parasitic mode of life exhibited by selected members of the group.

ZOO 313: Arthropod Diversity (2 Units C: LH 15; PH 45)

Learning Outcomes
The students, at the end of the course, will be able to:
1. illustrate arthropod taxonomy;
2. describe the general insect morphology and physiology;
3. explain the role played by arthropods in food, agriculture, medicine, and as disease vectors and pests; and
4. have practical experiences in the laboratory and field conditions, to collect, identify and preserve local arthropods.

Course Contents
Adaptive radiation within the phylum Arthropoda with reference to the structure and functions of the body appendages. General biology of selected arthropod class. Biological success of the arthropods.

ZOO 318: Principles of Animal Development (2 Units C: LH 15; PH 45)

Learning Outcomes
The students at the end of this course will be able to:
1. discuss the basic concepts of development and explain the theories of preformation, and concepts like growth, differentiation, and reproduction;
2. explain the principles and process of fertilization, cleavage, gastrulation, and embryogenesis;
3. explain the fundamental concept of organogenesis;
4. describe the early embryonic development of selected invertebrates and vertebrates; and

5. demonstrate practical experiences in the laboratory to incubate and observe the developmental stages of the chick embryo.

Course Contents
Problems and processes of development. Cellular and molecular basis of embryogenesis. Gametogenesis Gene-activity in oogenesis. Cytoplasmic localisation in the mature egg. Fertilisation and cleavage in the zygote; blastulation, gastrulation and cell interactions. Cellular and molecular basis of embryogenesis. Differentiation and tissue interactions in development. Organogenesis; placentation and the significance of the placenta in the development of immunity; parthenogenesis in animals

ZOO 316: Histology (2 Units C: LH 15; PH 45)

Learning Outcomes
The students at the end of this course will be able to:
1. describe the differentiation and organisation of cells and maintenance of tissues;
2. describe the structure and function of different types of tissues (epithelium, connective, and nervous tissues);
3. identify the roles of different dyes and stains in histology; and
4. demonstrate practical knowledge of preparing, staining, sectioning, and general handling of tissues for microtomy studies.

Course Contents
Histological structure and functions of liver, intestine, pancreas, spleen, kidney, pituitary, thyroid, adrenal glands, testis, and ovary. Histochemistry: stains and staining – Types: natural and synthetic dyes, mordents, and their mode of action. Immunohistochemical staining methods. Histopathology-degenerative changes and histopathological manifestations in liver cirrhosis and nephrosis. Mammalian organs. The cellular basis of tissue formation. Cell communication. Stability of the differentiated state. The formation, distribution, structure, and function of vertebrate tissues. The organisation of the tissues into organ systems.

ZOO 399: Industrial Attachment (SIWES) (3 Units C: PH 135)

Learning Outcomes
The students at the end of the course will be able to:
1. describe their place of industrial attachment;
2. describe the industrial processes and production;
3. demonstrate technical knowledge and principle of major tools equipment used; and
4. relate their industrial experiences to the study of Zoology.

Course Contents
Students should be attached to some industrial organisations for additional 12 Weeks at their 300 level preferably during the long vacation for more industrial experience. Students are to be assessed based on seminar presentation, their reports and assessment by supervisors.

400 Level

BIO 407: Field Course II **(1 Unit C: PH 45)**

Learning Outcomes
At the end of the field course, the students should be able to:
1. demonstrate knowledge on various field aspects of biology;
2. demonstrate ability to plan and conduct a series of simple field experiments and collection of data;
3. exhibit the ability to record, summarize, classify, preserve specimens collected from the field;
4. demonstrate working and individual skills, learn to manage time effectively; and
5. write biological and field reports with appropriate presentation.

Course Contents
Field trips should be conducted to meet the requirements of various aspects of Biology taught in the classroom. The field course should add to, and fulfil other practical aspects of ecology, hydrobiology, wildlife and forestry, taxonomy, and systematics, etc.
Guided field visits by students to observe plants and animals, learn sampling techniques as related to plants and animals, collect samples, classify, preserve in herbarium and museum accordingly. Conduct field research, collect data, and analyse. Visit to industries, wildlife parks, zoological gardens, afforestation fields/woodlot parks, reservoirs /dams, farms, environmental control establishments and sites, and other areas of biological importance. Field projects (individual or grouped), report writing and examination.

ZOO 411: Entomology **(2 Units C: LH 15; PH 45)**

Learning Outcomes
Students at the end of this course will be able to:
1. describe the phylogeny and taxonomy of insects;
2. describe the biology of selected insect groups;
3. elucidate the methods of control of insect pests of crops and stored products;
4. highlight the methods of control of insect vectors of diseases;
5. identify insects of economic importance and ways of controlling them using ecologically friendly methods; and
6. demonstrate practical experiences in the laboratory and field conditions, to collect, and identify and preserve selected insects of economic importance.

Course Contents
Origin and phylogeny of insects. Biology and control of selected groups of insects which are of economic importance in the tropics (particularly in Nigeria) with respect to crops, stored products, and vectors of diseases of man and his domestic animals. Techniques for collection, preservation, and identification of insects of medical, veterinary, agricultural, and aesthetic importance.

ZOO 412: Parasitology (2 Units C: LH 15; PH 45)

Learning Outcomes
The students at the end of the course will be able to:
1. define the basic terms in parasitology;
2. explain animal associations and their types;
3. describe the host-parasite relationship;
4. discuss the life cycle and control of important tropical parasites;
5. illustrate transmission routes of animal and zoonotic parasites and understand the role of vectors in the transmission of tropical parasites;
6. list and describe diseases of parasitic origin; and
7. describe basic epidemiological studies and measures of disease outcomes.

Course Contents
Evolution of parasitic mode of life. Nature of parasitism in relation to other forms of animal associations. Host-parasitic relationships. Epidemiology, control, and economic importance of parasitic diseases in humans and animals. The role of vectors in the transmission of these diseases.

ZOO 419: Essay Topics in Zoology/Seminar (2 Units C: PH 90)

Learning Outcomes
The students at the end of the course would be able to:
1. conduct a review of the literature on essay topics in Zoology;
2. demonstrate the relevant knowledge and understanding of the assigned essay topic;
3. exhibit knowledge of referencing styles appropriately and cite materials used in such reviews while avoiding the errors of plagiarism;
4. make a short presentation to staff and students.

Course Contents
An essay based on a review of the literature on a Zoological topic. The students should be assessed based on the quality of a submitted report and seminar presentation.

ZOO 422: Entrepreneur and Economic Zoology (2 Units C: LH 30)

Learning Outcomes
The students at the end of the course would be able to:
1. apply zoological knowledge for the benefit of mankind, food security and entrepreneurship;
2. identify animals for food and food products, describe economically beneficial animals, conserve on animals of aesthetic importance and animals for scientific research;
3. know about culturing animals for mass production for human use (snail breeding, apiculture, vermiculture, sericulture, lac culture, aquaculture, and research animal businesses); and
4. learn to control or eliminate animals that are injurious to man directly or indirectly (fumigation).

Course Contents
Elements of business management. Factors in choosing a zoological production career. Site location. Sources of funding. Raw material sourcing and recycling. Staffing. Records and accounting. Sourcing and creating market. Consumer psychology. Intellectual property development. Visits to business enterprises of zoology, medical/veterinary-based industrial productions. snailery, apiculture, lac culture, aquaponics, raising insects for food. Silk production (sericulture), aquaculture, vermiculture, maggoty, fish culture and fumigation businesses. Environmental impact assessment relating to animal conservation and biodiversity.

ZOO 499: Research Project **(6 Units C: PH 270**)

Learning Outcomes
The students at the end of the course would be able to:
1. conduct independent laboratory or field experiments on any concept and problem in zoology using biological research tools and draw inferences from their findings; and
2. prepare a written research project report, including research hypothesis, study design, data collection, statistical analysis, and results and discussion submitted for external assessment.

Course Contents
A research project involving an investigation in any discipline of zoology (animal physiology, entomology, parasitology, animal taxonomy, and animal ecology). Oral and written presentations, discussion of results.

Minimum Academic Standards

Equipment

1. Skeletal system model
2. Muscular system model
3. Brain and nervous system model
4. Circulatory system model
5. Digestive system model
6. Eye and vision model
7. Skin and excretory organs models
8. Embryology models
9. Ice cube maker
10. Embedding bath
11. Water baths
12. Digital balances
13. Hot plates
14. Incubators
15. Binocular microscopes
16. Stereo microscopes
17. Dissecting microscopes
18. Research microscopes

19. Refrigerators
20. Shakers
21. pH meters
22. Sahli's haemoglobinometer
23. Distillers (all glass)
24. Relative humidity with thermometer
25. Portable physiochemical meter
26. Embedding oven
27. Ovens
28. Thermostatic incubator
29. Microtome
30. Automatic tissue processor
31. Tissue embedding centre
32. Air pumps (Diaphragm)
33. Vacuum pumps
34. Tissue grinder glass
35. Photometer and atometre
36. Barothermograph
37. Kymograph muscle
38. Spirometer
39. Colorimeter
40. Insect light traps
41. Insect box
42. Slide projector
43. Overhead projector
44. Bench centrifuges
45. Micro refrigerated centrifuges
46. Steel frame aquaria auxanometer
47. Oxygen meter
48. Glass wares
49. Aquarium and fish tanks
50. UV-Visible spectrophotometer
51. PCR systems

Minimum laboratory study specimens and permanent slide collections

S/N	Phylum	Study/ Preserved Specimen collection	Permanent Slide collection
1	Protozoa	Soil and Blood Protozoa	Entamoeba, Euglena, Noctiluca, Paramecium, Plasmodium, Trypanosoma
2	Porifera	*Sycon, Hyalonema, Spongilla*	Spicules and gemmule from Sponges
3	Coelenterates	*Physalia, Aurelia, Gorgonia, Fungia, Metridium*	T.S of Hydra, Obelia colony

S/N	Phylum	Study/ Preserved Specimen collection	Permanent Slide collection
4	Platyhelminthes	Planaria, Fasciola (liver flukes), Taenia (tape worm) Schistosoma (blood flukes)	*Fasciola hepatica*, Scolex, Proglottids, eggs, Taenia cyst in beef and pork muscles
5	Nematoda	*Ascaris lumbricoides, Ancylostoma duodenale.*	T.S of *Ascaris* (different regions) e.g., head, Pharynx, intestines
6	Annelida	Earthworm, Nereis, Sabella, Aphrodite, Hirudinaria granulose	T.S of Earthworm (different regions)
7	Arthropoda	Penaeus, Sacculina, Scolopendra, Scorpion, Aranea, Lepisma, Gryllotalpa, Carausius, butterfly, Rhinoceros beetle, Cimex hemipterus (bed bug), wasp	Mouthpart's cockroach & Mosquito. Appendages of crayfish
8	Mollusca	Land Snails, bivalves, freshwater snails	Glochidium larva, Shells of Xancus, cyprea, scallop, Nautilus, and Cuttlebone.
9	Echinodermata	Astropecten, Ophiothrix, Echinus, cucumaria, Antedon, Slides of Bipinnaria & Echinopluteus larvae, Aristotle lantern, Pedicellaria Hemichordate – Balanoglaossus,	Slide of Tornaria larva
10	Protochordate	Lancet (Amphioxus)	L/S showing Notochord
11	Amphibia	Toads, Frogs, salamanders, newts	Tadpoles
12	Pisces	Fishes (cartilaginous and bony) – Tilapia, Claris, Shark	
13	Reptilia	lizard, snake, wall geckos, turtle	
14	Aves	pigeons, chickens	
15	Mammals	rats, cats, bats, guinea pig, mice	

Staffing

Academic Staff

The guidelines on academic staff/student ratio of 1:20 for Science Programmes shall apply. To start any programme in Science, there should be a minimum of six academic staff. There is need to have a reasonable number of staff with PhD degrees accounting for at least 70% of the total number and having adequate teaching experience for every programme in the Discipline.

Minimum Academic staff specialization mix: Animal Physiology, Entomology, Parasitology, Animal Ecology, and Animal Taxonomy.

Administrative Support Staff

The services of the administrative support staff are indispensable in the proper administration of the Department. It is important to recruit very competent, computer literate senior staff.

Technical Support Personnel
The services of technical support staff, which are indispensable in the proper running of laboratories are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

Library
Textbooks and Journals in the following areas are required:
1. General Biology
2. General Zoology
3. Histology
4. Animal Physiology
5. Animal Ecology
6. General Parasitology
7. Entomology
8. Animal behaviour
9. Developmental Animal Biology
10. Atlas of Embryology
11. Practical Invertebrate Zoology
12. Invertebrate Zoology
13. Practical Vertebrate Zoology
14. Chordate & Vertebrate Zoology
15. Comparative Vertebrate Anatomy
16. Animal Taxonomy/Systematic

Classrooms, Laboratories, Workshops and Office Space
The NUC recommends the following physical space requirements:

Description	**Size m^2**
Professor's Office	18.50
Head of Department's Office	18.50
Tutorial Teaching Staff's Office	13.50
Other Teaching Staff Space	7.00
Technical Staff Space	7.00
Secretarial Space	7.00
Research Laboratory	16.50
Seminar Space/per student	1.85
Laboratory Space per FTE	7.50
Conference Room -	37.0
Small animal house (small animal breeding and research)	30.0m2
Insectary	30.0m2
Audio/visual room	30.0m2