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NATIONAL UNIVERSITIES COMMISSION

BENCHMARK MINIMUM ACADEMIC STANDARDS

For

UNDERGRADUATE PROGRAMMES

In

NIGERIAN UNIVERSITIES

SCIENCES

NOVEMBER 2014

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shall be made on the minimum CGPA of 1.5
for graduation after the forthcoming workshop on
Grading System

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 programmes taught in Nigerian universities. In 1989, the Commission, in collaboration with the universities and their staff, developed minimum academic standards for all the programmes taught in Nigerian universities and the Federal Government subsequently approved the documents.

After more than a decade of using the Minimum Academic Standard (MAS) documents as a major instrument of quality assurance, the Commission in 2001 initiated a process to revise the documents. The curriculum review was necessitated by the fact that the frontiers of knowledge in all academic disciplines had been advancing with new information generated as a result of research. The impact of Information and Communication Technologies on teaching and learning and the dynamics of the skills set required to face the challenge of competition engendered by globalization were also compelling reasons for the curriculum review.

Other compelling reasons included the need to update the standard and relevance of university education in the country as well as to integrate entrepreneurial studies and peace and conflict studies as essential new platforms that will guarantee all graduates from Nigerian universities the knowledge and appropriate skills, competencies and dispositions that will make them globally competitive and capable of contributing meaningfully to Nigeria's socio-economic development. Recognising that the content-based MAS documents were rather prescriptive, a decision was taken to develop outcome-based benchmark statements for all the programmes in line with contemporary global best practice. To actualize this, the Commission organized a stakeholders' workshop to benchmark each programme in all the disciplines taught in Nigerian universities. Following comments and feedback from critical stakeholders in the universities indicating that the Benchmark-style Statements were too sketchy to meaningfully guide the development of curricula and were also inadequate for the purpose of accreditation, the Commission put in place the mechanism for the merger of the Benchmark-style Statements and the revised Minimum Academic Standards into new documents referred to as the Benchmark Minimum Academic Standards (BMAS).

The resultant documents, an amalgam of the outcome-based Benchmark statements and the content-based MAS clearly enunciates the learning outcomes and competencies expected of graduates of each academic programme without being overly prescriptive while at the same time providing the requisite flexibility and innovativeness consistent with institutional autonomy.
The first step in the process of amalgamation of the Benchmark statements and the content-based MAS was the conduct of a needs assessment survey and the publication of the findings in the report titled *Needs Assessment Surveys of Labour Market for Nigerian Graduates*. This was carried out for all the disciplines taught in Nigerian universities. The exercise involved major stakeholders particularly employers of Nigerian graduates. The objectives of the Needs Assessment Survey included identification of expected knowledge, attitudes and skills for graduates and their ability to fit into the requirements of the new national and global economy. The second stage was the organisation of a workshop at which academic experts across Nigerian universities, including Vice-Chancellors, participated with the objective of ensuring that the designed BMAS for the

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various disciplines took into cognizance the identified knowledge and skill gaps. At the end of the workshop, draft BMAS documents were produced for the various programmes in the thirteen broad academic disciplines into which the Nigerian University System has been structured. Of significance was the introduction of science- and social science/humanities-based courses under the General Studies programme which are compulsory for all first- year students in Nigerian universities, irrespective of their course of study.

The documents were later sent to the Universities offering relevant disciplines for comments and input. Following the collation of the input and comments from the Universities, another workshop was held at which invited academic experts studied and incorporated the relevant comments and input received into the draft documents.

After content and language editing, by relevant experts, a one-day workshop was held at which the edited documents were harmonized to produce the final BMAS documents.
Consequent upon the afore-mentioned processes, BMAS documents were produced for the under-listed academic disciplines:

i. Administration; Management and Management Technology;
ii. Agriculture, Forestry, Fisheries and Home Economics;
iii. Arts;
iv. Basic Medical and Health Science;
v. Education;
vi. Engineering and Technology;
vii. Environmental Sciences;
viii. Law;
ix. Pharmaceutical Sciences;
x. Medicine and Dentistry;
xi. Science;
xii. Social Sciences; and
xiii. Veterinary Medicine.

For each programme, the document contains suggestions of the status of each course in terms of *compulsory*, *required* and *elective*. Universities are encouraged to take due cognizance of the BMAS while bringing necessary innovation into the content and delivery of their programmes towards achieving their overall objectives and goals. Programmes are to be structured in such a way that a typical student does not carry less than 30 credit units or more than 48 credit units per session.

It is the Commission's expectation that this BMAS document will serve as a guide to the universities in the design of curricula for their programmes in terms of the minimum acceptable standards of input, process as well as measurable benchmark of knowledge, skills and competences expected to be acquired by an average graduate of each of the academic programmes.

Professor Julius A. Okojie, *OON*
Executive Secretary

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GLOSSARY OF COURSE CODES

These are the 3-letter codes for the identification of courses offered in the various programmes in the Science discipline as well as courses offered in other disciplines covered in the BMAS for the Nigerian University System. They are in three categories based on the sources of courses involved:

Category A: Course codes for courses offered in programmes outside the Science Discipline

Category B: Course codes for common basic courses offered by students registered in various programmes in the Science Discipline.

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

Category A:

The Programme offering the Courses	Course Code
Aquaculture and Fisheries Management Programme in Agriculture, Forestry, Fisheries and Home Economics Discipline	AFM
Forest Resources Management in Agriculture, Forestry, Fisheries and Home Economics Discipline	FRM
Food Science & Technology Programme in Engineering& Technology Discipline	FST
Forest Resources & Wildlife Management in Agriculture, Forestry, Fisheries and Home Economics Discipline	FWM
General Engineering & Technology Foundation Course in Engineering & Technology Discipline	GET
Management Technology Programme in Administration & Management Discipline	MTC
Petroleum & Gas Engineering Programme in Engineering & Technology Discipline	PGE
Soil Science and Land Management in Agriculture, Forestry, Fisheries and Home Economics Discipline	SOS
Wildlife Management in Agriculture, Forestry, Fisheries and Home Economics Discipline	WLM
Water Resources Management &Agrometeorology Programme in Agriculture, Forestry, Fisheries& Home Economics	WMA

Category B:

The Programme offering the Course	Course Code
General Studies Courses offered at the University Level for students registered in all the disciplines in the university.	GST

Category C:

The Programme offering the Courses	Course Code
Biochemistry	BCH
Biology	BIO
Biotechnology	BTG
Botany	BOT
Brewing Science and Technology	BST
Chemistry	CHM
Computer Science	CSC
Environmental Management &Toxicology	EMT
Forensic Chemistry	FCH
Geology	GEY
Geophysics (Applied Geophysics)	GPH
Industrial Mathematics	
Mathematics	MTH
Meteorology	MET
Microbiology	MCB
Petroleum Chemistry	PCM
Physics	PHY
Science Laboratory Technology – Biochemistry Techniques	SBC
Science Laboratory Technology – Biology Techniques	SBL
Science Laboratory Technology – Chemical/Petroleum Technology Techniques	SCP
Science Laboratory Technology – Chemistry Techniques	SCH
Science Laboratory Technology – Geology/Mining Techniques	SGM
Science Laboratory Technology –Microbiology Techniques	SMB
Science Laboratory Technology –Physics with Electronics Techniques	SPE
Science Laboratory Technology – Physiology/Pharmacology Techniques	SPP
Statistics	STA
Zoology	ZOO

SECTION ONE:

BASIC ELEMENTS OF THE OPERATION OF THE BENCHMARK MINIMUM ACADEMIC STANDARDS (BMAS) FOR UNDERGRADUATE DEGREE PROGRAMMES IN THE SCIENCES.

Preamble

The Benchmark Minimum Academic Standards (BMAS) is for undergraduate degree programmes in the Sciences. This BMAS document stipulates the minimum academic requirements for the training of undergraduates in various programmes in the Sciences and the document is therefore expected to be used as a guide by degree awarding institutions in Nigeria when designing curricula for programmes in the Sciences. Institutions are however encouraged to exceed the stipulated minimum standards while bringing necessary innovation into the content and delivery of their programmes for the training of competent scientists.

1.1 Programmes and Degrees

Presented in Table 1.1 is a list of programmes and degrees covered in this BMAS 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.

List of Programmes and Degrees in View

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

1.2 Philosophy and Objectives

Science programmes are the bed-rock of technological development and therefore of national growth with attendant contribution to human welfare, health and progress.

The training towards degrees in the Sciences is fundamentally geared to ensuring that Nigeria possesses a critical mass of properly trained and highly competent scientists that will effectively facilitate the development of a sustainable and competitive modern economy that guarantees a very high standard of living and quality of life for its citizens.

The training of competent scientists will enable Nigeria to be in a position to adequately utilise its vast natural resources to successfully transform its economy to that of one of the top global economies by leveraging on science, technology and innovation.

The training of Scientists should involve the broad strategy of human resources development with its broader goals of social and political modernization. The training in Science needs to be thorough and relevant which will assure graduates employment opportunities or an environment whereby they could be creative, innovative and seek self-employment.

These considerations lead to the concepts on which the following model curricula for Science programmes are constructed:-

(a) The need for broad training in the Sciences
(b) The need for skill acquisition to ensure competence in one's chosen field of study;
(c) The need for interdisciplinary orientation to imbibe the rewards of inter-disciplinary approach to the solution of complex life problems;
(d) The need for social relevance, to ensure social responsibility and service to society.

1.3 Basic Admission Requirements and Expected Duration of the Programmes

Candidates can be admitted into any of the degree programmes in Science by one of the following three ways:

- The Unified Tertiary Matriculation Examination (UTME)
- Direct Entry
- Inter-University Transfer

UTME Entry Mode

The minimum academic requirement is credit level passes in five subjects at O'Level in nationally recognised examination including English Language, Mathematics and three other Science subjects which are relevant to the intended programme at not more than two sittings. In addition, an acceptable pass in the Unified Tertiary Matriculation Examination (UTME) with relevant subject combination is also required for admission into 100 Level.

Direct Entry Mode

Candidates seeking admission into a programme in Science through Direct Entry must have passes at GCE 'A' Level/IJMB or its equivalent in a minimum of two Science subjects relevant to the intended programme to be considered for admission into 200 Level. This is

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in addition to fulfilling the requirement of a minimum of credit level passes in five relevant subjects at 'O' Level as indicated above.

Inter-University Transfer Mode
Students can transfer into 200-Level courses provided they have the relevant qualifications. Universities are to certify that students meet the minimum requirements for the Inter-university Transfer.

1.4 Minimum Duration
The minimum duration of Science programmes is four academic sessions for candidates who enter through the UTME Mode. Direct Entry candidates admitted into the 200 level of their programmes will spend a minimum of three academic sessions.

1.5 Graduation Requirements

1.5.1 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, e.g. Level or year I courses are 100, 101 etc and Level II or year II courses are 200, 202 etc.

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 work load.

(i) 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.

(ii) As a measure of work load, "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:

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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.

1.5.2 Standard Terminologies

The following standard terminologies are used for different categories of courses.

i. **Core/Compulsory Course:**
A course which every student must compulsorily take and pass in any particular programme at a particular level of study.

ii. **Elective Course**
A course that students take within or outside the faculty. Students may graduate without passing the course provided the minimum credit unit for the course had been attained.

iii. **Optional Course**
A course which students can take based on interest and may count towards the minimum credit unit required for graduation.

iv. **Pre-requisite Course**
A course which student must take and pass before taking a particular course at a higher level.

v. **Required Course**
A course that you take at a level of study and must be passed before graduation.

1.5.3 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.

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 – 45	E	1
< 40	F	0

1.5.4 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 product of the total number of Units x Grade Point (TUGP) by the total number of units (TNU) for all the courses taken (whether passed or failed) 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.

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**

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

1.5.5 Degree Classifications

The determination of the class of degree shall be based on the Cumulative Grade Point Average (CGPA) earned at the end of the programme. The CGPA shall be used in the determination of the class of degree as summarized in Table 1.4. It is important to note that the CGPA shall be calculated and expressed correct to two decimal places.

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Degree Classification

Cumulative Grade Point Average (CGPA)	Class of Degree
4.50 – 5.00	1st Class Honours
3.50 – 4.49	2nd Class Honours (Upper Division)
2.40 – 3.49	2nd Class Honours (Lower Division)
1.50 – 2.39	3rd Class Honours

The maximum length of time allowed to obtain an honours degree in the Faculty of Science shall be ten semesters for the 4-year degree programme and eight semesters for students admitted through Direct Entry.

Students who transfer from other universities shall be credited with only those courses deemed relevant to their programmes of study, which they have already passed prior to their transfer. Such students shall however be required to pass the minimum number of units specified for graduation for the number of sessions he/she has spent in the Faculty; provided that no student shall spend less than two sessions (4 semesters) in order to earn a degree. Students who transfer from another programme in the Faculty or other Faculties for any approved reason shall be credited with those units passed that are within the curriculum of the programme to which he/she has transferred. Appropriate decisions on transfer cases shall be subjected to the approval of Senate on the recommendation of the Faculty.

1.5.6 **Probation**

A student whose Cumulative Grade Point Average is below 1.50 at the end of a particular year of study, earns a period of probation for one academic session. A student on probation is allowed to register for courses at the next higher level in addition to his/her probation level courses provided that:

i) the regulation in respect of student work-load is complied with; and
ii) the pre-requisite courses for the higher level courses have been passed.

1.5.7 **Withdrawal**

A candidate whose Cumulative Grade Point Average is below 1.50 at the end of a particular year of probation should be required to withdraw from the University. .

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1.6 Evaluation

1.6.1 Techniques of Student Assessment

(a) **Practicals**

By the nature of the programmes in Science, laboratory practicals are very important in the training of students. To reflect the importance of practical work, a minimum of 9 hours per week or 135 hours per semester (equivalent to 3 units) should be spent on students' laboratory practicals. Consequently, some of the courses have both theory and practical components. Thus, in the description of courses to be taken in any programme, as presented in Section 2, the number of lecture contact hours (LH) and the number of practical contact hours (PH) per semester are indicated. The overall performance of students in such courses is to be based on the evaluation of the performance in written examination (which tests theory) and also the performance in the laboratory work (based on actual conduct of experiments and the reports of such experiments).

The experiments to achieve the practical components of the courses must be designed in quality and quantity to enrich students' grasp of the theoretical foundations of the courses. It is left for the department to organise all the experiments in the best way possible. One of the ways to achieve this is to lump all the laboratory practicals under a course, which a student must pass.

(b) **Tutorials**

The timetable for courses shall be designed to make provision for tutorials of at least one hour for every four hours of lecture. Thus a 3-unit course of 45 hours per week should attract about 10 hours of tutorials.

(c) **Continuous Assessments**

Continuous assessment shall be done through essays, tests, homework, practical exercises etc.

i. Scores from continuous assessment shall normally constitute 30% of the full marks for courses which are primarily theoretical.
ii. For courses which are partly practical and partly theoretical, scores from continuous assessment may constitute 40% of the final marks.
iii. For courses that are entirely practical, continuous assessment shall be based on a student's practical work or reports and shall constitute 100% of the final marks.

(d) **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: 70% - 60%

Continuous assessment (Quizzes, Homework, Tests): 30% - 40%

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Each course shall normally be completed and examined at the end of the semester in which it is offered. A written examination shall normally last a minimum of one hour for one unit course.

1.6.2 **External Examiners' 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..

1.6.3 **SIWES Rating and Assessment**

All students taking any degree in the Sciences must undergo industrial training in order to earn a minimum of 6 credit units. The minimum duration of the Students Industrial Work Experience Scheme (SIWES) should be 24 weeks. Students should be assessed using the Log Book, a report and a Seminar.

1.6.4 **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 system; serving as feedback mechanism for achieving the following:

i. Improvement in the effectiveness of course delivery.
ii. Continual update of lecture materials to incorporate emerging new concepts.
iii. Effective usage of teaching aids and tools to maximize impact of knowledge on students.
iv. Improvement in students' performance through effective delivery of tutorials, timely conduct of continuous assessment and high quality examination.

The evaluation should be conducted preferably before the final semester examinations. 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 analysed and results discussed with course lecturers towards improvement in course delivery in all its ramifications.

1.6.5 **Maintenance of Curricula Relevance**

Using the BMAS as guide, the curriculum in each discipline should be reviewed from time to time to determine the continued relevance and fitness of purpose.

The NUC, in its role as the national quality assurance agency on university programmes, shall subject the benchmark statements for review periodically.

It is recommended that universities review their programme, at least once in five years, using the current quality assurance benchmark statements.
Unless otherwise essential for particular programmes, all science programmes in a university should be reviewed at the same time. A committee of staff senior enough and competent to carry out an effective review shall perform each curriculum review. The review shall include

an assessment as to whether the goals and objectives of the programme as formulated are still relevant.

Reviews should endeavour to incorporate the opinions of relevant stakeholders such as students, staff, external examiners, employers, professional bodies, policy makers etc.

Each curriculum so revised should be subjected to consideration and approval at the levels of Department, Faculty/Colleges, and Senate in the University. Specifically, a good review should examine the curriculum and resources in accordance with the following criteria:

(i) Re-assessment/re-formulation of goals and objectives of the programme in relation to the needs of the learners and market requirements taking into account the broader aspects of the discipline.
(ii) The market demands of the graduates now and in the future, in terms of skills needed to function competitively in the current labour market on a global scale.
(iii) Relevance of the current content in terms of knowledge, skills and attitudes being taught/developed and how these meet the needs of the present and future requirements of the clientele.
(iv) How the teaching and learning methods meet or fall short of current and future standards of comparable programmes.
(v) the quality of teaching and learning materials used.
(vi) Outcomes of learning in terms of success, experience of learners (pass rate, knowledge and skills acquisition, professional capability and integrity) as contributed by the programme.
(vii) The views of employers and community members on the quality and relevance of the curriculum.

1.6.6 Performance Evaluation Criteria

The accreditation of the Science degree programme means a system of recognising educational institutions/universities and programmes offered by them for a level of performance, integrity and quality which entitles them to the confidence of the educational and professional community, the public they serve, and employers of labour.

The objectives of the accreditation exercise are to:

(i) Ensure that at least the provisions of the benchmark minimum academic standards are attained, maintained and enhanced.
(ii) Assure employers and other members of the community that graduates of these institutions have attained an acceptable level of competence in their areas of specialisation.
(iii) Certify to the international community that the programmes offered in these universities are of high standards and that their graduates are adequate for employment and for admission for further studies.

1.7 Resource Requirement

1.7.1 Personnel

a) **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.

Qualifications for Appointments/Promotion of Academic Staff

	LEVEL	QUALIFICATIONS
i.	Graduate Assistant	A good Bachelor's Degree (with a minimum Second Class Upper Division) This is a training position and complete their Master's degree within two years of their appointment.
ii.	Assistant Lecturer	A good Bachelor's Degree and Master's Degree.
iii.	Lecturer II	A Doctorate Degree in addition to a good Bachelor's degree Promotion from Assistant Lecturer grade after a minimum of three years.
iv.	Lecturer I	In addition to the qualifications specified for Lecturer II, Lecturer I should have had at least three years post-doctoral teaching experience and demonstrated ability for research work and evidence of scholarship.
v.	Senior Lecturer	Basic qualifications for Lecturer I plus at least three years of teaching experience.. Must have demonstrated research capability through good academic publications.
vi.	Associate Professor (Reader)	Basic qualifications set out for Senior Lecturer plus at least three years of experience. Must have considerable publications resulting from research as well as demonstrated academic leadership ability. A Reader should have evidence of participation in University administration and community activities. External assessment is required for promotion to the level of an Associate Professor.
vii	Professor	Basic qualifications as for Reader/Associate Professor. Must have had at least three years experience as Associate Professor as well as some professional recognition. External assessment is required for promotion to the level of a Professor. A Professor should demonstrate clear evidence of scholarship through considerable academic publications.

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b) **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.

c) **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.

1.7.2 **Physical Facilities**

a) **Spaces**
The NUC recommends the following physical space requirement:

		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
Science Staff Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space per FTE	-	7.50

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) **Equipment**
To achieve the benchmark statements for any programme, there should be:

(i) A minimum number of identifiable and adequately equipped laboratories for each programme which should be in accordance with the recommended space requirements.
(ii) At least one large and reasonably equipped central laboratory for teaching and research.

It is important that laboratory equipment should be acquired in sufficient numbers to enable adequate implementation of the benchmark statements.
Please see Section 4 for the recommended list of equipment for each programme.

1.7.3 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 least 25% of the total student enrolled in each academic programme. The funding of the Library should be in line with NUC guidelines.

1.8 General Studies (GST)

There are also courses from the General Studies Programme (GST) that students from the Faculty of Science are expected to take. All students are expected to sit and pass all stipulated GST courses.

Goal:

To produce a well-rounded morally and intellectually capable graduates with vision and entrepreneurial skills in an environment of peace and social cohesiveness.

Objectives

The objectives of the General Studies programme consist of the following:

a) Acquisition, development and inculcation of proper value-orientation for the survival of the individual and society.
b) The development of intellectual capacities of individuals to understand, appreciate and promote peaceful co-existence.
c) Production of graduates with broad knowledge of the Nigerian Nation and people with a view to inculcating in them mutual understanding and patriotism.
d) Exposing graduates of Nigerian Universities to the rudiments of ICT for computer literacy and ability to live usefully in this ICT- driven age.
e) Preparing students for a post university life with opportunities for job creation and entrepreneurial skills.
f) Production of graduates capable of communicating effectively (both oral and written).

The details of the courses under the General Studies are presented in Section 2.

SECTION TWO:

COURSE STRUCTURE AND SYNOPSES OF COMMON COURSES FOR UNDERGRADUATE DEGREE PROGRAMMES IN THE SCIENCES.

Preamble

There are some basic courses which are offered in most of the Degree Programmes in the Science Discipline particularly at the 100 level. The rationale is to ensure that all undergraduate students in the Faculty of Science have the required basic training in the core basic science programmes. These common courses consist of basic courses in Biology, Chemistry, Computer Science, Mathematics, Physics as well as the General Studies courses. The Students Industrial Work Experience Scheme (SIWES) is also compulsory for Science programmes.

2.1 Common Courses

The common courses are basically in the following four categories:

- Courses in core basic sciences of Biology, Chemistry, Mathematics and Physics
- General Studies (GST)
- Entrepreneurship
- Student Industrial Work Experience (SIWES)

2.1.1 Common Basic Science Courses.

The basic science courses which students of most Degree programmes in Science have to register for at the 100 Level are:

BIO 101: General Biology I	(3 Units)
BIO 102: General Biology II	(3 Units)
BIO 107: General Biology Practical I	(1 Unit)
BIO 108: General Biology Practical II	(1 Unit)
CHM 101: General Chemistry I	(3 Units)
CHM 102: General Chemistry II	(3 Units)
CHM 107: General Chemistry Practical I	(1 Unit)
CHM 108: General Chemistry Practical II	(1 Unit)
CSC 101: Introduction to Computer Science	(3 Units)
MTH 101: Elementary Mathematics I	(3 Units)
MTH 102: Elementary Mathematics II	(3 Units)
PHY 101: General Physics I	(3 Units)
PHY 102: General Physics II	(3 Units)
PHY 107: General Physics Practical I	(1 Unit)
PHY 108: General Physics Practical II	(1 Unit)

2.1.2 General Studies (GST)

The goal and objectives of the General Studies (GST) Programme have been fully outlined in Section 1.7. In a nut-shell the aim of the General Studies Programme is to expose students to a course of liberal education through which they can develop and expand their awareness

of their social, cultural and natural environments. The goal is to produce well-rounded graduates that are intellectually sound, competent in the use of English Language.
The objectives of the programme include:

- Acquisition of a body of situational relevant knowledge outside of the respective field of specialization of the students for productive, healthy living and promotion of peaceful coexistence.
- Development of competence in the use of English Language as a tool for their studies and effective means of communication in the society and in their future employment/enterprise.

Students are expected to pass a minimum of 10 units of GST courses including GST 111, GST121 and GST 122 before graduating.

General Studies: Course structure

Course Code	Course Title	Units
GST 111	Communication in English I	2
GST 112	Logic, Philosophy & Human Existence	2
GST 113	Nigerian Peoples and Culture	2
GST 121	Use of Library, Study Skills and ICT	2
GST 122	Communication in English II	2
GST 123	Communication in French	2
GST 124	Communication in Arabic	2
GST 125	Contemporary Health Issues	2
GST 211	Environment & Sustainable Development	2
GST 222	Peace and Conflict Resolution	2
GST 223	Introduction to Entrepreneurship	2
GST 224	Leadership Skills	2
GST 311	Entrepreneurship	2

2.1.3 Entrepreneurship

Towards Nigeria's quest for accelerated economic growth, it is important that active and virile youth population is assisted to develop and convert their innovative ideas into business ventures. These skills can be acquired particularly by those so innately inclined. This underscores the need to actively promote and train students to be entrepreneurial within our educational system. The entrepreneurship programme aims at re-orientating students towards a job- creation mind-set rather than the fixed attitude of job-seeking. It will equip them with the skills required in establishing businesses or making them add value to existing systems, if employed in organizations. The main objective is to introduce students to concepts and opportunities available in entrepreneurship and innovation. It assumes no previous knowledge and takes students through the rudiments of entrepreneurship to selecting a desired business and starting it with a Feasibility Report.

Entrepreneurship is incorporated into the General Studies Programme as two courses, GST 223 and GST 311.

The specific objectives of the GST 223 (Introduction to Entrepreneurship) and GST 311 (Entrepreneurship), are to enable students to:

- Understand the relationship of enterprise, entrepreneur, business, entrepreneurship, innovation and creativity.
- Analyse the historical perspective of entrepreneurship in Nigeria, and relate it to the recent trend of unemployment, under-employment and job dissatisfaction, personal, national and global economic recession.
- Identify the roles of entrepreneurial development agencies and regulatory bodies.
- Cultivate the spirit of entrepreneurship.
- Correct wrong attitudes and mind-sets and develop high entrepreneurial potential in student.
- Select possible business ideas.
- Build the capacity to develop business plan to start a business.

2.1.4 Students Industrial Work Experience Scheme (SIWES)

An important aspect of the education and training of science students in the universities is organised exposure to some elements of industrial art as articulated below under the Students Industrial Work Experience Scheme (SIWES). This is being emphasised herein in view of the rather poor handling of SIWES, in some existing universities in the country.

Universities are expected to establish a SIWES Unit to co-ordinate SIWES in all programmes that have SIWES component to shoulder the following responsibilities:

- Soliciting co-operative placements (jobs) in business, industry, government or service agencies depending upon the needs and qualifications of the student, and placing students on such training assignments after analysing the technical contents.
- Coordinating and supervising the co-operative employment of students in such a way that students have the opportunity of learning useful scientific skills on real jobs and under actual working conditions.
- Conducting follow-up activities regarding all placements by checking regularly each student's job performance through company visits and individual student's interview.
- Assembling individual inventory records of students and employers for the purposes of placements and supervision in addition to maintaining functional departmental and personal records and reports.
- Providing necessary advice to students as to the relevance of their chosen field to the industrial requirements of the country.
- Organizing and conducting students' seminars on Work Reports.
- Liaison with NUC, ITF, other agencies and industries on student industrial training programme of the University.

Students are expected to have a total of at least 24 weeks of industrial attachment. It should be noted that Industrial Training as a course involves the following:

- Working successfully in the industry for the specified period.
- Submitting of a Work Report to the coordinating office at the end of the training

period.
- Presentation of seminar on the industrial training experience.

The course codes for Industrial Attachment for each programme are represented by the three letter code for the programme followed by 299 (industrial attachment at 200 level) or 399 (industrial attachment at 300 level). Thus BCH 299 will be industrial attachment for Biochemistry Students at 200 level while BCH 399 represents industrial attachment for Biochemistry Students at 300 level. Each industrial attachment course is a 3 unit course.

2.1.5 Structure of the Common Courses

Course Structure of Common Courses at 100 Level in Science

Course Code	Course Title	Units	Status	LH	PH
BIO 101	General Biology I	3	**	45	-
BIO 102	General Biology II	3	**	45	-
BIO 107	General Biology Practical I	1	**	-	45
BIO 108	General Biology Practical II	1	**	-	45
CHM 101	General Chemistry I	3	**	45	-
CHM 102	General Chemistry II	3	**	45	-
CHM 107	General Chemistry Practical I	1	**	-	45
CHM 108	General Chemistry Practical II	1	**	-	45
CSC 101	Introduction to Computer Science	3	C	30	45
GST 111	Communication in English	2	C	30	-
GST 112	Logic, Philosophy and Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use Library, Study Skills & ICT	2	C	30	-
GST 122	Communication in English II	2	C	30	-
GST 123	Communication in French	2	E	30	-
GST 124	Communication in Arabic	2	E	30	-
GST 125	Contemporary Health Issues	2	R	30	-
MTH 101	Elementary Mathematics I	3	**	45	-
PHY 101	General Physics I	3	**	45	-
PHY 102	General Physics II	3	**	45	-
PHY 107	General Physics Practical I	1	**	-	45
PHY 108	General Physics Practical II	1	**	-	45
*XYZ 299	Industrial Attachment I (12 Weeks)	3	C		
*XYZ 399	Industrial Attachment II (12 Weeks)	3	C		

LH = Lecture Contact Hours; PH = Practical Contact Hours; C = Compulsory; R = Required; E = Elective. *XYZ represents the three letter code for each programme. ** The status of each of these courses depends on the programme under consideration.

Course Structure of Common Courses at 200 - 300 Levels in Science

Course Code	Course Title	Units	Status	LH	PH
GST 211	Environment & Sustainable Development	2	R	30	-
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-

2.1.6 GST Course Synopses

GST 111: **Communication in English I:** **(2 Units: LH 30)**
Effective communication and writing in English Language skills, essay writing skills (organization and logical presentation of ideas, grammar and style), comprehension, sentence construction, outlines and paragraphs.

GST 112: **Logic, Philosophy and Human Existence:** **(2 Units: LH 30)**
A brief survey of the main branches of Philosophy; Symbolic logic; Special symbols in symbolic logic-conjunction, negation, affirmation, disjunction, equivalent and conditional statements, law of tort. The method of deduction using rules of inference and bi-conditionals, qualification theory. Types of discourse, nature or arguments, validity and soundness, techniques for evaluating arguments, distinction between inductive and deductive inferences; etc. (Illustrations will be taken from familiar texts, including literature materials, novels, law reports and newspaper publications).

GST 113: **Nigerian Peoples and Culture:** **(2 Units: LH 30)**
Study of Nigerian history, culture and arts in pre-colonial times; Nigerian's perception of his world; Culture areas of Nigeria and their characteristics; Evolution of Nigeria as a political unit; Indigene/settler phenomenon; Concepts of trade; Economic self-reliance; Social justice; Individual and national development; Norms and values; Negative attitudes and conducts (cultism and related vices); Re-orientation of moral; Environmental problems.

GST 121: **Use of Library, Study Skills and ICT:** **(2 Units: LH 30)**
Brief history of libraries; Library and education; University libraries and other types of libraries; Study skills (reference services); Types of library materials, using library resources including e-learning, e-materials, etc; Understanding library catalogues (card, OPAC, etc) and classification; Copyright and its implications; Database resources; Bibliographic citations and referencing. Development of modern ICT; Hardware technology; Software technology; Input devices; Storage devices; Output devices; Communication and internet services; Word processing skills (typing, etc).

GST 122: **Communication in English II:** **(2 Units: LH 30)**

Logical presentation of papers; Phonetics; Instruction on lexis; Art of public speaking and oral communication; Figures of speech; Précis; Report writing.

GST 123: Communication in French: (2 Units: LH 30)
Introduction to French, alphabets and numerals for effective communication (written and oral); conjugation and simple sentence construction based on communication approach. Comprehension and reading of simple texts.

GST 124: Communication in Arabic: (2 Units: LH 30)
Introduction to Arabic alphabets and writing systems. Elementary conversational drills. Basic reading skills and sentence construction in Arabic.

GST 125: Contemporary Health Issues: (2 Units: LH 30)
Diet, exercise and health, nutritional deficiency diseases, malaria, other infections, hypertension, organ failure, air-borne diseases, sexually transmitted diseases, cancer and its prevention, sickle cell disease. HIV/AIDS: Introduction, epidemiology of HIV, natural history of HIV infection, transmission and predisposing factors to HIV, Impact of HIV/AIDS on the society, management of HIV infection, prevention of HIV. Drugs and Society: sources of drugs, classification of drugs, dosage forms and routes of drug administration, adverse drug reactions, drug abuse and misuse, rational drug use and irrational drug use. Human kinetics and health education: personal care and appearance, exercise and health, personality and relationship, health emotions, stress, mood modifiers, refusal to tobacco, alcohol and other psychoactive drugs.

GST 211: **Environment and Sustainable Development: (2 Units: LH 30)**
Man – his origin and nature. Introduction to the various areas of science and technology.
Man and his cosmic environment, scientific methodology, science and technology in the society and service of man. Renewable and non-renewable resources – man and his energy resources. Elements of environmental studies. Environmental effects of chemical plastics, textiles, wastes and other materials. Chemical and radiochemical hazards.

GST 222: **Peace Studies and Conflict Resolution : (2 Units: LH 30)**
Basic Concepts in peace studies and conflict resolution; Peace as vehicle of unity and development; Conflict issues; Types of conflict, e. g. Ethnic/religious/political/ economic conflicts; Root causes of conflicts and violence in Africa; Indigene/settler phenomenon; Peace – building; Management of conflict and security. Elements of peace studies and conflict resolution; Developing a culture of peace; Peace mediation and peace-keeping; Alternative Dispute Resolution (ADR). Dialogue/arbitration in conflict resolution; Role of international organizations in conflict resolution, e.g. ECOWAS, African Union, United Nations, etc.

GST 223: **Introduction to Entrepreneurship: (2 Units: LH 30)**
Introductory Entrepreneurial skills: Relevant Concepts: Enterprise, Entrepreneur, Entrepreneurship, Business, Innovation, Creativity, Enterprising and Entrepreneurial Attitude and Behaviour. History of Entrepreneurship in Nigeria. Rationale for Entrepreneurship, Creativity and Innovation for Entrepreneurs. Leadership and

Entrepreneurial Skills for coping with challenge. Unit Operations and Time Management. Creativity and Innovation for Self-Employment in Nigeria. Overcoming Job Creation Challenges. Opportunities for Entrepreneurship, Forms of Businesses, Staffing, Marketing and the New Enterprise. Feasibility Studies and Starting a New Business. Determining Capital Requirement and Raising Capital. Financial Planning and Management. Legal Issues, Insurance and Environmental Considerations.

GST 224: Leadership Skills: (2 Units: LH 30)

Transformation is a fundamental shift in the deep orientation of a person, organization or society such that the world is seen in new ways and new actions and results become possible that were impossible prior to the transformation. Transformation happens at the individual level but must be embedded in collective practices and norms for the transformation to be sustained. Leadership Development Programme (LDP) proposes novel approaches to teaching and learning, which emphasizes the practical involvement of participants. It is interactive and involves exercises and actual implementation of breakthrough projects by teams that make difference in the lives of the target population. In this course, leadership concepts comprising of listening, conversation, emotional intelligence, breakthrough initiatives, gender and leadership, coaching and leadership, enrolment conversation and forming and leading teams will be taught

GST 311: Entrepreneurship: (2 Units: LH 30)

Profiles of business ventures in the various business sectors such as:

Soap/Detergent, Tooth brush and Tooth paste making; Photography; Brick making; Rope making; Brewing; Glassware production/Ceramic production, Paper production; Water treatment/conditioning/packaging; Food processing/preservation/packaging; Metal fabrication; Tanning industry; Vegetable oil extraction; Farming; Fisheries/aquaculture; Plastic making; Refrigeration/Air-conditioning; Carving, Weaving; Bakery; Tailoring; Printing; Carpentry; Interior Decoration; Animal husbandry etc. Case Study Methodology applied to the development and administration of Cases that bring out key issues of business environment, start-up, pains and gains of growth of businesses, etc. with particular reference to Nigerian businesses. Experience sharing by business actors in the economy with students during Case presentations.

SECTION THREE:

COURSE STRUCTURE AND SYNOPSES OF SCIENCE DEGREE PROGRAMMES

3.1 BIOCHEMISTRY (BSc)

3.1.1 Philosophy, Aims and Objectives of the Degree Programme

The main aims and objectives of the degree programme in biochemistry should be:

a. To provide students with a broad and balanced foundation of biochemical knowledge and practical skills

b. To develop in students the ability to apply knowledge and skills to solving theoretical and practical problems in biochemistry

c. To develop in students, a range of transferable skills that are of value in biochemical and non-biochemical employment

d. To 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

e. To provide, through training and orientation, an appreciation of the rewards of inter- and multi-disciplinary approach to the solution of complex life problems

f. To generate in students an appreciation of the importance of biochemistry in industrial, economic, environmental, technological and social development

g. To instil in students a sense of enthusiasm for biochemistry, an appreciation of its application in different contexts and to involve them in an intellectually stimulating and satisfying experience of learning and studying.

3.1.2 Admission and Graduation Requirements

The entry requirements shall be at least credit level passes in five subjects consisting of 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. Expected duration for UTME candidates shall be 4 years.

Candidates with at least two A level passes in relevant science subjects at the GCE Advanced Level or IJMB may be considered for admission into 200 Level. Expected duration for Direct Entry (DE) candidates shall be 3 years.

Students are required to pass a minimum of 120 units for graduation, 60 of which must be from Biochemistry courses.

3.1.3 Learning Outcomes

Biochemistry graduates are expected to develop a wide range of different skills and abilities. These are divided into three broad categories:

a. *Regime of Subject Knowledge*
Graduates of biochemistry are expected to develop high cognitive abilities and skills related to biochemistry.

b. *Competencies and Skills*
Biochemistry graduates are also expected to exhibit high practical skills in biochemistry.

c. *Behavioural Attitudes*
Graduates of biochemistry are expected to be able to transfer this skill to non biochemistry specific competencies.

3.1.4 Attainment Level

Graduates of biochemistry are expected to have the ability to apply their knowledge and skills to solving theoretical and practical problems in biochemistry in relation to national and societal problems.

3.1.5 Resource Requirement for Teaching and Learning

a) Academic and non-academic staff. (See section 1.6)
b) Academic and Non-Academic Spaces (See section 1.6)
c) Academic and Administrative Equipment (See section 4)
d) Library and Information Resources (See section 1.6)

3.1.6 Course Structure and Synopses

Course Structure at 100 Level: Biochemistry

Course Code	Course Title	Units	Status	LH	PH
BIO 101	General Biology I	3	R	45	-
BIO 102	General Biology II	3	R	45	-
BIO 107	General Biology Practical I	1	R	-	45
BIO 108	General Biology Practical II	1	R	-	45
CHM 101	General Chemistry I	3	R	45	-
CHM 102	General Chemistry II	3	R	45	-
CHM 107	General Chemistry Practical I	1	R	-	45
CHM 108	General Chemistry Practical II	1	R	-	45
CSC 101	Introduction to Computer Science	3	R	30	45
GST 111	Communication in English I	2	C	30	-
GST 112	Logic, Philosophy & Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study skills and ICT	2	R	30	-
MTH 101	Elementary Mathematics I	3	R	45	-

PLEASE NOTE: Conclusive statement shall be made on the minimum CGPA of 1.5 for graduation after the forthcoming workshop on Grading System

MTH 102	Elementary Mathematics II	3	R	45	-
PHY 101	General Physics I	3	R	45	-
PHY 102	General Physics II	3	R	45	-
PHY 107	General Physics Practical I	1	R	-	45
PHY 108	General Physics Practical II	1	R	-	45
	Total	**41**			

LH = Lecture Contact Hours; PH = Practical Contact Hours.

Electives to be determined by each University.

Course Structure at 200 Level: Biochemistry

Course Code	Course Title	Units	Status	LH	PH
BCH 201	General Biochemistry I	3	C	45	-
BCH 202	General Biochemistry II	3	C	45	-
BCH 203	General Biochemistry Practical I	1	C	-	45
BCH 299	Industrial Attachment I (12 Weeks)	3	C		
BIO 201	Genetics I	2	R	30	-
BIO 204	Biological Techniques	2	R	15	45
CHM 210	Physical Chemistry I	3	C	30	45
CHM 211	Organic Chemistry I	3	C	30	45
CHM 212	Inorganic Chemistry I	3	R	30	45
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MCB 221	General Microbiology	3	R	30	45
STA 201	Statistics for Agriculture & Biological Sciences	4	R	60	-
	Total	**38**			

Electives to be determined by each University

Course Structure at 300 Level: Biochemistry

Course Code	Course Title	Units	Status	LH	PH
BCH 301	Introductory Enzymology	3	C	45	-
BCH 302	Chemistry and Metabolism of Carbohydrates	2	R	30	-
BCH 303	Chemistry and Metabolism of Lipids	2	R	30	-
BCH 304	Chemistry & Metabolism of amino acids & Proteins	2	C	30	-
BCH 305	Chemistry & Metabolism of Nucleic Acids	2	C	30	-
BCH 306	Analytical Methods in Biochemistry	3	C	30	45
BCH 307	Membrane Biochemistry	1	R	15	-
BCH 308	Food & Nutritional Biochemistry	2	R	30	-
BCH 310	Bioenergetics	1	R	15	-
BCH 311	General Biochemistry Practical II	2	C	-	90
BCH 312	Principles of Endocrinology	2	R	30	-
BCH 313	Principles of Immunology	2	R	30	-
BCH 314	Toxicology I	2	R	30	-
BCH 399	Industrial Attachment II (12 weeks)	3	C		
CHM 301	Physical Chemistry II	3	R	30	45
CHM 303	Organic Chemistry II	3	R	30	45
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
	Total	**39**			

Course Structure at 400 Level: Biochemistry

Course Code	Course Title	Units	Status	LH	PH
BCH 401	Enzymology	2	C	30	-
BCH 402	Biosynthesis of Macromolecules	1	R	15	-
BCH 403	Tissue Biochemistry	1	E	15	-
BCH 404	Bioinorganic Chemistry	1	E	15	-
BCH 405	Molecular Biology	3	C	45	-
BCH 406	Metabolic Regulations	2	R	30	-
BCH 407	Plant Biochemistry	2	E	30	-
BCH 408	Biochemical Reasoning	1	R	15	-
BCH 409	Special Topics/Seminar in Biochemistry	2	R	30	-
BCH 410	Advanced Biochemical Methods	2	R	-	90
BCH 411	Research Project	6	C	-	270
BCH 412	Industrial Biochemistry	3	R	45	-
BCH 413	Pharmacological Biochemistry	2	R	30	-
BCH 414	Endocrinology	2	R	30	-

BCH 415	Forensic Biochemistry	3	R	45	-
BCH 416	Molecular Aspects of Immunology	2	R	30	-
BCH 417	Toxicology II	2	R	30	-
	Total	**37**			

3.1.7 **Course Synopses**

BCH 201: General Biochemistry I **(3 Units: LH 45)**
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. Introductory chemistry 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. Biological functions of proteins. 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 **(3 Units: LH 45)**
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. Enzymes. Water and bio-molecules: protein, carbohydrates, lipids etc.

BCH 203: General Biochemistry Practical I **(1 Unit: PH 45)**
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.

BCH 299: Industrial Attachment I **(3 Units)**
Students should be attached to some industrial organizations for 12 Weeks at the 200 Level preferably during the long vacation for real-time relevant industrial experience. Students to be assessed based on seminar presentation, their reports and assessment by supervisors.

BCH 301: Enzymology **(3 Units: LH 45)**
Discovery, classification and nomenclature of enzymes. Vitamins and co-enzymes; minerals in enzyme biochemistry. Fat and water soluble vitamins. Structures and functions of vitamins and co-enzymes. Genetics of enzymes. Enzyme inhibition. Mechanisms of enzyme-catalysed reactions. Effects of temperature, pH, ions and inhibitors on enzyme catalysed reactions. 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 etc. Production, isolation, purification and characterization of enzymes. Recent advances in enzymology.

BCH 302: Chemistry and Metabolism of Carbohydrates **(2 Units: LH 30)**

Chemistry and function, isolation and purification of polysaccharides. Molecular weight determination and analytical methods for structural determination of polysaccharides. Biochemistry of important 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 glyconeogenesis. Regulation of carbohydrate metabolism. Disorders of carbohydrate metabolism.

BCH 303: Chemistry and Metabolism of Lipids (2 Units: LH 30)
Classification of lipids - fatty acids, triglycerides, glycosylglycerols, phospholipids, waxes, prostaglandins. Lipid micelles, monolayers, bilayers. Lipoprotein systems, transport protein of blood plasma. Oxidation of fatty acids. Microsomal peroxidation of polyunsaturated fatty acids. Metabolism of unsaturated fatty acids; essential and non-essential. Metabolism of acylglycerols. Degradation and turnover of phospholipids. Cholesterol biosynthesis and breakdown. Formation of ketone bodies. Integration of lipid metabolism. Acetic acid as a central precursor for biosynthesis of lipids.

BCH 304: Chemistry and Metabolism of Amino Acids & Proteins (2 Units: LH 30)
Amino acids as building blocks of proteins; 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. 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. Biosynthesis of amino acids and some derivatives; the urea cycle; metabolism of inorganic nitrogen. Disorders of amino acid metabolism.

BCH 305: Chemistry and Metabolism of Nucleic Acids (2 Units: LH 30)
Structure and function of nucleic acids. DNA replication and protein synthesis. DNA repairs. The genetic code and protein synthesis. Metabolism of purines and pyrimidines, nucleosides and nucleotides. Degradation of purine and pyrimidine nucleotides. Abnormalities in nucleic acid metabolism-xeroderma pigmentation and skin cancer.

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

BCH 307: Membrane Biochemistry (1 Unit: LH 15)

Structure, composition and functions of biological membranes. Isolation, characterization and classification of membranes; chemistry and biosynthesis of membranes. Molecular organization of membrane components. Natural and artificial membrane bilayers - the unit membrane hypothesis. Membrane transport system - active versus passive transport systems. Transport of sugars and amino acids.

BCH 308: Food and Nutrition Biochemistry (2 Units: LH 30)
An introduction to the theory and application of physical and chemical methods for determining the constituents of food. Food processing, preservation and storage of traditional foods – root and stem tubers, fruits and fruit drinks, seeds and grains, greens and vegetables. Food poisoning and intoxication; prevention and cure. Food nutrients; Energy values of foods and energy expenditure by mammalians. Nutritive value of foods - carbohydrates, fats, proteins, vitamins, mineral elements and water. Nutritional disorders, prevention and therapy. Nutritional status and nutritional requirements. Recommended dietary allowances. Assessment of nutritional status. Nutrient requirements in relation to physical activity and ageing, diet and disease, obesity and under nutrition.

BCH 310: Bioenergetics (1 Unit: LH 15)
High-energy compounds; Chemical potentials, Electrochemical potentials, Electron transport system and oxidative phosphorylation; Regulation of ATP production. Chemical thermodynamics; Oxidations and reductions.

BCH 311: General Biochemistry Practical II (2 Units: PH 90)
Laboratory methods and procedures employed in studying biochemical processes cutting across a wide spectrum of general biochemistry.

BCH 312: Principles of Endocrinology (2 Units: LH 30)
Organization of the mammalian endocrine system. Chemistry and functions of hormones, mechanism of hormone action. Storage and secretion of hormones. Steroid hormones, thyroid hormones, parathyroid hormones. Role of intercellular receptors, hormone responsive elements, enhancer elements, fusion genes, Peptide hormones. Role of cyclic AMP as a second messenger. Adesylate cyclase system, protein kinase C, phosphoproteins, phosphodiesterase, phosphatases, guanylate cyclase, G. proteins. Hormones acting through calcium and phosphoinositides, calmodulin-calcium system as a mediator of hormones. Structure and synthesis of insulin. Prostaglandins.

BCH 313: Principles of Immunology (2 Units: LH 30)
Blood chemistry and composition. Preparation of serum and plasma. Protein components of plasma. Innate and acquired immunity. Antigens, antibodies, cellular immunity. Antigen-antibody interactions. Immunological tolerance and suppression. Immunological anomalies, diagnostic immunology, vaccines. Structure of immunoglobulins. Combining sites of antibodies. Myeloma and hybridoma immunoglobulins. The antigen binding site. Domains of antibody molecules-gene duplication and diversification. Generation of diverse antibody specificities, clonal selection theory of antibody formation. Biological significance of clonal selection.

BCH 314: Toxicology I **(2 Units: LH 30)**
Basic principles of toxicology, definition and scope; absorption and distribution of toxicants; toxicokinetics, metabolism of toxicants; comparative toxicology; elimination of toxicants and their metabolites, toxicant-receptor interactions, genetic poisons, chemical carcinogenesis; trace element toxicity, hepatotoxicity.

BCH 399: Industrial Attachment II **(3 Units)**
Students should be attached to some industrial organizations for additional 12 Weeks at the 300 Level preferably during the long vacation. Assessment to be based on seminar presentation, report and assessment by supervisor.

BCH 401: Enzymology **(2 Units: LH 30)**
Chemistry of enzyme catalysis. Steady state enzyme kinetics. Transport 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: Biosynthesis of Macromolecules **(1 Unit: LH 15)**
Structures and functions of macromolecules. Biosynthesis and storage of polysaccharides, mucopolysaccharides, glycoproteins. Bacterial cell wall synthesis of complex lipids, lipoproteins and nucleic acids.

BCH 403: Tissue Biochemistry **(1 Unit: LH 15)**
Biochemistry of muscles, kidney, liver, and adipose tissues. General metabolism of the brain and neuronal biochemistry. Biochemistry of reproductive tissues. Detoxification and excretion in tissues.

BCH 404: Bioinorganic Chemistry **(1 Unit: LH 15)**
Relationship between the physicochemical properties and biological functions of inorganic ions. Ligand complexes and their biochemical significance. Electrolyte metabolism. Nitrogen fixation and sulphur cycle.

BCH 405: Molecular Biology **(3 Units: LH 45)**
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. Control of cell proliferation. Genetic engineering and recombinant gene technology.

BCH 406: Metabolic Regulations **(2 Units: LH 30)**
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-feed back inhibition versus enzyme synthesis. Catabolite repression, end product repression. Identification of different regulatory mechanisms in metabolic pathways.

BCH 407: Plant Biochemistry **(2 Units: LH 30)**
Organization of plant cells. The biochemistry of important plant processes and metabolic pathways. Photosynthesis; alkaloids, flavonoids and plant hormones. Biosynthesis of carotenoid pigments. Biochemistry of plant development. The plant cell wall structure, formation and growth. Lignin formation. Free amino acids, pyrimidines, purines and nucleosides in plants. Metabolism of auxins, gibberellins and cytokinins. Synthetic growth regulators and herbicides. Structure - activity relationship of plant hormones.

BCH 408: Biochemical Reasoning **(1 Unit: LH 15)**
Evaluation and design of experimental biochemistry from available information and data. Analysis, interpretation and inference - drawing from biochemical research data.

BCH 409: Special Topics/Seminar in Biochemistry **(2 Units: LH 30)**
Hormones, immunochemistry, oncology, brain biochemistry, monoclonal antibodies. These may be taught or seminars may be given by students.

BCH 410: Advanced Biochemical Methods (Practical) **(2 Units: PH 90)**
The purpose of this course is to familiarise students with operations of latest biochemical equipment and with methods of research, assimilation and dissemination of information. Students will therefore go round lecturers and laboratories housing specialized equipment with the aim of exposing them to such equipment under the supervision of lecturers. Part of the course will also cover the effective use of the library, preparation of dissertations or theses, papers for journal publications and journal reviews. Special assignments and essays will be given to students.

BCH 411: Research Projects **(6 Units: PH 270)**
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 412: Industrial Biochemistry **(3 Units: LH 45)**
A short review of microbial physiology and genetics. A review of general metabolic pathways and application in industrial processes. Continuous culture methods, principles and applications. The chemostat and its application in industrial fermentations. Primary and secondary metabolism. Process evaluation and development. Over production of metabolites - amino acids, taste enhancers, vitamins, toxin etc. Methods for screening and selecting micro-organisms of industrial importance. Induction of mutation in micro-organism and plants for the purpose of over production; Strain selection/development and enhancement. Gene dosage and its application in industrial processes.

BCH 413: Pharmacological Biochemistry **(2 Units: LH 30)**

Cellular metabolism in infected cells. Biochemical aspects of host-parasite relationships. Metabolic factors affecting chemotherapeutic agents. Theories of the mechanism of drug action. Drug resistances and other factors affecting drug efficacy. The physiological and biochemical action of some selected drugs. Nigerian traditional medicinal plants in the management and therapy of common ailments in Nigeria - malaria, sickle cell anaemia, common cold, hepatitis etc.

BCH 414: Endocrinology (2 Units: LH 30)
Hormones: Biochemistry and molecular mechanism of action, cyclic AMP. Hormone receptors: isolation and properties. Diabetes mellitus and hypoglycemia. Biochemistry and functions of insulin and other hormones controlling carbohydrate metabolism. The thyroid hormones: biochemistry and functions. The steroid hormones; mineralocorticoids and glucocorticoids.

BCH 415: Forensic Biochemistry (3 Units: LH 45)
Procedure for the extraction of contaminants of forensic interest from tissues. Collection and preservation techniques for materials of forensic interest. Analytical procedures in forensic science. Law, science and medicine in forensic practices.

BCH 416: Molecular Aspects of Immunology (2 Units: LH 30)
Immune type and manifestation. Basis of immune response. Autoimmunity; cancer and immune response. Immunoanalytical techniques. The immunosuppressive drugs/agents.

BCH 417: Toxicology II (2 Units: LH 30)
Biological effects of toxic substances in living organisms. Metabolism, cellular and tissue targets, mechanisms of action, and pathological effects. Resistance and tolerance of toxicants, natural toxicants, chronic testing in animals; tests for mutagenicity in toxicological evaluation of chemicals; isolation and structural elucidation of toxicants; enzymatic detoxification.

3.2 BIOLOGY (BSc)

3.2.1 Philosophy, Aims and Objectives of the Degree Programme

The main aims and objectives of the degree programme in biology should be:

a. To provide students with a broad and balanced foundation of biological knowledge and practical skills.

b. To develop in students the ability to apply knowledge and skills to solving theoretical and practical problems in biology.

c. To develop in students, a range of transferable skills that are of value in biological as well as non-biological employment.

d. To provide students with knowledge and skills base from which they can proceed to further studies in specialized areas of biological sciences or multi-disciplinary areas involving biology.

e. To provide, through training and orientation, an appreciation of the rewards of inter- and multi-disciplinary approach to the solution of complex life problems.

f. To generate in students an appreciation of the importance of biology in industrial, economic, environmental, technological and social development.

g. To 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 and studying.

3.2.2 Admission and Graduation Requirements

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 School Certificate or its equivalent. In addition, an acceptable pass in the Unified Tertiary Matriculation Examination (UTME) in relevant subject combination is required for admission into 100 Level. Expected duration for UTME candidates shall be 4 years.

Expected duration for Direct Entry (DE) candidates with at least two A level passes at the GCE/IJMB Advanced Level in relevant science subjects shall be 3 years.

Students are required to complete a minimum of 120 units for graduation, 60 of which must come from Biological sciences.

3.2.3 Learning Outcomes

Biology graduates are expected to develop a wide range of different skills and abilities. These are divided into three broad categories:

a. Regime of Subject Knowledge

Graduates of biological sciences are expected to develop high cognitive abilities and skills related to biological sciences.

PLEASE NOTE: Conclusive statement shall be made on the minimum CGPA of 1.5 for graduation after the forthcoming workshop on Grading System

b. *Competencies and Skills*
Biological sciences graduates are also expected to exhibit high practical skills in biological sciences.

c. *Behavioural Attitudes*
Graduates of biological sciences are expected to be able to transfer this skill to non biological sciences specific competencies.

3.2.4 Attainment Levels

Graduates of biological sciences are expected to have the ability to apply their knowledge and skills to solving theoretical and practical problems in biological sciences in relation to national and societal problems.

3.2.5 Resource Requirements for Teaching and Learning

a) Academic and Non-Academic staff. (See section 1.6)
b) Academic and Non-Academic Spaces (See section 1.6)
c) Academic and Administrative Equipment (See section 4)
d) Library and Information Resources (See section 1.6)

3.2.6 Course Structure

Course Structure at 100 Level: Biology.

Course Code	Course Title	Units	Status	LH	PH
BIO 101	General Biology I	3	C	45	-
BIO 102	General Biology II	3	C	45	-
BIO 107	General Biology Practical I	1	C	-	45
BIO 108	General Biology Practical II	1	C	-	45
CHM 101	General Chemistry I	3	R	45	-
CHM 102	General Chemistry II	3	R	45	-
CHM 107	General Chemistry Practical I	1	R	-	45
CHM 108	General Chemistry Practical II	1	R	-	45
CSC 101	Introduction to Computer Science	3	R	30	45
GST 111	Communication in English I	2	C	30	-
GST 112	Logic, Philosophy & Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills & ICT	2	R	30	-
MTH 101	Elementary Mathematics I	3	R	45	-
PHY 101	General Physics I	3	R	45	-
PHY 102	General Physics II	3	R	45	-
PHY 107	General Physics Practical I	1	R	-	45
PHY 108	General Physics Practical II	1	R	-	45
STA 111	Descriptive Statistics	4	R	60	-
	Total	**42**			

Course Structure at 200 Level: Biology

Course Code	Course Title	Units	Status	LH	PH
BIO 201	Genetics I	2	C	30	-
BIO 202	Introductory Ecology	2	C	15	45
BIO 203	General Physiology I	2	C	30	-
BIO 204	Biological Techniques	2	C	15	45
BIO 205	Introductory Developmental/Cell Biology	3	R	30	45
BIO 299	Industrial Attachment I (12 weeks)	3	C	-	-
BOT 202	Seedless Plants	2	R	30	-
BOT 203	Seed Plants	2	E	30	-
CHM 211	Organic Chemistry I	3	R	30	45
CHM 213	Analytical Chemistry I	3	E	30	45
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MCB 221	General Microbiology	3	E	30	45
STA 201	Statistics for Agriculture & Biological Sciences	4	R	60	-
ZOO 211	Invertebrate Zoology	3	R	30	45
ZOO 212	Chordate Zoology	3	E	30	45
	Total	**45**			

Course Structure at 300 Level: Biology

Course Code	Course Title	Units	Status	LH	PH
BCH 201	General Biochemistry I	3	R	45	-
BCH 202	General Biochemistry II	3	R	45	-
BIO 301	Genetics II	3	C	30	45
BIO 302	Field Course I	1	R	-	45
BIO 303	General Cytology	3	R	30	45
BIO 304	General Ecology	3	R	30	45
BIO 305	Molecular Biology	3	R	45	-
BIO 306	General Physiology II	3	R	30	45
BIO 308	Evolution	2	E	30	-
BIO 309	Introductory Nematology	2	E	30	-
BIO 399	Industrial Attachment II (12 weeks)	3	C	-	-
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
MCB 307	Immunology	3	E	30	45
MCB 309	Food Microbiology	2	E	15	45
MCB 324	Microbial Ecology	3	E	30	45
MCB 326	Introductory Virology	3	E	30	45
	Total	**46**			

Course Structure at 400 Level: Biology

Course Code	Course Title	Units	Status	LH	PH
BIO 401	Population Genetics	3	C	45	-
BIO 402	Cytogenetics of Plants	3	C	30	45
BIO 403	Soil Ecology	3	C	45	-
BIO 404	Systematic Biology	3	C	45	-
BIO 405	Developmental Biology	3	C	30	45
BIO 406	Marine Biology	3	E	30	45
BIO 407	Hydrobiology	3	E	30	45
BIO 413	Field Course II	3	R	-	-
BIO 414	Human Genetics and Genomics	3	R	45	-
BIO 415	Project	6	C	-	-
MCB 404	Advanced Food Microbiology	3	E	30	45
MCB 423	Industrial Microbiology	3	E	30	45
MCB 425	Environmental Microbiology	3	E	30	45
MCB 482	Virology and Tissue Culture	3	E	30	45
ZOO 412	Principles of Parasitology	4	E	45	45
	Total	**49**			

3.2.7 Course Synopses

BIO 101: General Biology I **(3 Units: LH 45)**
Origin of life and influence of living things on the chemistry of the Earth. Essentials of life, including sources and use of energy, responsiveness to natural selection and cellularity. Cell structure and organization, functions of cellular organelles, diversity, characteristics and classification of living things, general reproduction, interrelationship of organisms; heredity and evolution, elements of ecology and types of habitat.

BIO 102: General Biology II **(3 Units: LH 45)**
A generalized survey of the plant and animal kingdoms based mainly on the study of similarities and differences in the external features, ecological adaptation of these forms.

BIO 107: General Biology Practical I **(1 Unit; PH 45)**
Laboratory experiments designed to illustrate the topics covered in BIO 101

BIO 108: General Biology Practical II **(1 Unit; PH 45)**
Experiments designed to emphasise the practical aspects of topics of course BIO 102

B10 201: Genetics I **(2 Units: LH 30)**
Hereditable and non-hereditable characteristics. Probability and tests of goodness of fit. Quantitative inheritance, variation in genome structure, introduction to population genetics.

BIO 2O2: 1ntroductory Ecology **(2 Units: LH 15; PH 45)**
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.
Practicals: to include among others community and population studies of each species in a habitat.

BIO 203: General Physiology I **(2 Units: LH 30)**
Physical and chemical processes in basic plants and animal physiology. Basic elements of respiration, photosynthesis, transportation or circulation. Reproduction, germination, growth hormones and enzymology

BIO 204: Biological Techniques **(2 Units: LH 15; PH 45)**
Preparation of microscope slides, biological drawings, microtomy, colorimetry, photometry, cytological techniques, chromatography, collection and preservation of biological specimens. Herbarium techniques. Laboratory experiments designed to cover practical aspects of topics on genetics and cell biology should be included.

BIO 205: Introductory Developmental Cell Biology **(3 Units: LH 30; PH 45)**
History and present trends in cell biology. Reproduction, cell division, cell differentiation and growth of cells. A brief study of the molecular basis of cell structure and development. Organelles. Proteins and nucleic acids. The genetic code and its relationship to cellular function.

BIO 299: Industrial Attachment I **(3 Units)**
Students should be attached to some industrial organizations for 12 Weeks at the 200 Level preferably during the long vacation. Assessment to be based on seminar presentation, report and assessment by supervisor.

BIO 301: Genetics II **(3 Units: LH 30; PH 45)**
Aspects of human genetics; pedigree analysis. Further consideration of various deviations from basic principles. Gene interaction. Pre- requisite -BIO 201.

BIO 302: Field Course I **(1 Unit; PH 45)**
Sampling techniques in local habitats. Assessment by report. This could be in any area of specialization not necessarily ecology.

BIO 303: General Cytology **(3 Units: LH 30; PH 45)**
Light, Phase contrast, dark-field and electron microscopy, auto-radiography, florescence; cell cycle; introductory cytogenetics.

BIO 304: General Ecology **(3 Units: LH 30; PH 45)**
The ecosystem approach to the study of ecology. Energy flow and nutrients cycling. Dynamics of populations and communities in ecosystem; influence of man.
Pre-requisite -BIO 202.

BIO 305: Molecular Biology I **(3 Units: LH 45)**
Structure, expression and regulation of eukaryotic genes. Chromosome structure and replication ; gene structure, transcription and RNA processing; protein synthesis and translational control, development, immune system and oncogenesis. Genetic engineering and gene technology
Pre-requisite -BIO 205.

BIO 306: General Physiology II **(3 Units: LH 30; PH 45)**
A general study of osmoregulation, excretion, transport, homeostasis and their co-ordination in animals. Plant water relation, growth and growth regulation. Physiological aspect of crop yield. Prerequisite -BIO 203.

BIO 308: Evolution **(2 Units: LH 30)**
Current concepts in evolution. Geological periods and epochs. Genetic variation and speciation. Evolution of selected organisms.

BIO 309: Introductory Nematology **(2 Units: LH 30)**
Principal characteristics of nematodes, morphology, position and outlines of classification of nematodes. Morphology and biology of important plant parasitic nematodes and their economic importance. Nematological techniques. General principles and methods of controlling nematodes.

BIO 399: Industrial Field Experience/Attachment for 12 Weeks **(3 Units)**
Industrial field experience in any one of the following:
a) Aquatic Pollution (3 Units)
b) Pest Control (3 Units)
c) Public Health (3 Units)

BIO 401: Population Genetics **(3 Units: LH 45)**
An introductory consideration of mathematical models for the analysis of gene frequencies and genetic variation in populations.

BIO 402: Cytogenetics of Plants **(3 Units: LH 30; PH 45)**
Aspects of cell and nuclear divisions. Morphology and behaviour of chromosomes. aberrations and polypidy.
Pre-requisite -BIO 205

BIO 403: Soil Ecology **(3 Units: LH 45)**
Physical and chemical nature of soil. Detritus organisms. Cycling of minerals and nutrient pools.

BIO 404: Systematic Biology **(3 Units: LH 45)**
A bio-systematic approach to the classification of organisms and nomenclature.

BIO 405: Developmental Biology **(3 Units: LH 30; PH 45)**
Molecular and genetic aspects of development. A detailed study of the cellular and multicellular bases of development.

BIO 406: Marine Biology **(3 Units: LH 30; PH 45)**
A study of the biology of marine fauna and flora. Economic importance of the marine organisms.

BIO 407: Hydrobiology **(3 Units: LH 30; PH 45)**
Types of aquatic habitat; ecological adaptations to aquatic life.

BIO 413: Field Course II **(3 Units)**
This is designed to give students an opportunity to carry out a small independent research project dealing with biological material, under the supervision of one or more members of the academic staff.

BIO 414: Human Genetics and Genomics **(3 Units: LH 45)**
Human molecular genetic variation, molecular basis of metabolic disorders, chromosome aberrations and consequences. Fundamentals of genomics, including structural genomics, functional genomics and proteomics. Analysis of the human genome.

BIO 415: Project **(6 Units: PH 270)**
A short research project involving an investigation on a selected biological problem. The project is to be written up in the form of a scientific report.

3.3 BIOTECHNOLOGY (BSc)

3.3.1 Philosophy, Aims and Objectives

The programme has been designed to provide a sound understanding of the concepts and methodologies of modern molecular biotechnology in key areas that meet the needs of society. The main objectives of the programme are to broadly educate students for positions in the modern biotechnology industry and to prepare them for graduate and professional studies in the life sciences at the molecular level.

3.3.2 Admission and Graduation Requirements

The entry requirements shall be at least credit level passes in five subjects including English Language, Mathematics and Biology to form the core subjects with credit in two other relevant science subjects; Chemistry, Physics, Agricultural Science and Geography at the Senior Secondary School Certificate or its equivalent. In addition, an acceptable pass in the Unified Tertiary Matriculation Examination (UTME) is required for admission into 100-level.

Candidates with two A level passes at the GCE/IJMB Advanced Level in relevant subjects (Biology, Botany, Chemistry, Geography, Mathematics and Physics) may be admitted into 200-level.

3.3.3 Learning Outcomes

All students in the biotechnology programme are expected to develop the following abilities and skills:

a. *Regime of Subject Knowledge*
Cognitive abilities and skills relating to solution of problems in modern biotechnology

b. *Competencies and Skills*
Practical skills relating to the conduct of laboratory and field work in modern biotechnology

c. *Behavioural Attitudes*
General skills relating to non-subject specific competencies, communication, interpersonal, organization skills and ethical standards.

3.3.4 Attainment Level

Graduates of modern biotechnology are expected to have the ability to apply knowledge and skills to solving theoretical and practical problems in modern biotechnology in relation to national and societal problems.

3.3.5 Resource Requirement for Teaching and Learning

a. Academic and non-academic staff. (See section 1.6)
b. Academic and Non-Academic Spaces (See section 1.6)
c. Academic and Administrative Equipment (See section 4)
d. Library and Information Resources (See section 1.6)

3.3.6 Course Structure

Course Structure at 100 Level: Biotechnology

Course Code	Course Title	Units	Status	LH	PH
BIO 101	General Biology I	3	C	45	-
BIO 102	General Biology II	3	C	45	-
BIO 107	General Biology Practical I	1	C	-	45
BIO 108	General Biology Practical II	1	C	-	45
CHM 101	General Chemistry I	3	R	45	-
CHM 102	General Chemistry II	3	R	45	-
CHM 107	General Chemistry Practical I	1	R	-	45
CHM 108	General Chemistry Practical II	1	R	-	45
CSC 101	Introduction to Computer Science	3	R	30	45
GST 111	Communication in English I	2	C	30	-
GST 112	Logic, Philosophy & Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills & ICT	2	C	30	-
MTH 101	Elementary Mathematics I	3	R	45	-
MTH 102	Elementary Mathematics II	3	R	45	-
PHY 101	General Physics I	3	R	45	-
PHY 102	General Physics II	3	R	45	-
PHY 107	General Physics Practical I	1	R	-	45
PHY 108	General Physics Practical II	1	R	-	45
	Total	**41**			

Course Structure at 200 Level Courses: Biotechnology

Course Code	Course Title	Units	Status	LH	PH
BCH 201	General Biochemistry I	3	R	45	-
BIO 201	Genetics I	2	C	30	-
BIO 204	Biological Techniques	2	C	15	45
BTG 202	Introduction to Biotechnology	3	C	45	-
BTG 203	Principles of Plant Biotechnology	3	R	30	45
BTG 299	Industrial Attachment I (12 weeks)	3	C	-	-
CHM 211	Organic Chemistry I	3	R	30	45
CHM 213	Analytical Chemistry I	3	R	30	45
GST 122	Communication in English II	2	C	30	-

GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MCB 221	General Microbiology	3	R	30	45
MTH 103	Elementary Mathematics III	3	R	45	-
STA 201	Statistics for Agriculture & Biological Sciences	4	R	60	-
	Total	**40**			

Course Structure of Core Courses at 300 Level: Biotechnology (All Options)

Course Code	Course Title	Units	Status	LH	PH
BCH 202	General Biochemistry II	3	R	45	-
BCH 311	General Biochemistry Practical	2	R	-	90
BTG 301	Molecular Genetics	3	C	45	-
BTG 302	Molecular Genetics Laboratory	2	C	-	90
BTG 304	Molecular Cell Biology	3	C	45	-
BTG 399	Industrial Attachment II (12 Weeks)	3	C	-	-
GST 222	Peace Studies & Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
	Total	**22**			

Course Structure at 400 Level: Biotechnology (All Options)

Course Code	Course Title	Units	Status	LH	PH
BTG 401	Biotechnology Seminar	1	C		
BTG 403	Methods in recombinant DNA Technology	4	C	45	45
BTG 404	Industrial Biotechnology	3	C	45	-
BTG 405	Nucleotide sequence analysis	3	C	45	-
BTG 406	Metabolic Engineering	3	C	45	-
BTG 407	Research Project in Biotechnology	6	C	-	270
BTG 416	Bioresources Management	3	R	45	-
BTG 418	Biosafety issues	1	R	15	-
BTG 420	Intellectual Property Rights & Bioethics	1	R	15	-
	Total	**25**			

Please see List of Additional Required and Elective Courses for each Biotechnology option at 300 and 400 Levels below. At least 1 of the courses in the Required Courses listed below for each Biotechnology option is expected to be offered each semester, starting from the 2^{nd} semester of the third year.

Course Structure of Required and Electives Courses at 300 and 400 Levels for General Biotechnology Option

Course Code	Course Title	Units	Status	LH	PH
BCH 301	Enzymology	3	R	45	-
BCH 306	Analytical Methods in Biochemistry	3	R	30	45
BTG 308	Animal Microtechniques & Tissue Culture	3	R	30	45
BTG 411	Process Biotechnology	3	R	45	-
BTG 412	Biotechnology Robotics	3	R	30	45
BTG 415	Analytical Methods in Microbiology	3	R	15	90
BTG 423	Plant Gene Transfer	3	R	30	45
MCB 307	Immunology	3	R	30	45
	Total	**24**			

Three or four additional required courses are expected to be taken from the courses in the table above while three elective courses can be chosen from the lists of required and elective courses for the other four biotechnology options.

Course Structure of Required and Elective Courses at 300 and 400 Levels for Animal Biotechnology Option

Course Code	Course Title	Units	Status	LH	PH
BCH 301	Enzymology	3	E	45	-
BCH 306	Analytical Methods in Biochemistry	3	E	30	45
BTG 307	General Nutrition	2	R	30	-
BTG 308	Animal Micro-techniques and Tissue Culture	3	R	30	45
BTG 408	Biotechnology of Animal Reproduction	3	E	45	-
BTG 410	Comparative Virology	3	E	45	-
BTG 411	Process Biotechnology	3	E	45	-
BTG 412	Biotechnology Robotics	3	E	30	45
BTG 415	Analytical Methods in Microbiology	3	R	15	90
BTG 422	Biology of Cancer	3	E	45	-
MCB 307	Immunology	3	R	30	45
	Total	**32**			

About 10 units of required courses (at least 1 course per semester starting from first semester of 3rd year and about 9 units of elective courses are expected to be taken by each student from the courses listed in Table in 3.3.6 above.

Course Structure of Required and Elective Courses at 300 and 400 Levels for Microbial Biotechnology Option

Course Code	Course Title	Units	Status	LH	PH
BCH 301	Enzymology	3	E	45	-
BCH 306	Analytical Methods in Biochemistry	3	E	30	45
BCH 308	Food and Nutrition in Biochemistry	2	E	30	-
BTG 305	Microbial Technology	3	R	45	-
BTG 306	Applied Microbiology	3	R	45	-
BTG 308	Animal Micro-techniques and Tissue Culture	3	E	30	45
BTG 410	Comparative Virology	3	E	45	-
BTG 411	Process Biotechnology	3	E	45	-
BTG 412	Biotechnology Robotics	3	E	30	45
BTG 415	Analytical Methods in Microbiology	3	R	15	90
BTG 419	Marine Biotechnology	3	E	30	45
BTG 423	Plant Gene Transfer	3	E	30	45
MCB 231	Basic Techniques in Microbiology	2	R	-	90
MCB 307	Immunology	3	E	30	45
MCB 324	Microbial Ecology	3	E	30	45
MCB 407	Pathogenic Microbiology	3	E	30	45
MCB 424	Bacterial Physiology and Metabolism	3	E	30	45

Students are expected to register for the required courses as well as any 9 units from the elective courses in Table 3.3.7 above.

Required Courses and Electives at 300 and 400 Levels for Plant Biotechnology Option

Course Code	Course Title	Units	Status	LH	PH
BCH 301	Enzymology	3	E	45	-
BCH 306	Analytical Methods in Biochemistry	3	E	30	45
BCH 308	Food and Nutrition Biochemistry	2	E	30	-
BIO 202	Introductory Ecology	2	E	15	45
BOT 202	Seedless Plants	2	R	30	-
BOT 203	Seed Plants	2	R	30	-
BOT 301	Plant Taxonomy	3	R	30	45
BOT 303	Plant Physiology	3	E	45	-
BOT 306	Plant Breeding	3	E	15	90
BOT 311	Medicinal Plants	3	E	15	90
BOT 406	Plant Pathology	3	E	45	-
BOT 408	Plant Tissue Culture	3	R	15	90
BTG 410	Comparative Virology	3	E	45	-
BTG 411	Process Biotechnology	3	E	45	-
BTG 412	Biotechnology Robotics	3	E	30	45
BTG 417	Plant Molecular Biology	3	E	30	45

BTG 423	Plant Gene Transfer	3	R	30	45
MCB 324	Microbial Ecology	3	E	30	45

Students are expected to register for the required courses and any 9 units of the elective courses out of the courses listed in Table 3.3.8 above.

Course Structure of Required and Elective Courses at 300 and 400 Levels for Bioinformatics Option

Course Code	Course Title	Units	Status	LH	PH
CSC 204	Fundamentals of Data Structures	3	R	30	45
STA 112	Probability I	4	R	60	-
STA 211	Probability II	4	E	45	-
	One of the following:				
CSC 482	Introduction to Molecular Modelling	3	E	30	45
BTG 411	Process Biotechnology	3	E	45	-
	At least one of the following:				
CSC 201	Computer Programming I	3	E	30	45
CSC 208	Discrete Structures	3	E	45	-
CSC 304	Data Management I	3	E	45	-
CSC 314	Architecture and Organisation I	3	E	45	-
CSC 404	Data Management II	3	E	30	45

Students are expected to register for at least 11 units of the courses indicated in Table 3.3.9 above.

3.3.7 Course Synopses:

BTG 202: **Introduction To Biotechnology** **(3 Units: LH 45)**
Historical developments. Principles and applications of biotechnology. Implications of molecular biology, including ethical and social controversies. Topics to be covered should include introductory aspects of microbial biotechnology, agricultural biotechnology, biofuels, cloning, bioremediation, medical biotechnology, DNA fingerprinting and forensics.

BTG 203: Principles of Plant Biotechnology **(3 Units: LH 30; PH 45)**
Principles and concepts of plant biotechnology including recombinant DNA technology, molecular biology, genomics, cell and tissue culture, gene transfer and crop improvement strategies using transgenic crops.

BTG 299: Industrial Attachment I (12 Weeks) **(3 Units)**
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.

BTG 301: **Molecular Genetics** **(3 Units: LH 30)**
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.

BTG 302: Molecular Genetics Practical **(2 Units: PH 90)**
Experiments designed to achieve the practical components of BTG 301 and enrich students' grasp of the theoretical foundation of the course.

BTG 304: Molecular Cell Biology **(3 Units: LH 45)**
Genetics at the molecular level as related to gene structure, function, variation and control with a comprehensive treatment of plant and animal cell structure and function. Basic concepts of cell physiology are treated.

BTG 305: **Microbial Technology** **(3 Units: LH 45)**
An integrated discussion of recent genetic biochemical and engineering approach
to microbial processing from antibiotics, biomass and citric acids to zymomonas and ethanol production.

BTG 306: Applied Microbiology **(3 Units: LH 45)**
Applications of micro-organisms in industry, agriculture, environment with emphasis on the physical and chemical factors of growth and control in relation to industrial and natural processes.

BTG 307: **General Nutrition** **(2 Units: LH 30)**
Basic principles of nutrition with special emphasis on nutrients; digestion and absorption and their problems. Control of appetite. Nutritive value of tropical foods and Nigerian diets. Selection and formulation of balanced diets. Foetus as a parasite. Non-conventional foods. Food enrichment and supplementation in general.

BTG 308: Animal Microtechniques and Tissue Culture **(3 Units: LH 30; PH 45)**
Microscopic structure of organism, introductory microtechniques.

BTG 399: Industrial Attachment II (12 Weeks) **(3 Units)**
Students should be attached to relevant industrial organizations for additional 12 Weeks preferably during the long vacation for appropriate experience. Students should be assessed based on seminar presentations, written reports and supervisors' assessments.

BTG 401: Biotechnology Seminar **(1 Unit)**
Development of communication skills needed by professionals in the field of biotechnology through student oral presentations.

BTG 403: Methods in Recombinant DNA Technology **(4 Units: LH 45; PH 45)**
Introduction to techniques and experimentation approaches used in DNA technology: Principles and techniques of polymerase chain reaction, Southern, Northern and Western Blot methods of protean and DNA identifications. Methods of gene transfer. Principles,

methodologies and applications of electrophoresis, chromatography, spectroscopy, spectrophotometry, centrifugation and isotopic techniques. Ultracentrifugation, dialysis, optical microscopy. Review of modern analytical methods.

BTG 404: Industrial Biotechnology (3 Units: LH 45)
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. Basic fermentation design and operations. Single cell proteins, bioinsecticides and biofertilizers. Development and prospects of enzyme technology. Biodegradation of industrial materials. Industrial production of organic acids, amino acids, antibiotics and vitamins.

BTG 405: Nucleotide Sequence Analysis (3 Units: LH 45)
Computer analysis of nucleotide sequences assembly; restriction analysis; gene location and identification; protein sequence analysis and structure prediction; database searching; sequence alignments; and phylogenetic analysis.

BTG 406: Metabolic Engineering (3 Units: LH 45)
Regulation of metabolism, induction, nutritional repression, feedback regulation, metabolic control mechanisms; regulatory mechanism of carbohydrates metabolism; regulation of protein and amino acid synthesis; Regulation of biosynthetic pathways in prokaryotes and eukaryotes, feedback resistance mutation.

BTG 407: Research Project in Biotechnology (6 Units: PH 270)
Independent research undertaken by students into selected areas of biotechnology under the guidance of project supervisors.

BTG 408: Biotechnology of Animal Reproduction (3 Units: LH 45)
The issue of food security, principle of animal breeding; marker assisted selection and breeding; artificial insemination, *in vitro* fertilization, multiple relation embryo techniques for farm animals; 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.

BTG 410: Comparative Virology (3 Units: LH 45)
Biology of viruses and approaches to control through the use of antiviral agents and genetic engineering. Genome organization, gene expression, replication, movement and transmission across kingdom.

BTG 411: Process Biotechnology (3 Units: LH 45)
Description of various types of vessels for cell cultivation. Bioreactor design and optimization. Agitation of bioreactors. Survey of the applications of biotechnology, emphasizing the pharmaceutical industry and the operation of fermentation systems. Case studies of down stream separation and purification protocols employed on an industrial scale.

BTG 412: Biotechnology Robotics **(3 Units: LH 30; PH 45)**
Application and use of robotic equipment in the analysis of large number of samples; assay and protocol design; data collating, analysis and interpretation, applications in various life science industries.

BTG 415: Analytical Methods in Microbiology **(3 Units: LH 15; PH 90)**
Hands-on training in the use of analytical instrumentation in microbiological research and applications including biotransformatics and fermentations, biodegradation and identification of bacteria and fungi.

BTG 416: Bioresources Management **(3 Units: LH 45)**
Biological diversity, genetic diversity, specific diversity; species of local cereals,; local legume species, local fruit tree species. Genetic diversity expressed through large number of associations or combinations of genes in individuals of single species. Wild local plants related to cultivated species and whose genetic diversity is crucial ingredient to co-breeding or hybridization processes aimed at giving more vigour to the crop varieties that have been cultivated over so many years. Loss of genetic variability of crops or genetic erosion; species disease resistance, utilization of plant and animal genetic resources, local germplasms. Conservation of plant and animal genetic resources, the effects of destruction of natural environment on local plant and animal genetic resources. The importance of conserving the biological heritage of plant and animal kingdoms. Development of seed and gene banks, modes of operation of gene banks, germplasm collections of local crop species, gene banks and breeding. Selection of resistant varieties, biotechnologically-based alternatives to live animal experiments; biotechnological protection of forest plantations and economic plants, germplasm appropriation and privatization for crop improvement. Patents and plant breeders' rights, production of improved plants and animals.

BTG 417: Plant Molecular Biology **(3 Units: LH 30; PH 45)**
Fundamental and applied aspects of plant molecular biology; structure, expression and isolation of plant nuclear genes; molecular biology of plant development, plant organelles and plant-microbe interactions and plant biotechnology.

BTG 418: Biosafety **(1 Unit: LH 15)**
Definition and scope. Hierarchy of regulatory organs. Overview of safety issues and application in various products and services. Environmental risks associated with gene manipulation. Biohazards, risk assessment and management.

BTG 419: **Marine Microbiology** **(3 Units: LH 30; PH 45)**
Examination of the roles of microbes in the oceans and their impact on oceanographic processes and biochemical cycles. Emphasis on bacteria and their interactions with other marine organisms and the marine environment. Laboratory exercises that should make use of modern techniques to study metabolic rates and community structure.

BTG 420: Intellectual Property and Bioethics **(1 Unit: LH 15)**

Definition and scope, ethical issues, sperm bank designer babies, organ donation. Property rights protection, patents, innovations and lineation and other legal instruments.

BTG 422: Biology of Cancer (3 Units: LH 45)
A consideration of chemical, viral and physical oncogenic agents; genetics and host factors; immunological response to neoplasia; chemotherapy.

BTG 423: Plant Gene Transfer (3 Units: LH 30; PH 45)
Principles and experimental techniques of non sexual gene transfer in plants. Application of gene-transfer techniques in crop improvement and research in gene expression.

3.4 BOTANY (BSc)

3.4.1 Philosophy, Aims and Objectives of the Degree Programme

The programme has been designed to provide a sound understanding of the concepts and methodologies of botany in key areas that meet the needs of society. The main objectives of the programme are to broadly educate students for positions in the conservation and bio-diversity sectors, employment in plant products based industries and institutions and to prepare them for graduate and professional studies in the plant sciences at the molecular level.

3.4.2 Admission and Graduation Requirements

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 School Certificate 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 two A level passes at the GCE/IJMB Advanced Level in relevant subjects (Biology, Botany, Chemistry, Mathematics and Physics) may be admitted into 200- Level. This is in addition to fulfilling the requirement of a minimum of credit level passes in five relevant subjects at SSCE or WASCE/GCE ‘O’ Level as indicated above.

3.4.3 Learning Outcomes

All Bachelors honours degree student in botany are expected to develop the following abilities and skills:

a. *Regime of Subject Knowledge*
Cognitive abilities and skills relating to solution of problems in botany

b. *Competencies and Skills*
Practical skills relating to the conduct of laboratory and field work in botany

c. *Behavioural Attitudes*
General skills relating to non-subject specific competencies, communication, interpersonal, organization skills.

3.4.4 Attainment Levels

Graduates of botany are expected to have the ability to apply knowledge and skills to solving theoretical and practical problems in botany in relation to national and societal needs.

3.4.5 Resource Requirement for Teaching and Learning

a) Academic and non-academic staff. (See section 1.6)
b) Academic and Non-Academic Spaces (See section 1.6)
c) Academic and Administrative Equipment (See section 4)
d) Library and Information Resources (See section 1.6)

PLEASE NOTE: Conclusive statement shall be made on the minimum CGPA of 1.5 for graduation after the forthcoming workshop on Grading System

3.4.6 Course Structure

Course Structure at 100 Level: Botany

Course Code	Course Title	Units	Status	LH	PH
BIO 101	General Biology I	3	C	45	-
BIO 102	General Biology II	3	C	45	-
BIO 107	General Biology Practical I	1	C	-	45
BIO 108	General Biology Practical II	1	C	-	45
CHM 101	General Chemistry I	3	R	45	-
CHM 102	General Chemistry II	3	R	45	-
CHM 107	General Chemistry Practical I	1	R	-	45
CHM 108	General Chemistry Practical II	1	R	-	45
CSC 101	Introduction to Computer Science	3	R	30	45
GST 111	Communication in English	2	C	30	-
GST 112	Logic, Philosophy & Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills and ICT	2	C	30	-
MCB 121	Introductory Microbiology	3	R	30	45
MTH 101	Elementary Mathematics I	3	R	45	-
MTH 102	Elementary Mathematics II	3	E	45	-
PHY 101	General Physics I	3	R	45	-
PHY 102	General Physics II	3	E	45	-
PHY 107	General Physics Practical I	1	E	-	45
PHY 108	General Physics Practical II	1	E	-	45
	Total	**44**			

Course Structure at 200 Level; Botany

Course Code	Course Title	Units	Status	LH	PH
BIO 201	Genetics I	2	C	30	-
BIO 202	Introductory Ecology	2	R	15	45
BIO 203	General Physiology	2	C	30	-
BIO 204	Biological Techniques	2	C	15	45
BIO 205	Introductory Developmental/Cell Biology	3	C	30	45
BOT 202	Seedless Plants	2	C	30	-
BOT 203	Seed Plants	2	C	30	-
BOT 299	Industrial Attachment I (12 Weeks)	3	C	-	-
CHM 211	Organic Chemistry I	3	R	30	45
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environmental and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MCB 221	General Microbiology	3	R	30	45
STA 201	Statistics for Agriculture and Biological Sciences	4	R	60	-
	Total	**36**			

Add relevant courses from Biology and Zoology as Electives

PLEASE NOTE: Conclusive statement
shall be made on the minimum CGPA of 1.5
for graduation after the forthcoming workshop on
Grading System

Course Structure at 300 Level: Botany

Course Code	Course Title	Units	Status	LH	PH
BOT 301	Plant Taxonomy	3	C	30	45
BOT 302	Comparative Anatomy of Plant	3	R	30	45
BOT 303	Plant Physiology	3	C	45	-
BOT 304	Plant Ecology	3	R	15	90
BOT 305	Mycology	3	C	30	45
BOT 306	Plant Breeding	3	R	15	90
BOT 311	Medicinal Plants	3	R	15	90
BOT 312	Conservation and Biodiversity	3	R	30	45
BOT 399	Industrial Field Attachment II (12 Weeks)	3	C	-	-
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
	Total	**33**			

Add relevant courses as Electives

Course Structure at 400 Level: Botany

Course Code	Course Title	Units	Status	LH	PH
BOT 401	Seminar	1	C		
BOT 402	Economic Botany	2	E	30	-
BOT 403	Nigerian Vegetation	2	R	30	-
BOT 404	Soil Science	3	R	30	45
BOT 406	Plant Pathology	3	R	45	-
BOT 407	Plant Reproduction	3	R	45	-
BOT 408	Plant Tissue Culture	3	R	15	90
BOT 409	Plant Virology	3	R	45	-
BOT 413	Research Project	6	C	-	270
BOT 414	Plant Molecular Biology	3	R	45	-
BOT 415	Palaeobotany and Palaeontology	3	E	45	-
BOT 416	Plant Cytogenesis	3	R	45	-
BOT 417	Plants and Environmental Pollution Monitoring	3	E	30	45
BOT 418	Host-Pathogen Relations & Plant Disease Management	3	R	30	45
BOT 419	Introduction to Mushroom Growing Technology	3	E	30	45
	Total	**44**			

3.4.7 **Course Synopses:**

BOT 202: Seedless Plants **(2 Units: LH 30)**
Morphology and reproduction of algae, bryophytes and pteridophytes including fossils.

BOT 203: Seed plants **(2 Units: LH 30)**
Morphology and reproduction of seed plants.

BOT 299: Industrial Attachment I **(3 Units)**
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.

BOT 301: Plant Taxonomy **(3 Units; LH 30: PH 45)**
Taxonomy and its significance, principles and concepts in plant taxonomy. Construction and use of taxonomic keys. Experimental taxonomy with special emphasis on cyto-taxonomy and chemotaxonomy. Sources of taxonomic data and methods of analysis.

BOT 302: Comparative Anatomy of Plants **(3 Units: LH 30: PH 45)**
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.

BOT 303: Plant Physiology **(3 Units: LH 45)**
Plant water relation, photosynthesis, respiration, growth and growth regulation, flowering, dormancy, seed germination, senescence; Physiological aspects of crop yield. Pre -requisite -B10 203.

BOT 304: Plant Ecology **(3 Units: LH 15; PH 90)**
Study of various plant communities and their ecological framework; Nigerian vegetation, desert and semi-desert plant productivity. Modern concepts in ecology.
Pre-requisite -BIO 202.

BOT 305: Mycology **(3 Units: LH 30; PH 45)**
Structure, life cycles, physiology and classification of fungi. Fungi of economic importance. Metabolites of fungi, industrial uses of fungi. Fungi in medicine.

BOT 306: Plant Breeding **(3 Units: LH 15; PH 90)**
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; LH 15: PH 90)**
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. Biodiversity convention – Rio etc.

BOT 312: Conservation and Biodiversity **(3 Units: LH 30; PH 45)**
Plant breeding concepts and methods.

BOT 399: Industrial Attachment II **(3 Units)**
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.

BOT 401: Seminar **(1 Unit)**
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: LH 30)**
A study of the botany and cultivation of plant species with particular reference to Nigerian economic plants.

BOT 403: Nigerian Vegetation **(2 Units: LH 30)**
A study of Nigerian forests, savannah grass lands and arid zones.

BOT 404: Soil Sciences **(3 Units: LH 30; PH 45)**
Classification and characteristics of soils. Chemical component and analysis of soils and plant tissue. Plant, soil water relationships.

BOT406: Plant Pathology **(3 Units: LH 45)**
Principles and concepts in plant pathology. The concept of disease, infection, pathogenesis, host-pathogen relationship and methods and theory of biological therapy and chemotherapy.
Pre-requisite -BOT 305.

BOT 407: Plant Reproduction **(3 Units: LH 45)**
Development trends of sexual and asexual reproductions.

BOT 408: Plant Tissue Culture **(3 Units: LH 15; PH 90)**
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; LH 45)**

General characteristics of plant viruses. Viral multiplication, selected viral diseases in plants.

BOT 413: Research Project **(6 Units: 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: LH 45)**
Fundamental and applied aspects of plant molecular biology, structure, expression and isolation of plant nuclear genes. Molecular biology of plant development, plant organelles and plant-microbe interactions and plant biotechnology.

BOT 415: Palaeobotany and Palaeontology **(3 Units: LH 45)**
Morphology and classification of spurs and pollen; their stratigraphic and pale environment application. Study of fossils. Oil implications of fossils.

BOT 416: Plant Cytogenesis **(3 Units: LH 45)**
Morphology and behaviour of Chromosomes, Chromosomal Aberrations and Polyploidy, importance of polyploidy, Population cytogenesis. Examples with reference to specific individuals.

BOT 417: Plants and Environmental Pollution Monitoring **(3 Units: LH 30; PH 45)**
The use 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: LH 30; PH 45)
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: LH 30; PH 45)**
Biology, ecology and economic importance of mushrooms. Collection, identification and preservation of mushrooms. History of mushroom cultivation. Spawn production and cropping.

3.5 BREWING SCIENCE AND TECHNOLOGY (BSc)

3.5.1 Philosophy, Aims and Objectives of the Degree Programme

The programme is designed to train students and equip them primarily for direct employment in brewing industries, although they may as well be employed in other allied and related industries such as malting, alcoholic liquor or soft drinks manufacturing industries and distilleries. Consequently, emphasis is placed on practical work and industrial training during the course of the B.Sc. programme. The programme also broadens the perspective of students 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. The first two years are spent mostly on introductory 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 two industrial training courses will be run for 12 weeks at 200 level and 12 weeks at 300 level. Some of the core brewing science courses will also be offered at 200 level.

3.5.2 Admission and Graduation Requirements

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 School Certificate or its equivalent. In addition, an acceptable pass in the Unified Tertiary Matriculation Examination (UTME) 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 (Biology, Botany, Chemistry, Mathematics and Physics) may be admitted into 200-level. This is in addition to fulfilling the requirement of a minimum of credit level passes in five relevant subjects at SSCE or WASCE/GCE 'O' Level as indicated above.

3.5.3 Learning Outcomes

All graduates in brewing science are expected to develop the following abilities and skills:

a. *Regime of Subject Knowledge*
Cognitive abilities and skills relating to solution of problems in brewing industry and other allied and related industries.

b. *Competencies and Skills*
Practical skills relating to the conduct of laboratory and industrial work in brewing industries

c. *Behavioural Attitudes*
General skills relating to non-subject specific competencies, communication, interpersonal, organization skills.

PLEASE NOTE: Conclusive statement shall be made on the minimum CGPA of 1.5 for graduation after the forthcoming workshop on Grading System

3.5.4 Attainment Level

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.

3.5.5 Resource Requirement for Teaching and Learning

a) Academic and non-academic Staff. (See section 1.6)
b) Academic and Non-Academic Spaces (See section 1.6)
c) Academic and Administrative Equipment (See section 4)
d) Library and Information Resources (See section 1.6)

3.5.6 Course Structure

Course Structure at 100 Level: Brewing Science & Technology

Course Code	Course Title	Units	Status	LH	PH
BIO 101	General Biology I	3	C	45	-
BIO 102	General Biology II	3	C	45	-
BIO 107	General Biology Practical I	1	C	-	45
BIO 108	General Biology Practical II	1	C	-	45
CHM 101	General Chemistry I	3	R	45	-
CHM 102	General Chemistry II	3	R	45	-
CHM 107	General Chemistry Practical I	1	R	-	45
CHM 108	General Chemistry Practical II	1	R	-	45
GST 111	Communication in English I	2	C	30	-
GST 112	Logic, Philosophy & Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills & ICT	2	C	30	-
MTH 101	Elementary Mathematics I	3	R	45	-
MTH 102	Elementary Mathematics II	3	R	45	-
PHY 101	General Physics I	3	R	45	-
PHY 102	General Physics II	3	R	45	-
PHY 107	General Physics Practical I	1	R	-	45
PHY 108	General Physics Practical II	1	R	-	45
GET 111	Basic Engineering Drawing	2	R	15	45
	Total	**40**			

Course Structure at 200 Level: Brewing Science and Technology

Course Code	Course Title	Units	Status	LH	PH
BCH 201	General Biochemistry I	3	R	45	-
BCH 202	General Biochemistry II	3	R	45	-
BST 221	Introduction to Brewing Science	2	C	15	45
BST 222	Engineer-in-Society	2	C	30	-
CHM 211	Organic Chemistry I	3	R	30	45
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MCB 221	General Microbiology	3	R	30	45
MTH 201	Mathematical Methods I	3	R	45	-
PHY 202	Electric Circuits and Electronics	3	R	30	45
STA 202	Statistics for Physical Sciences & Engineering.	4	R	60	-
	Total	**34**			

Course Structure at 300 Level: Brewing Science and Technology

Course Code	Course Title	Units	Status	LH	PH
BCH 301	Enzymology	3	R	45	-
BCH 302	Chemistry and Metabolism of Carbohydrates	2	R	30	-
BCH 304	Chemistry and Metabolism of Amino Acids & Proteins	2	R	30	-
BCH 308	Food and Nutritional Biochemistry	2	R	30	-
BST 311	Introductory Food Engineering	2	C	30	-
BST 312	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	3	C	30	-
BST 323	Process Engineering	3	R	45	-
BST 399	Industrial Attachment I (12 Weeks)	3	C		
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
	Total	**36**			

Course Structure at 400 Level: Brewing Science & Technology

Course Code	Course Title	Units	Status	LH	PH
BCH 406	Metabolic Regulations	2	R	30	-
BCH 408	Plant Biochemistry	1	R	15	-
BCH 412	Industrial Biochemistry	3	R	45	-
BST 411	Quality Control I	3	C	45	-
BST 412	Beer Treatment & Packaging	3	C	45	-
BST 413	Process Engineering II	3	C	45	-
BST 499	Industrial Attachment II (24 Weeks)	6	C	-	-
MCB 412	Microbial Genetics	3	R	30	45
MCB 423	Industrial Microbiology	3	R	30	45
MCB 424	Microbial Physiology & Metabolism	3	R	30	45
	Total	**30**			

Course Structure at 500 Level: Brewing Science and Technology.

Course Code	Course Title	Units	Status	LH	PH
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 514	Soft Drink-Making Technology	3	C	30	45
BST 515	Technical Writing and Presentation	1	R	15	-
BST 520	Project	6	C	-	270
BST 521	Seminar	1	C		
MTC 209	Elements of Management	3	R	45	-
	Total	**22**			

Electives to be determined by the university.

3.5.7 Course Synopses

BST 221: Introduction to Brewing Science **(2 Units: LH 15; PH 45)**

Historical background of brewing process. Traditional brewing processes. Importance of beer. Beer production and world economy. Beer and health, the metabolism of ethanol and its effects. Cereals in beer production. *Malting barley* – selection, handling, storage stability and treatment. Modern brewing processes for beer, wines and potable spirits. Other uses of barley malt.

BST 222: Engineer-in-Society **(2 Units: LH 30)**

(i) Philosophy of Science
(ii) History of Engineering and Technology
(iii) Safety in Engineering and introduction to risk analysis
(iv) The role of Engineer in Nation Building
(v) Invited lectures from professionals.

BST 311: Introductory Food Engineering **(2 Units: LH 30)**
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.

BST 312: Raw Materials in Brewing **(3 Units: LH 30; PH 45)**
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: LH 15; PH 45)**
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, irradiation.

BST 314: Food Analysis **(2 Units: LH 15; PH 45)**
Principles and application of analytical methods such as photometry, colorimetry, gravimetry, refractometry. Physical and chemical analysis of water and other major food components – carbohydrates, fats, proteins, minerals; analyses for food colours, additives, trace metals, contaminants.

BST 321: Brew-House Theory and Technology **(3 Units: LH 45)**

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: Fermentation **(3 Units: LH 30; PH 45)**
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. Pre-requisite MCB 221

BST 323: Process Engineering **(3 Units: LH 45)**
Fluid Flow: Flow of incompressible non-Newtonian fluids in pipes; shear rate and pressure drop. Velocity distribution for a power law fluid in laminar and turbulent flow in a pipe. Drying of solids. Humidification (psychrometry). *Steam Generation*: PV diagram showing saturation and super saturation points. Enthalpy, Entropy, simple problems involving enthalpy and entropy. Steam as a gas obeying Boyle's Law. Steam tables and their uses. Mollier chart and how they are used. Gas processes. Power cycles. *Refrigeration*: Reversible carnot cycle. Curves showing enthalpy of ammonia, Freon 12, 22, etc and their uses, coefficient of performance. Tonnage of refrigeration. Simple problems of refrigeration. Types and qualities of refrigerant. *Compressors*: Introduction to compressible fluids. Gas laws. Adiabatic and polytropic expansions. Gas constants, simple problems involving gas constants. Introduction to compressors. Single stage compressor. Problem solving. *Carbon dioxide*: Introduction to cryogenic properties of CO_2. Dryness fraction of CO_2, electricity, instrumentation and control. Pre-requisite BST 311

BST 399: Industrial Attachment I (12 Weeks) **(3 Units)**
Students should be attached to relevant industrial establishments for 12 weeks, during the long vacation 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.

BST 411: Quality Control I **(3 Units: LH 45)**
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. Pre-requisite BST 311

BST 412: Beer Treatment and Packaging **(3 Units: LH 45)**

Beer stabilization methods, clarification and filtration techniques. Exclusion of air. Chilling, 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. Pre-requisite BST 321

BST 413: Process Engineering II **(3 Units: LH 45)**

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, water-cooled. Cooling tower and how they function. Types of evaporators and their evaporating systems. Ammonia controls – automatic values, etc. 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. Pre-requisite BST 323

BST 499: Industrial Attachment II: (24 Weeks) **(6 Units)**

Students should be attached to relevant industrial establishments for additional 24 weeks to gain hands-on experience on brewing technology. Performance of students should be assessed based on written reports, seminar presentation and supervisors' reports.

BST 511: Quality Control II **(3 Units: LH 30; PH 45)**

Microbial contamination in breweries. 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.

Pre-requisite BST 411

BST 512: Brewing Calculations and Plant Design **(2 Units: LH 30)**

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.

BST 513: Wine – Making Technology (3 Units: LH 30; PH 45)

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 514: Soft Drink–Making Technology (3 Units: LH 30; PH 45)

History of soft drink development. Classification of soft drinks – carbonated and non-carbonated. Important properties. Sweeteners- sucrose, malt and maltose syrups; sweeteners from starch, lactose and lactitol, fructose; syrups, sorbitol, mannitol and xylitol; protein and peptide based sweeteners. Planning and layout of soft-drink factories. The polyester/glass bottle. Labelling of soft drinks containers. CIP and associated technology. Post-mix dispensing technology. Packaging.

BST 515: Technical Writing and Presentation (1 Unit: LH 15)

Principles of effective communication. Professional use of English Language, principles of technical writing. Oral presentation of technical ideas.

BST 520: Research Project (6 Units: PH 270)

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 521: Seminar: (1 Unit)

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.

GET 111: Basic Engineering Drawing (2 Units: LH 15; PH 45)

Introduction to Engineering Drawing as a means of communication. Drawing paper format. Use of drawing instruments. Types of lines and their uses in Engineering Drawing. Circles and tangent. Circles to satisfy conditions involving other circles, lines and points. Conic sections, various methods of their construction.

Cycloid, epi- and hypocycloids. Involute. Archimedes spiral. Loci: the helix (cylindrical and conical) single and multi-start threads. Coiling of compression and tension springs. Loci – Paths of points on moving link work. The theory of projection. Perspective (briefly), parallel projections (oblique – general, cavalier, cabinet). (Orthographic – Multi-view, two views, three views, auxiliary views). (Axonometric – Isometric, dimetric, trimetric). Multi-view representation. 1st and 3rd angle representations. Isometric drawing. Oblique drawings. Revisions.

MTC 209: Elements Of Management **(3 units, LH: 45)**

Evolution of Management Thought and Practice. Different Schools of Management thought. Managerial function and processes. Organizational Management: Classical and Neo Classical theories: Contemporary organizational theories, Management by Objectives.

3.6 CHEMISTRY (BSc)

3.6.1 Philosophy, Aims and Objectives of the Degree Programme

Chemistry is the index of industrial development. The giant strides made by man in the understanding and exploitation of nature, synthesis of new materials essential to the enhancement of the quality of life, and the surge in and sustenance of economic and technological progress have benefited immensely from chemistry. A degree programme in chemistry should foster in the undergraduate an 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.

A degree programme in chemistry should therefore aim to:

a. Stimulate in the students sustained interest and enthusiasm in chemistry and its applications
b. Build in students a culture of continuing enquiry
c. Provide students with a broad and balanced base of chemical knowledge and practical skills
d. Develop in students a range of skills applied in chemical and non-chemical areas, that can provide confidence for employment
e. Provide students with a solid base of chemical knowledge and skills that are required for postgraduate studies and research, and
f. Inculcate in students an appreciation of chemistry in all human endeavours.

3.6.2 Admission and Graduation Requirements

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.

Candidates with at least two A level passes (graded A-E) at the GCE Advanced Level in relevant subjects may be admitted into 200-level.

3.6.3 Learning Outcomes

All Bachelors honours degree student in chemistry are expected to develop the following abilities and skills:

a. *Regime of Subject Knowledge*
Cognitive abilities and skills relating to solution of problems in chemistry and allied chemical industries.

b. *Competencies and Skills*
Practical skills relating to the conduct of laboratory work in chemical industries.

c. *Behavioural Attitudes*
General skills relating to non-subject specific competencies, communication, interpersonal and organizational skills.

3.6.4 Attainment Levels

Graduates of chemistry are expected to have the ability to apply knowledge and skills to solving theoretical and practical problems in chemistry and allied industries in relation to national and societal needs.

3.6.5 Resource Requirement for Teaching and Learning

a Academic and Non-Academic Staff (See section 1.6)
b Academic and Non-Academic Spaces (See section 1.6)
c Academic and Administrative Equipment (See section 4)
d Library and Information Resources (See section 1.6)

Course Structure and Synopses

Course Structure at 100 Level: Chemistry

Course Code	Course Title	Units	Status	LH	PH
BIO 101	General Biology I	3	R	45	-
BIO 102	General Biology II	3	R	45	-
BIO 107	General Biology Practical I	1	R	-	45
BIO 108	General Biology Practical II	1	R	-	45
CHM 101	General Chemistry I	3	C	45	-
CHM 102	General Chemistry II	3	C	45	-
CHM 107	General Chemistry Practical I	1	C	-	45
CHM 108	General Chemistry Practical II	1	C	-	45
CSC 101	Introduction to Computer Science	3	R	30	45
GST 111	Communication in English I	2	C	30	-
GST 112	Logic, Philosophy & Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills & ICT	2	C	30	-
MTH 101	General Mathematics I	3	R	45	-
MTH 102	General Mathematics II	3	R	45	-
PHY 101	General Physics I	3	R	45	-
PHY 102	General Physics II	3	R	45	-
PHY 107	General Physics Practical I	1	R	-	45
PHY 108	General Physics Practical II	1	R	-	45
	Total	**41**			

Course Structure at 200 Level: Chemistry

Course Code	Course Title	Units	Status	LH	PH
CHM 210	Physical Chemistry I	3	C	30	45
CHM 211	Organic Chemistry I	3	C	30	45
CHM 212	Inorganic Chemistry I	3	C	30	45
CHM 213	Analytical Chemistry I	3	C	30	45
CHM 214	Structure and Bonding	2	R	30	-
CHM 299	Industrial Attachment I (12 Weeks)	3	C		
CSC 201	Computer Programming I	3	E	30	45
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment & Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MTH 203	Sets, Logic and Algebra I	3	R	45	-
PHY 201	Elementary Modern Physics	3	R	45	-
PHY 202	Electric Circuits and Electronics	3	E	30	45
STA 202	Statistics for Physical Sciences & Engineering	4	E	60	-
	Total	**41**			

Course Structure at 300 Level: Chemistry

Course Code	Course Title	Units	Status	LH	PH
CHM 301	Physical Chemistry II	2	C	15	45
CHM 302	Inorganic Chemistry II	3	C	30	45
CHM 303	Organic Chemistry II	3	C	30	45
CHM 304	Atomic & Molecular Structure & Symmetry	3	C	45	-
CHM 305	Petroleum Chemistry	2	R	30	-
CHM 307	Carbohydrate Chemistry	1	R	15	-
CHM 310	Polymer Chemistry	3	R	45	-
CHM 311	Colour Chemistry & Technology	3	R	30	45
CHM 312	Separation Methods and Analysis	3	C	30	45
CHM 313	Applied Surface and Colloid Chemistry	1	E	15	-
CHM 316	Applied Spectroscopy	3	R	45	-
CHM 317	Industrial Raw Materials Resource Inventory	1	R	15	-
CHM 318	Industrial Chemical Process	3	R	45	-
CHM 319	Environmental Chemistry	2	R	30	-
CHM 399	Industrial Attachment II (12 Weeks)	3	C		
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
	Total	**42**			

C

Course Structure at 400 Level: Chemistry

Course Code	Course Title	Units	Status	LH	PH
CHM 400	Seminar	1	C		
CHM 401	Research Project	6	C	-	270
CHM 402	Theory of Molecular Spectroscopy	2	E	30	-
CHM 403	Quantum Chemistry	2	R	30	-
CHM 404	Group Theory and Symmetry	2	R	30	-
CHM 405	Statistical Mechanics	1	E	15	-
CHM 406	Reaction Kinetics	2	R	30	-
CHM 407	Electrochemistry	2	E	15	45
CHM 408	Statistical Thermodynamics	2	E	30	-
CHM 409	Nuclear and Radiation Chemistry	2	E	30	-
CHM 410	Analytical Chemistry II	2	R	15	45
CHM 412	Colour Chemistry and Technology	3	E	30	45
CHM 413	Industrial Chemical Technology	2	E	30	-
CHM 415	Polymer Technology	2	E	30	-
CHM 418	Photochemistry and Pericyclic reactions	2	E	30	-
CHM 419	Organic Synthesis	2	R	30	-
CHM 420	Natural Product Chemistry	2	R	30	-
CHM 421	Heterocyclic Chemistry	2	R	30	-
CHM 422	Physical Organic Chemistry	2	E	30	-
CHM 423	Organometallic Chemistry	3	R	45	-

CHM 424	Co-ordination Chemistry	2	R	30	-
CHM 425	Non-aqueous Solvents	1	E	15	-
CHM 426	Chemistry of Lanthanides and Actinides	1	E	15	-
	Total				

To ensure acquisition of balanced knowledge in various areas of Chemistry, a student must take, in addition to the compulsory courses, a minimum of 6 Units from each of the following groups of courses: Group I (CHM 402 – CHM 409; Group II (CHM 410 – CHM 415); Group III (CHM 418 – CHM 422) and Group IV (CHM 423 – CHM 426).

3.6.6 **Course Synopses:**

CHM 101: General Chemistry I **(3 Units: LH 45)**
Atoms, molecules 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 **(3 Units: LH 45)**
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: PH 45)**
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: PH 45)**
Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

CHM 210: Physical Chemistry I **(3 Units: LH 30; PH 45)**
Pre-requisite –CHM 101
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 **(3 Units: LH 30; PH 45)**
Pre-requisite – CHM 102
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 (3 Units: LH 30; PH 45)
Pre-requisite – CHM 101; CHM 102
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 (3 Units: LH 30; PH 45)
Pre-requisite –CHM 101 and 102
Theory of errors; and statistical treatment of data: Theory of sampling. Chemical methods of analysis including volumetric, gravimetric and physicochemical methods, Optical methods of analysis; separation methods.

CHM 214: Structure and Bonding (2 Units: LH 30)
Pre-requisite –CHM 101 and 102
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 299: Industrial Attachment I(12 Weeks) (3 Units)
Students should be attached to some industrial organizations for 12 Weeks at the 200 Level preferably during the long vacation for real-time relevant industrial experience. Students to be assessed based on seminar presentations, their reports and assessment by supervisors

CHM 301: Physical Chemistry II (2 Units: LH 15; PH 45)
Pre-requisite –CHM 210
A review of Gibbs Function. Chemical thermodynamics. Introduction to statistical thermodynamics. Ideal solutions and non-Ideal solutions. Properties of electrolytes. Colligative Properties.

CHM 302: Inorganic Chemistry II (3 Units: LH 30; PH 45)
Pre-requisite –CHM 212
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 **(3 Units: LH 30; PH 45)**
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 e.g. Beckmann, Baeyer-Villiger etc to illustrate various reaction mechanisms and types.

CHM 304: Atomic and Molecular Structure and Symmetry **(3 Units : LH 45)**
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 305: Petroleum Chemistry **(2 Units: LH 30)**
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.

CHM 307: Carbohydrate Chemistry **(1 Unit: LH 15)**
Classification, structure and nomenclature of carbohydrates. Preparations and reactions. Configurations. Epimerization.

CHM 310: Polymer Chemistry **(3 Units: LH 45)**
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.

CHM 311: Colour Chemistry and Technology **(3 Units: LH 30; PH 45)**
Colour and constitution. Chemistry, properties of dyes and pigments. Classification of dyes and fibres. Dyeing mechanisms. Preparation and dyeing of natural and synthetic fibres. Colour fastness properties. Quality control procedures and the colouration industry. Paints, inks, classification, preparation and uses. Chemistry and application of reactive dyes.

Dyeing machineries. Printing. Colouring matters for food, drugs and cosmetics. Dyes used in paper industry and colour photography.

CHM 312: Separation Methods and Analysis (3 Units: LH 30: P 45)
Intermediate theory and laboratory techniques in analytical and physical chemistry. Advanced data analysis methods and goodness-of-fit criteria Spectroscopic methods and instrumentation. Separation methods: ion exchange, gas, paper, liquid and column chromatography; electrophoresis. Atomic and molecular absorption, emission and fluorescence spectrophotometry. Electroanalytical techniques. Quantitative analysis. X-ray methods. Refractometry, Interferometry, Polarimetry, Polarography & Calorimetry.

CHM 313: Applied Surface and Colloid Chemistry (1 Unit: LH 15)
Some general principles relating to surfaces. Electrical potentials. Attractive forces. Solid gas interface and solid liquid interface. Definition of colloid and history of colloid development. Types of colloids. Polymers, Proteins, Gels, Association colloids, Detergents.

CHM 316: Applied Spectroscopy (3 Units: LH 45)
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: LH 15)
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 (3 Units: LH 45)
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.

CHM 319: Environmental Chemistry (2 Units: LH 30)
Concepts of elementary cycles. Characteristics of the atmosphere. Sources, types and effects of environmental pollution. Waste water 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 II (12 Weeks) (3 Units)
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)**
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 Units: PH 270)**
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 402: Theory of Molecular Spectroscopy **(2 Units: LH 30)**
Pre-requisite –CHM 301, 304, 316
Quantum theory of rotation and vibration. Theory of microwave, IR, Raman, UV- Visible and NMR spectroscopy. General introduction to electron spin resonance, Mossbauer effect, nuclear quadruple resonance and other modern techniques.

CHM 403: Quantum Chemistry **(2 Units: LH 30)**
Pre-requisite –CHM 304
Postulates of Quantum mechanics; operators; angular momentum solution of the hydrogen atom problem. Theory of atomic spectra. Self-consistent Field theory. Computational aspects. Perturbation and variation methods.

CHM 404: Group Theory and Symmetry **(2 Units: LH 30)**
Review of molecular symmetry operations. Definition of groups. Molecular symmetry groups. Introduction to the mathematical structure of groups. Group representations. Detailed study of groups Cn, Dn, C∞v and full rotation group. Applications. General symmetry applications. Symmetry of crystal lattices, Block orbitals for infinite system.

CHM 405: Statistical Mechanics **(1 Unit: LH 15)**
Pre-requisite –CHM 301
Maxwell-Boltzmann statistics; calculation of thermodynamic properties; partition functions; heat capacities; entropy; equilibrium constants; use of spectroscopic data; transition state theory; quantum effects.

CHM 406: Reaction Kinetics **(2 Units: LH 30)**
Pre-requisite –CHM 301
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 407: Electrochemistry **(2 Units: LH 15; PH 45)**
Pre-requisite –CHM 301

Electrical double layer, potential at zero charge, polarisable and non-polarisable interface, mass transport, concentration polarisation, Fick's Laws, Levich equation. Electrodics. Polarography. Corrosion – types and prevention.

CHM 408: Statistical Thermodynamics (2 Units: LH 30)

Microstates and randomness; ensembles; probability and distribution functions; the Boltzmann distribution; statistical thermodynamics of gases; the calculation of thermodynamic equilibrium constant from partition function; statistical thermodynamics of monatomic solids; introduction to Fermi-Dirac and Dose-Einstein statistics.

CHM 409: Nuclear and Radiation Chemistry: (2 Units: LH 30)

Natural radiations/radioactivity, fusion, fission, decay processes, nature of radiation. Nuclear models, science of nuclear reaction. Principles and measurement of radioactivity. Applications of radioactivity. Radiation hazards.

CHM 410: Analytical Chemistry II (2 Units: LH 15; PH 45)

Pre-requisite – CHM 301

Sampling and sample pre-treatment. Theory of Errors. 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 413: Industrial Chemical Technology (2 Units: LH 30)

Heat transfer and mass transfer processes. Unit operations. Chemical technology equipment. Hydrogen and carbon monoxide synthesis; gas, oxo-process, water gas, source of hydrogen and its application. Industrial organic materials, raw materials. Technical and economic principles of processes and product routes. Flow diagrams. Selected oils and fats, soaps and detergents, sugar, varnishes, plastics, wood-pulp and paper. Environmental pollution.

CHM 415: Polymer Technology (2 Units: LH 30)

Pre-requisite –CHM 310

Large scale industrial processes. Polymer Tech. Polymer processing, injection, extrusion, compression and transfer moulding of thermoplastics. Polymer additives. Polymeric surface coatings and adhesives.

CHM 418: Photochemistry and Pericyclic Reaction (2 Units: LH 30)

Pre-requisite –CHM 303

Interaction of radiation with matter, electronic excitation, selection rules, deactivation routes, photofragmentation, oxidation, reduction, rearrangement, pericyclic reactions and molecular orbital symmetry.

CHM 419: Organic Synthesis (2 Units: LH 30)

Prerequisite –CHM 303

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.

CHM 420: Natural Products Chemistry **(2 Units: LH 30)**
Prerequisite –CHM 303
General methods of isolation, separation, purification and structural determination of natural products. Classifications and biogenesis. Chemistry of terpenoids, steroids, alkaloids, antibiotics, flavonoids. Prostaglandins and chlorophylls. Other natural products of pharmaceutical importance. Cholesteryl benzoate, liquid crystals and digital displays in computer screens, etc.

CHM 421: Heterocyclic Chemistry: **(2 Units: LH 30)**
Prerequisite –CHM 303
The synthetic and mechanistic aspects of fused heterocyclic system; particularly quinolines, isoquinolines, benzofurans, benzothiophenes, indoles, benzopyrylium salts, coumarins and chromones. Application of heterocyclic systems in drug synthesis.

CHM 422: Physical Organic Chemistry **(2 Units: LH 30)**
Prerequisite –CHM 303 and 308
Preparation and reactions of stereoisomers, stereoselectivity, neighbouring group effects, and a few special topics in Physical Organic Chemistry. Conformational Analysis.

CHM 423: Organometallic Chemistry **(3 Units: LH 45)**
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: LH 30)**
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.

CHM 425: Non-Aqueous Solvents **(1 Unit: LH 15)**

Prerequisite –CHM 302

Classification and general characteristics, solute-solvent interaction. Protonic solvents. Oxyhalide solvents. Liquid halides. Dinitrogen tetroxide, sulphur dioxide. Levelling effects, non-aqueous titrations.

CHM 426: Chemistry of Lanthanides and Actinides **(1 Unit: LH 15)**

Pre-requisite –CHM 302

The elements and the position of the two series in the periodic table. Comparison of the two series. Lanthanides contractions. The electronic configuration and their sequences on oxidation states, size relationship, magnetic properties and colour. Chemical properties and structure of the elements and their compounds. Recovery and separation of the elements. Uses of Lanthanides and Actinides.

3.7 COMPUTER SCIENCE (BSc)

3.7.1 Philosophy, Aims and Objectives of the Degree Programme

The aims and objectives of bachelors honours degree programme in computer science should include:

- Create in students the awareness of and enthusiasm for computer science and its capabilities.
- Involve the students in an intellectually stimulating and satisfying experience of learning and studying
- Provide a broad and balanced foundation in computer science knowledge and practical skills.
- Develop in students through an education in computer science a range of transferable applicable skills of information technology to all aspects of human endeavours.
- Generate in students an appreciation of the importance of computer in an industrial, economic, technological and social context.
- Provide students with knowledge and skills base for further studies in computer science or multi-disciplinary studies involving computer science.

3.7.2 Admission and Graduation Requirement

The entry requirements shall be at least credit level passes in five subjects including English Language, Mathematics, Physics to form the core subjects with credit in any other two relevant science subjects, at the Senior Secondary School Certificate 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 two A level passes (graded A-E) at the GCE/IJMB Advanced Level in relevant subjects (Chemistry, Mathematics and Physics) may be admitted into 200-level. This is in addition to fulfilling the requirement of a minimum of credit level passes in five relevant subjects at SSCE or WASCE/GCE 'O' Level as indicated above.

3.7.3 Learning Outcomes

a *Regime of Subject Knowledge*

Each institution providing degree programmes in Computer Science is free, within the context of university autonomy and academic freedom to decide on the content, nature and organization of its courses and modules. However, it is expected that all programmes will ensure that students are conversant with the core areas of computer science:

b. *Competencies and Skills*

PLEASE NOTE: Conclusive statement shall be made on the minimum CGPA of 1.5 for graduation after the forthcoming workshop on Grading System

Students are expected to develop a wide range of different abilities, dynamism and skills.These may be divided into three categories, viz.
Cognitive Abilities and Skills
Practical Skills
General Skills

c *Behavioural Attitudes*
General skills relating to non-subject specific competencies, communication, interpersonal, organization skills.

3.7.4 Attainment Levels

Graduates of Computer Science are expected to have the ability to apply knowledge and skills to solving theoretical and practical problems in Computer Science, development of relevant ICT for national development and societal needs.

3.7.5 Resource Requirement for Teaching and Learning

a) Academic and Non-Academic Spaces (See section 1.6)
b) Academic and Administrative Equipment (See section 4)
c) Library and Information Resources (See section 1.6)

3.7.6 Course Structure

Course Structure at 100 Level: Computer Science

Course Code	Course Title	Units	Status	LH	PH
BIO 101	General Biology I	3	E	45	-
CHM 101	General Chemistry I	3	R	45	-
CSC 101	Introduction to Computer Science	3	C	30	45
CSC 102	Introduction to Problem Solving	3	C	30	45
GST 111	Communication in English I	2	C	30	-
GST 112	Logic, Philosophy & Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills and ICT	2	R	30	-
MTH 101	General Mathematics I	3	R	45	-
MTH 102	General Mathematics II	3	R	45	-
MTH 103	General Mathematics III	3	R	45	-
PHY 101	General Physics I	3	R	45	-
PHY 102	General Physics II	3	R	45	-
PHY 107	General Physics Practical I	1	R	-	45
PHY 108	General Physics Practical II	1	R	-	45
	Total	**37**			

Electives : Some units to be selected from Mathematics and Physics Courses.

PLEASE NOTE: Conclusive statement
shall be made on the minimum CGPA of 1.5
for graduation after the forthcoming workshop on
Grading System

Course Structure at 200 Level: Computer Science

Course Code	Course Title	Units	Status	LH	PH
CSC 201	Computer Programming I	3	C	30	45
CSC 202	Computer Programming II	3	C	30	45
CSC 204	Fundamentals of Data Structures	3	R	30	45
CSC 205	Operating Systems I	3	C	30	45
CSC 208	Discrete Structure	3	R	45	-
CSC 212	Computer Hardware	3	R	30	45
CSC 218	Foundations of Sequential Program	3	R	45	-
CSC 299	Industrial Training (12 Weeks)	3	C		
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment & Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MTH 201	Mathematical Methods	3	R	30	45
PHY 202	Electric circuits and Electronics	3	R	30	45
	Total	**38**			

Electives: Elective courses may be selected from the following: MTH 204, Linear Algebra I (2 units); MTH 205, Linear Algebra II (2 units); PHY 201 General Physics III (3 units); and some Statistics courses.

Course Structure at 300 Level: Computer Science

Course Code	Course Title	Units	Status	LH	PH
CSC 301	Structured Programming	3	C	45	-
CSC 302	Object- Oriented Programming	3	R	45	-
CSC 304	Data Management I	3	C	45	-
CSC 305	Operating Systems II	3	C	45	-
CSC 310	Algorithms and Complexity Analysis	3	R	45	-
CSC 314	Computer Architecture and Organization I	3	R	45	-
CSC 315	Computer Architecture and Organization II	3	R	45	-
CSC 316	Compiler Construction I	3	R	45	-
CSC 321	Systems Analysis and Design	3	R	30	45
CSC 332	Survey of Programming Language	4	C	45	45
CSC 333	Computational Science & Numerical Methods	3	R	45	-
CSC 399	Industrial Training II (12 Weeks)	3	C		
GST 222	Peace Studies and Conflict Resolution	2	E	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
	Total	**43**			

Course Structure at 400 Level: Computer Science

Course Code	Course Title	Units	Status	LH	PH
CSC 401	Organisation of Programming Languages	3	R	45	-
CSC 403	Software Engineering	4	C	45	45
CSC 404	Data Management II	3	C	30	45
CSC 411	Artificial Intelligence	3	R	45	-
CSC 421	Net-Centric Computing	3	R	45	-
CSC 423	Computer Networks/Communications	3	C	30	45
CSC 441	Human Computer Interface	2	R	30	-
CSC 499	Project	6	C		
	Total	**27**			

Electives: 9 Units to be selected from:

Course Code	Course Title	Units	Status	LH	PH
CSC 405	Special Topics in Software Engineering	3	E	30	45
CSC 406	Queuing Systems Performance Evaluation	3	E	45	-
CSC 408	Computer System Performance Evaluation	3	E	45	-
CSC 416	Compiler Construction II	3	E	45	-
CSC 422	Project Management	3	E	30	45
CSC 432	Distributed Computing System	3	E	30	45
CSC 433	Computer Graphics and Visualisation	2	E	30	45
CSC 435	Optimization Techniques	3	E	30	45
CSC 452	Formal Models of Computation	3	E	30	45
CSC 461	Information Technology Law	2	E	30	-
CSC 482	Modelling and Simulation	3	E	30	45
CSC 492	Special Topics in Computer Science	3	E	30	45

3.7.7 Course Synopses:

CSC 101: Introduction to Computer Science (3 Units: LH 30, PH: 45)

Survey of computers and information processing and their roles in society. This course introduces a historical perspective of computing, hardware, software, information systems, and human resources and explores their integration and application in business and other segments of society. Students will be required to complete lab assignments using the PC's operating system, and several commonly used applications, such as word processors, spreadsheets, presentations, graphics and other applications. Internet and on-line resources, browsers and search engines.

CSC 102: Introduction to Problem Solving **(3 Units: LH 30, PH 45)**
Role of Algorithms in problem solving process, concepts and properties of Algorithms. Implementation strategies, Development of Flow Charts, Pseudo Codes. Program objects. Implementation of Algorithms in a programming Language - Visual BASIC/JAVA/C/C^{++}

CSC 201: Computer Programming I **(3 Units: LH 30, PH 45)**
Introduction to problem solving methods and algorithm development, designing, coding, debugging and documenting programmes using techniques of a good programming language style, programming language and programming algorithm development. A widely used programming language should be used in teaching the above.

CSC 202: Computer Programming II **(3 Units: L30, P45)**
Principles of good programming, structured programming concepts, Debugging and testing, string processing, internal searching and sorting, recursion. Use a programming language different from that in CSC 201. E.g. C-Language

CSC 204: Fundamentals of Data Structures **(3 Units: LH 30, PH 45)**
Primitive types, Arrays, Records Strings and String processing, Data representation in memory, Stack and Heap allocation, Queues, TREES. Implementation Strategies for stack, queues, trees. Run time Storage management; Pointers and References, linked structures.

CSC 205 Operating System I **(3 Units: LH 30, PH 45)**
Overview of O/S: Role & Purpose, Functionality Mechanisms to Support Client- server models, hand-held devices, Design Issues influences of Security, networking, multimedia, Windows.
O/S Principles: Structuring methods, Abstraction, processes of resources, Concept of APIS Device organization interrupts.

CSC 208: Discrete Structure **(3 Units: LH 45)**
Basic Set Theory: Basic definitions, Relations, Equivalence Relations Partition, Ordered Sets. Boolean Algebra & Lattices, Logic, Graph theory: Directed and Undirected graphs, Graph Isomorphism, Basic Graph Theorems, Matrices; Integer and Real matrices, Boolean Matrices, Matrices med m, Path matrices. Adjacency Vectors/Matrices: Path adjacency matrix, Numerical & Boolean Adjacency matrices. Applications to counting, Discrete Probability Generating Functions,

CSC 212: Computer Hardware: **(3 Units: LH 30, PH 45)**
Computer circuits; diode arrays, PIAs etc, Integrated circuits fabrication process. Use of MSI, LSI and VLSI IC' hardware Design. Primary and Secondary memories; core memory, etc. Magnetic devices; disks, tapes, video disks etc. Peripheral devices; printers,

CRT's, keyboards, character recognition. Operational amplifiers; Analog-to- digital and Digital-to-analog converter.

CSC 218 Foundations of Sequential Program: (3 Units: LH 45)
The relationships between H/L languages and the Computer Architecture that underlies their implementation: basic machine architecture, specification and translation of P/L Block Structured Languages, parameter passing mechanisms.

CSC 299: Industrial Training I (3 Units)
Require 3 months of Industrial Training. Students' experience will be documented and presented in a Seminar.

CSC 301: Structured Programming (3 Units: LH 45)
Structured Programming elements, structured design principles, abstraction modularity, stepwise refinement, structured design techniques. Teaching of a structured programming language etc.

CSC 302: Object-Oriented Programming (3 Units: LH 45)
Basic OOP Concepts: Classes, Objects, inheritance, polymorphism, Data Abstraction, Tools for developing, Compiling, interpreting and debugging, Java Programs, Java Syntax and data objects, operators. Central flow constructs, objects and classes programming, Arrays, methods. Exceptions, Applets and the Abstract, OLE, Persistence, Window Toolkit, Laboratory exercises in an OOP Language.

CSC 304: Data Management I (3 Units: LH 45)
Information storage & retrieval, Information management applications, Information capture and representation, analysis & indexing, search, retrieval, information privacy; integrity, security; scalability, efficiency and effectiveness.
Introduction to database systems: Components of database systems DBMS functions, Database architecture and data independence use of database query language.

CSC 305: Operating System II (3 Units: LH 45)
Concurrency: States & State diagrams Structures, Dispatching and Context Switching; interrupts; Concurrent execution; Mutual exclusion problem and some solutions Deadlock; Models and mechanisms (Semaphores, monitors etc.)
Producer – Consumer Problems & Synchronization.
Multiprocessor issues.
Scheduling & Despatching
Memory Management: Overlays, Swapping and Partitions, Paging & Segmentations Placement & replacement policies, working sets and Trashing, Caching.

CSC 310: Algorithms and Complexity Analysis (3 Units: LH 45)
Basic algorithmic analysis: Asymptotic analysis of Upper and average complexity bounds; standard Complexity Classes Time and space tradeoffs in algorithms analysis recursive algorithms.

Algorithmic Strategies: Fundamental computing algorithms: Numerical algorithms, sequential and binary search algorithms; sorting algorithms, Binary Search tress, Hash tables, graphs & its representation.

CSC 314: Computer Architecture I and Organization I (3 Units: LH 45)
Fundamental building blocks, logic expressive immunization, sum of product forms. Register transfer notation, Physical considerations. Data representation, and number bases, Fixed and Floating point systems, representation memory systems organization and architecture.

CSC 315: Computer Architecture and Organization II (3 Units: LH 45)
Memory system, general; characteristics of memory operation. (Technology-magnetic recording semi-conductor memory, coupled devices, magnetic bubble). Memory addressing, memory hierarchy, virtual memory control systems. Hardware control, micro programmed control, Asynchronous control, i/c control. Introduction to the methodology of faulty tolerant computing.

CSC 316: Compiler Construction I (3 Units: LH 45)
Review of compilers assemblers and interpreters, structure and functional aspects of a typical compiler, syntax semantics and, functional relationship between lexical analysis, expression analysis and code generation. Internal form of course programme. Use of a standard compiler (FORTRAN<COBOL/PL) as a working vehicles. Error detection and recovery. Grammars and Languages: the parsing problem. The scanner.

CSC 321: Systems Analysis and Design (3 Units: LH 30; PH 45)
System Concept; System Development Life Cycle
Analysis: Fact gathering Techniques, data flow diagrams, Process description data modelling.
System Design: Structure Charts, form designs, security, automated Tools for design.

CSC 332: Survey of Programming Languages (4 Units: LH 45; PH 45)
Overview of programming languages: History of programming languages, Brief survey of programming paradigms (Procedural languages, Object-oriented languages, Functional languages, Declarative – non-algorithmic languages, Scripting languages), the effects of scale on programming methodology; Language Description: Syntactic Structure (Expression notations, abstract Syntax Tree, Lexical Syntax, Grammars for Expressions, Variants of Grammars), Language Semantics (Informal semantics, Overview of formal semantics, Denotation semantics, Axiomatic semantics, Operational semantics); Declarations and types: The concept of types, Declaration models (binding, visibility, scope, and lifetime), Overview of type-checking, Garbage collection; Abstraction mechanisms: Procedures, function, and iterations as abstraction mechanisms, Parameterization mechanisms (reference vs. value), Activation records and storage management, Type parameters and parameterized types, Modules in programming languages; Object oriented language paradigm; Functional and logic language paradigms.

CSC 333: Computational Science and Numerical Methods (3 Units: LH 45)

Operations research, Numerical Computation, Graphical computation, Modelling and simulation, High performance computation.

CSC 399: Industrial Training II **(3 Units)**
Student's Industrial work experience of 3 months' duration. Students' reports will be presented in a seminar.

CSC 401: Organization of Programming Languages **(3 Units: LH 45)**
Language definition structure. Data types and structures, Review of basic data types, including lists and tress, control structure and data flow, Run-time consideration, interpretative languages, lexical analysis and parsing. Pre-requisite – CSC 201, 202, 304, 302.

CSC 403: Software Engineering **(4 Units: LH 45; PH 45)**
Software Design: Software architecture, Design Patterns, O. O. analysis & Design, Design for re-use. Using APIS: API programming Class browsers and related tools, Component based computing. Software tools and Environment: Requirements analysis and design modelling Tools, Testing tools, Tool integration mech.

CSC 404: Data Management II **(3 Units: L H 30; P 45)**
Rational Databases: Mapping conceptual schema to relational Schema; Database Query Languages (SQL) Concept of Functional dependencies & Multi-Valued dependencies.
Transaction processing; Distributed databases.
Text: CJ Date.

CSC 405 : Special Topics in Software Engineering **(3 Units : LH 30 ; PH 45)**
Topics from process improvement ; software re-engineering configuration management; Formal specification, software cost – estimation, Software architecture, Software patterns, Software Reuse and Open source development.

CSC 406: Queuing Systems: **(3 Units: LH 45)**
Introduction; Birth-death queuing systems; Markovian queues, the queue M/GI bounds, inequalities and approximations.

CSC 407 : Special Topics in Software Engineering **(3 Units: LH 30; PH 45)**
Topics from process improvement; software re-engineering configuration management; Formal specification, software cost – estimation, Software Architecture, Software patterns, Software Reuse and Open source development.

CSC 408: Computer System Performance Evaluation **(3 Units: LH 45)**
Measurement techniques, simulation techniques; techniques, workload characterization, performance evaluation in selection problems, performance evaluation in design problems, evaluation of programme performance.

CSC 411: Artificial Intelligence (3 Units: LH 45)
Introduction to artificial intelligence, understanding natural languages, knowledge representation, expert systems, pattern recognition, the language LISP.

CSC 416: Compiler Construction II (3 units: LH 45)
Grammars and languages, recognizers, Top-down and bottom-up language Run-time storage Organization, The use of display in run-time storage Organization. The use of display in run time storage allocation. LR grammars and analysers. Construction of LR table. Organisation of symbol tablets. Allocation of storage to run-time variables. Code generation. Optimisation/Translator with systems.

CSC 421: Net-Centric Computing (3 Units: LH 45)
Distributed Computing, Mobile & Wireless computing, Network Security; Client/Server Computing (using the web), Building Web Applications.

CSC 422: Project Management (3 Units: LH 30; PH 45)
Team Management, Project Scheduling, Software measurement and estimation techniques, Risk analysis, Software quality assurance, Software Configuration Management, Project Management tools.

CSC 423: Computer Networks/Communication (3 Units: LH 30; PH 45)
Introduction, wares, Fourier analysis, measure of communication, channel characteristics, transmission media, noise and distortion, modulation and demodulation, multiplexing, TDM FDM and FCM Parallel and serial transmission (synchronous vs asynchronous). Bus structures and loop systems, computer network Examples and design consideration, data switching principles broadcast techniques, network structure for packet switching, protocols, description of network e.g. ARPANET, etc.

CSC 432: Distributed Computing Systems (3 Units: LH 30; P 45)
Introduction: Definitions, Motivation; Communication Mechanisms: Communication Protocols, RPC, RMI, Stream Oriented Communication; Synchronization: Global State, Election, Distributed Mutual Exclusion, Distributed Transactions; Naming: Generic Schemes, DNS, Naming and Localization; Replication and Coherence: Consistency Models And Protocols; Fault Tolerance: Group Communication, Two-And Three-Phase Commit, Check pointing; Security: Access Control, Key Management, Cryptography; Distributed File Systems: NFS, Coda etc.

CSC 433: Computer Graphics and Visualization (2 Units: LH 30; P 45)
Hardware aspect, plotters microfilm, plotters display, graphic tablets, light pens, other graphical input aids Facsimile and its problems Refresh display refresh huggers, changing images, light pen interaction. Two and three dimensional transformation, perspective Clipping algorithms. Hidden line removal bolded surface removal. Warnock method/ algorithm, shading, data reduction for graphical input. Introduction to had writing and character recognition. Curve synthesis and fitting. Contouring. Ring structures versus doubly linked lists. Elerarchical structures. Data structure: Organization for intersotive graphics.

CSC 441: Human-Computer Interface (HCI) (2 Units: LH 30)
Foundations of HCI, Principles of GUI, GUI toolkits;
Human-centred software evaluation and development;
GUI design and programming.

CSC 452: Formal Models of Computation (3 Units: LH 30; PH 45)
Automata theory: Roles of models in computation. Finite state Automata, Push-down Automata, Formal Grammars, Parsing, Relative powers of formal models. Basic computability: Turing machines, Universal Turing_Machines, Church's thesis, solvability and Decidability.

CSC 482: Computer Simulations (3 Units: LH 30; PH 45)
Basic Definitions and Uses, Simulation Process, Some basic statistic Distributions Theory, Model and Simulation. Queues; Basic components, Kendal notation, Queuing rules, Little's Law, Queuing networks, Special/types of queues. Stochastic Processes; Discrete state and continuous state processes, Markov processes, Birth-Death Processes, Poisson Processes. Random Numbers; types of Random Number Exercises.

CSC 492: Special Topics in Computer Science (3Units: LH 30; P 45)
Special topics from any area of computer science considered relevant at given time. Topics are expected to change from year to year. Apart from seminars to be given by lecturers and guests, students are expected to do substantial readings on their own.

CSC 499: Project (6 Units: PH 270)
Students should embark on work that will lead to substantial software development under the supervision of a member of staff.

3.8 ENVIRONMENTAL MANAGEMENT AND TOXICOLOGY (BSc)

3.8.1 Philosophy, Aims and Objectives of the Degree Programme

The philosophy of the programme is in the training of Personnel to the highest academic standard in the identification and resolution of environmental issues. The programme will provide skilled manpower, trained specifically for environmental surveillance, monitoring and management as against the present practice where these tasks were performed by people trained in Basic and Applied Sciences.

The programme is designed to provide the training needed for an understanding of the environment and to build upon this foundation by exploring in some depths, specific aspect such as resource depletion, recycling, re-use and the impact of Science and Technology on the environment.

3.8.2 Admission and Graduation Requirements

Admission into the programme may be through any of the following modes:

- **UTME**: Candidates who have successfully completed the Senior Secondary School 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 at-least a pass in Physics. Candidate must have acceptable score in the UTME with relevant subject combination.

- **Direct Entry**: Candidates who fulfils above requirements and who have obtained G.C.E Advanced Level or equivalent passes in Biology and Chemistry may be admitted into the 200 Level of the programme.

3.8.3 Learning Outcomes

a) **Regime of Subject Knowledge**

The degree will provide students with the knowledge and understanding required by today's Environmental Scientists, with career opportunities in Environmental Management, Environmental Toxicology, Research, Consultancy, Policy and Environmental Protection.

b) **Competencies and Skills**

The degree programme emphasises the importance of integrating Biology, Ecology, Chemistry, Physics, Geography etc, in order to understand the Science of human impact on the environment, and how these need to be applied within the context of social, legal and political frameworks to resolve some of the major environmental issues facing the world.

PLEASE NOTE: Conclusive statement shall be made on the minimum CGPA of 1.5 for graduation after the forthcoming workshop on Grading System

c) **Behavioural Attitude**

Graduates of Environmental Management are governed by their code of professional conduct of the professional body.

These attributes relate to:

- The ability to discharge professional obligations to members of the public
- Display of professional integrity
- Competence with General Ethics
- Compliance with the Regulation of Society
- Participation in Professional Environmental Management

3.8.4 Attainment Levels

Graduates of Environmental Management and Toxicology are expected to have the ability to apply knowledge and skills to solving theoretical and practical problems in the environment relating to pollution, degradation and waste management.

3.8.5 Career opportunities

Employment opportunities exist for graduates of Environmental Management and Toxicology as practicing environmental scientists, resource analysts and planners in public agencies and private firms specialising in environmental issues.

3.8.6 Resource Requirement for Teaching and Learning

a) Academic and non-Academic Staff (See section 1.6)
b) Academic and Non-Academic Spaces (See section 1.6)
c) Academic and Administrative Equipment (See section 4)
d) Library and Information Resources (See section 1.6)

3.8.7 Course Structure

Course Structure at 100 Level: Environmental Management & Toxicology

Course Code	Course Title	Units	Status	LH	PH
ECO 101	Economic Principles	4	E	60	-
BIO 101	General Biology I	3	C	45	-
BIO 102	General Biology II	3	C	45	-
BIO 107	General Biology Practical I	1	C	-	45
BIO 108	General Biology Practical II	1	C	-	45
CHM 101	General Chemistry I	3	C	45	-
CHM 102	General Chemistry II	3	C	45	-
CHM 107	General Chemistry Practical I	1	C	-	45
CHM 108	General Chemistry Practical II	1	C	-	45
GST 111	Communication in English I	2	C	30	-
GST 112	Logic, Philosophy & Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills & ICT	2	C	30	-
MTH 101	Elementary Mathematics I	3	R	45	-
MTH 102	Elementary Mathematics II	3	R	45	-
PHY 101	General Physics I	3	R	45	-
PHY 102	General Physics II	3	R	45	-
PHY 107	General Physics Practical I	1	R	-	45
PHY 108	General Physics Practical II	1	R	-	45
	Total	**42**			

Course Structure at 200 Level: Environmental Management & Toxicology

Course Code	Course Title	Units	Status	LH	PH
BCH 201	General Biochemistry I	3	R	45	-
BCH 202	General Biochemistry II	3	E	45	-
BIO 202	Introductory Ecology	2	R	15	45
BIO 203	General Physiology I	2	E	30	-
CHM 210	Physical Chemistry I	3	R	30	45
CHM 211	Organic Chemistry I	3	R	30	45
CHM 212	Inorganic Chemistry I	3	R	30	45
CSC 201	Computer Programming I	3	R	30	45
EMT 201	Principles of Environmental Science	2	C	30	-
EMT 202	Methods in Environmental Analysis	3	C	30	45
AFM 310	Oceanography	2	E	15	45
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment & Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
WMA 202	Introduction to Climatology and Biogeography	3	E	30	45
WMA 204	Elements of Hydrology	2	E	30	-
	Total	**42**			

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Course Structure at 300 level: Environmental Management & Toxicology

Course Code	Course Title	Units	Status	LH	PH
EMT 300	Environment, Ecosystem and Man	2	C	30	-
EMT 301	Principles of Natural Resources Management	2	C	30	-
EMT 304	Hazardous Substance Management	2	C	30	-
EMT 305	Metal and the Environment	2	C	30	-
EMT 306	Environmental Assessment Techniques	3	C	45	-
EMT 307	Environmental Pollution Studies	2	R	15	45
EMT 308	Environmental Aspects of Pesticides and other Toxicants Usage	3	R	30	45
EMT 309	Remote Sensing Techniques	3	E	30	45
FWM 305	Wildlife Ecology and Management	2	E	15	45
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
PHY 206	Energy and Environment	1	R	15	-
SOS 312	Soil Chemistry and Soil Microbiology	3	R	30	45
STA 201	Statistics for Agriculture & Biological Sciences	4	R	60	-
	Total	**35**			

Course Structure at 400 Level: Environmental Management Option

Course Code	Course Title	Units	Status	LH	PH
EMT 401	Environmental Monitoring System & Techniques	3	R	30	45
EMT 403	Environmental Aspect of Farming Systems	3	E	30	45
EMT 405	Environmental Education & Awareness	2	R	30	-
EMT 409	Analysis of Miscellaneous Materials	3	R	30	45
EMT 411	Water Analysis	1	R	-	45
EMT 421	Regional Planning	2	R	30	-
EMT 427	Geographic Information System (GIS)	2	E	30	-
EMT 499	Industrial Attachment (24 Weeks)	6	C		
	Total	**22**			

Course Structure at 400 Level: Environmental Toxicology Option

Course Code	Course Title	Units	Status	LH	PH
EMT 401	Environmental Monitoring System & Techniques	3	R	30	45
EMT 403	Environmental Aspect of Farming	3	E	30	45
EMT 405	Environmental Education & Awareness	2	R	30	-
EMT 407	Principles of Toxicology I	3	C	30	45
EMT 409	Analysis of Miscellaneous Materials	3	R	30	45
EMT 411	Water Analysis	1	R	-	45
EMT 413	Experimental Pesticide Chemistry & Residue	1	R	-	45
EMT 427	Geographic Information System (GIS)	2	E	30	-
EMT 499	Industrial Attachment (24 Weeks)	6	C		
MCB 425	Environmental Microbiology	3	E	30	45
MCB 431	Petroleum Microbiology	3	E	30	45
	Total	**30**			

Course Structure at 500 Level: Environmental Management Option

Course Code	Course Title	Units	Status	LH	PH
BTG 416	Bio-resources Management	3	R	45	-
EMT 501	Environmental Law	2	R	30	-
EMT 504	Waste Management	3	C	30	45
EMT 506	Human Settlement and Development	3	R	30	45
EMT 507	Seminar	2	C		
EMT 510	Natural Resources Conservation & Environmental Management	2	R	30	-
EMT 511	Ecological Disasters and Control	3	R	30	45
EMT 512	Petroleum and Environment	2	R	30	-
EMT 523	Environmental Health	2	R	30	-
EMT 599	Research Project	6	C	-	270
	Total	**28**			

Course Structure at 500 Level: Environmental Toxicology Option

Course Code	Course Title	Units	Status	LH	PH
BTG 416	Bio-resources Management	3	R	45	-
CHM 312	Separation Methods and Analysis	3	R	30	45
EMT 501	Environmental Law	2	R	30	-
EMT 503	Principles of Toxicology II	2	C	30	-
EMT 504	Waste Management	3	C	30	45
EMT 505	Principles of Analysis of Toxicants	3	R	30	45
EMT 507	Seminar	2	C		
EMT 509	Structural Elucidation of Organic Pollutants	3	R	30	45
EMT 511	Ecological Disasters and Control	3	E	30	45
EMT 512	Petroleum and Environment	2	R	30	-
EMT 514	Miscellaneous Techniques in Environmental Analysis	2	R	30	-
EMT 599	Research Project	6	C	-	270
	Total	**34**			

3.8.8 **Course Synopses:**

EMT 201: Principles of Environmental Science (2 Units: LH 30)
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 (3 Units: LH 30; PH 45)
Review of fundamental concepts. Sampling techniques, statistical treatment, analytical data, accuracy, precision, errors, student's 'T' function, and rejection of outliers. Gravimetric analysis: Types; precipitate/crystal formation, contamination and appropriate handling of precipitates/crystals, co-precipitation, precipitation from homogenous solution. Titrimetric analysis: Acid-base, redox, complexometric, precipitation non-aqueous titrations, indicators. Colorimetry: Spectrophotometric reagents, elementary visible spectrophotometry: spectrophotometric titrations.

EMT 300: Environment, Ecosystems and Man (2 Units: LH 30)
Population, community, ecosystem, environment and environmental factors. Study of communities and ecosystem, abundance, density, yield, cover, frequency. The ecology of niche, 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 301: Principles of Natural Resources Management **(2 Units: LH 30)**
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 304: Hazardous Substances Management **(3 Units: LH 45)**
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 305: Metal and the Environment **(2 Units: LH 30)**
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 306: Environmental Assessment Techniques **(3 Units: LH 45)**
Introduction and principles of environmental assessment including Environmental Impact Assessment (EIA) and Environmental Auditing. Environmental Modelling, GIS methods. Types of Environmental Impact, identification, prediction, evaluation, impact mitigation, environmental monitoring. Environmental policy and regulations on environmental assessment. Risk assessment.

EMT 307: Environmental Pollution Studies **(2 Units: LH 15; PH 45)**
Introduction and principles of pollution of environmental media (air, soil and water) and associated resources. Fate of pollutants, effects and monitoring. Environmental indicators of pollution and marker compounds. Remediation of contaminated environment.

EMT 308: Environmental Aspects of Pesticide & other Toxicants' Usage
(3 Units: LH 45)
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 309: Remote Sensing Techniques (3 Units: LH 30; PH 45)
Concept of remote sensing. The electromagnetic spectrum; imaging systems and their capabilities, remote sensing platforms; applications in natural resource surveys and monitoring land use.

EMT 401: Environmental Monitoring Systems & Techniques
(3 Units: LH 30; PH 45)
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. green house 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: Environmental Aspects of Farming Systems (3 Units: LH 45)
- Farm systems and farming systems.
- The relevance of the farm-system approach
- Classification of farming systems
- Difficulties of farming systems
- Problems and peculiarities of shifting cultivation
- Characteristics and problems of permanent upland cultivation
- Irrigation farming
- Environmental and health implication of irrigation
- Perennial crop farming
- Ranching
- Institutional and environmental requirements of site related systems.

EMT 405: Environmental Education and Awareness (2 Units: LH 30)
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 407: Principles of Toxicology 1 **(3 Units: LH 30; PH 45)**

History of toxicology, Biochemistry cellular and molecular toxicology. Biotoxins, carcinogenesis, tetratogenesis and mutagenesis/genetic science, biotransformation of toxicants. Systematic toxicology, toxic responses of blood, liver, kidney, respiratory systems, central nervous systems, skin, reproductive system, eye and the immune systems. Practicals: Demonstration to topical application contract tests, systemic activity of pesticides. Acetycholinesterases inhibition in insects *in vivo* and *in vitro*. Inhibition of egg hatch in nematodes and chitin deposition in insects.

Resistance tests in insects. Probit analysis. Effect of gamma irradiation on insect development studies. Effect of morphogenic agents on larval and pupa development in insects. Autoradiographic studies. Bioassay of resistant/susceptible strains of insects, audiovisuals.

EMT 409: Analysis of Miscellaneous Materials **(3 Units: LH 30; PH 45)**

Analysis of air, soils, minerals, rocks and other miscellaneous materials.

EMT 411: Water Analysis **(1 Unit: PH 45)**

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 413: **Experimental Pesticide Chemistry and Residue Analysis** **(1Unit: PH 45)**

Sampling: Planning the sampling programme, sample containers, collection of various environmental samples – water, solid sediments, vegetation, blood, milk, fish, invertebrates, birds, mammals, air ,etc.

Sample Preservation: Extraction and clean-up methods, instrumentation for pesticide analysis, use of gas chromatograph for determination of pesticide residues; analytical quality assurance; recovery and precision studies. Pesticide formulation analysis. Experimental designs and field/green house trials on effect of pesticide on (a) growth and yield of crops, (b) control of pests and diseases, (c) insect resistance probit analysis. Screening of Nigerian herbs for pesticidal activities. Phytochemical characterisation/ analysis of extracts of Nigerian herbs. Maintenance, trouble shooting and calibration of instruments.

EMT 421: Regional Planning **(2 Units: LH 30)**

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 427: Geographic Information System (GIS) **(2 Units: LH 15; PH 45)**

Survey of the development of geographical data collection procedures; exploration, land use survey, regional planning surveys, computer cartography, geographic coding, remote sensing.

EMT 499: Industrial Attachment (24 Weeks) (6 Units)
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.

EMT 501: Environmental Law (2 Units: LH 30)
Basic concept 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 advance countries. e.g. USA, Canada, etc. International laws and conventions.

EMT 503: Principles of Toxicology II (2 Units: LH 30)
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 504: Waste Management (3 Units: LH 30; PH 45)
Types and forms of wastes. Sources of waste. Methods of solid, liquid and gaseous waste management technology including wastes recycling and utilization. Institutional arrangements for waste management. Environmental health effects of waste management. Economics of waste management; waste management strategies. Case studies.

EMT 505: Principles of Analysis of Toxicants (3 Units: LH 45)
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 506: Human Settlement and Development (3 Units: LH 45)
- 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 507: Seminar (2 Units)

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 509: Structural Elucidation of Organic Pollutants (3 Units: LH 30; PH 45)

Structural elucidation of organic pollutants, basic instrumentation and techniques. Applications of uv, ir, nmr, and ms in chemical analysis and structural elucidation of organic pollutants.

EMT 510: **Natural Resources Conservation & Environmental Management (2units: LH 30)**

Natural resources, concepts and definitions; Natural resources exploitation; environmental/ecological implications of threatened/endangered natural resources; sustainable use and conservation of natural resources.

EMT 511: Ecological Disasters and Control (3 Units: LH 45)

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 512: Petroleum and Environment (2 Units: LH 30)

Origin and composition of crude oil, composition of refined oils; extent, sources, fate and effects of oil in the environment. Characteristic of biogenic and petrogenic hydrocarbons; control of oil pollution. Oil pollution monitoring; sampling, sample containers, extraction, clean-up, identification and quantification; oil tagging. Use of bio-indicators in oil pollution monitoring. Biomarkers.

EMT 514: Miscellaneous Techniques in Environmental Analysis (2 Units: LH 30)

Miscellaneous advanced techniques in environmental analysis X-ray methods, neutron activation and radiochemical methods, enzymatic and kinetic methods, automated and process analyzers.

EMT 523: Environmental Health (2 Units: LH 30)

This course exposes 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: PH 270)**
Investigation of an environmental research problem.

AFM 310: Oceanography **(2 Units: LH 15; PH 45)**
Study of the temperature and chemistry of sea water. Biological activities and their distribution. Salinity, chlorinity, currents, tides, waves, sound and radiation in the sea, conductivity, diffusion, viscosity and dynamics of sea water distribution and plankton. Brackish water condition and fauna. Interrelationship and physiological adaptations of marine organisms.

ECO 101: Economic Principles **(4 Units: LH: 60)**
An introduction to the various issues, the nature of economic science, the methodology of economics, major areas of specialisation in economics, stressing historical development of ideas, major findings in the various areas of specialization, elementary principles of micro and macro-economics, current issues of interest and probable future developments.

FRM 505: Forest & Wildlife Policy, Law & Administration **(2 Units: LH 30)**
Forest, wildlife and related natural resources, policies, planning effective use of forest resources, structure of wildlife administration, problems of conserving forest and endangered species. Nigerian law on natural resources management. Administration and wildlife conservation for economic and recreation uses, problems of wildlife conservation in Nigeria.

FWM 306: Wildlife Ecology and Management **(3 Units: LH 30; PH 45)**
Organisation of Wildlife Resources. Wildlife in relation to their environment. Factors affecting distribution and abundance of wildlife. Wildlife population characteristic of mortality, movement, lifecycles, food and food habits. Wildlife capture techniques: objectives of traps and consideration for design: immobilization by drugs. Handling, care and feeding of captured animals; field exercises of different capture methods.

SOS 312: Soil Chemistry & Soil Microbiology **(3 Units: LH 30; PH 45)**
Introduction to soil chemistry. Historical perspective. Chemical composition of soils, soil colloids: inorganic and organic colloids. Silicate mineral chemistry. Cation and anion exchange phenomena and base saturation. Flocculation and dispersion. Soil reaction (active and reserve acidity, alkalinity, buffering capacity, soil acidity and liming, lime requirements and management consideration). Soil organisms, perspective on the biosphere (energy and nutrient cycles): Classification systems; Distribution in soils, growth requirements and functions of representative groups of microfauna and macrofauna, microflora and macroflora. Association between microbe and plants. Soil organic matter. Importance of soil organic matter in humid tropical soils; general decomposition process. Humification; organic matter maintenance. The dynamics of N, P and S pools.

WMA 202: Introduction to Climatology & Biogeography **(3 Units: LH 30; PH 45)**
Basic definitions and explanations in climatology and biogeography. Climatological problems and investigation methods – relationship with meteorology, bio-geography and hydrology, climatology data processing methods; basic factors of climate formation,

influence of relief on climate and plants. Geographical distribution of climate elements, plants and animals, climate and soil. The concept of adaptation in plants and animals. Classification of climate and biogeography of the earth.

WMA 204: Elements of Hydrology **(2 Units: LH 30)**
Definition, scope and application of hydrology. The concept of hydrological cycle and drainage basin characteristics: precipitation-forms, types and measurements. Factors affecting interception, evaporation, evapotranspiration, surface run-off and subsurface flow. Determination and analysis of infiltration, percolation, permeability, aquifers and groundwater movement.

WMA 307: Water Resources of Nigeria **(2 Units: LH 30)**
Rainfall-pattern, spread and quantity. Daily, monthly and yearly rainfall in different regions of the country. Rivers in Nigeria – main rivers and their flows, average flow, maximum and minimum flow, annual yield. Rivers Niger, Benue, Ogun, Kaduna, Sokoto, Rima, Hadejia, Jamare, Gurara etc. Lakes and reservoirs, natural and artificial lakes, reservoirs above dams - Kainji and Jebba. Tiga dams and reservoirs etc. Reservoirs behind small and medium earth dams in different states in Nigeria. Tidal and saline waters in the coastal areas. Groundwaters – in boreholes and tubewells. Use of water - irrigation for agriculture, water supply and waste water engineering, navigation, hydropower generation, environmental sanitation, industrial use, etc. Agencies – Federal Ministry of Agriculture and Water Resources. Water Corporations. Department of Waterways and Navigation, River Basin Development Authorities, Research Institute, Universities.

WMA 308: Synoptic Meteorology **(2 Units: LH 30)**
General information on synoptic meteorology methods of long and short range weather forecasts. Basic synoptic codes-prospects of using meteorological satellite data – elements of world weather watch: compilation and analysis of weather charts. Analysis of the fields of meteorological elements. Air masses – their classification and properties: Atmospheric forms, cyclone activity. Macro-synoptic processes and long-range weather forecast; laws of general atmospheric circulation: Peculiarities of circulation in various areas of the globe.

3.9 GEOLOGY (BSc)

3.9.1 Philosophy, Aims and Objectives of the Degree Programme

The main aims and objectives of the degree programme in Geology should be:

a. To instil in students a sense of enthusiasm for Geology, an appreciation of its application and relevance in the solution of different societal developmental problems, and to involve them in an intellectually stimulating and satisfying experience of learning and studying.

b. To provide students with a broad and balanced foundation of geological knowledge and practical skills.

c. To develop in students the ability to apply their geological knowledge and skills to the solution of theoretical and practical problems in geology.

d. To develop in students, a range of transferable skills and attitudes that are of value in geological and non-geological employment.

e. To provide students with the knowledge and skills base from which they can proceed to further studies in specialized areas of geology or multi-disciplinary areas involving geology

f. To inculcate in students an appreciation and application of Geology in an industrial, economic, environmental, technological and social development.

3.9.2 Admission and Graduation 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 School Certificate 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.

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.

3.9.3 Learning Outcomes

(i) **Regime of Subject Knowledge**

Each university providing degree programme in geology is free, within the context of academic freedom and university autonomy, to decide on the content, nature and organization of its courses and modules. Therefore, geology degree programmes offered by individual universities may differ in particular characteristics and depth of treatment of individual aspects. It is however expected that all geology programmes will ensure that students become conversant with the following main aspects of geology.

a. Major aspects of geological terminology, nomenclature, conventions, units and a sound understanding of the fundamental concepts in geology.
b. The major groups of rocks and their characteristic features
c. Earth history and the concept of time in geology
d. Physical geology and the practical identification of common rockforming minerals and fossils.
e. Crystallography, mineralogy and the principles and procedures of identifying minerals using the polarizing microscope.
f. Principles and techniques of field geology and the interpretation of topographic and geologic maps.
g. Systematic palaeontology covering the morphology, evolution, identification of major animal phyla including their stratigraphic and paleoecologic distributions.
h. The morphology and classification of pollens and spores and their applications in stratigraphic and palaeoenvironmental studies
i. The characteristics of igneous and metamorphic rocks and the geological processes which gave rise to them.
j. The characteristic features of sedimentary rocks including their structure and composition and the recognition of sedimentary environments from the rock records.
k. The principles and concepts of stratigraphy and their application in sedimentary basin analysis.
l. The principles and processes of formation of mineral deposits and techniques for their evaluation.
m. Petroleum geology and the nature of source and reservoir rocks and hydrocarbon traps and evaluation of petroleum potential of a sedimentary basin.
n. Applications of the physical and chemical properties of rocks in the design of exploration techniques in the search for groundwater, mineral deposits, hydrocarbon and engineering foundation studies.
o. An appreciation of the value of fieldwork in geology, which is practicalised by field training programmes and skills acquisition through industrial attachment.
p. Awareness of major issues currently at the frontiers of geological research and development.

(ii) **Competencies and Skills**

Geology students are expected to develop a wide range of different abilities and skills. These are divided into two broad categories as follows:
Geology – related cognitive abilities and skills
Geology – related practical skills

(iii) **Behavioural Attitudes**

Transferable skills that may be developed in the context of geology but are of a general nature and applicable in non-geology contexts.

3.9.4 Attainment Levels

Graduates of Geology are expected to have the ability to apply knowledge and skills to solving theoretical and practical problems in the exploration and exploitation of natural earth resources and also be able to carry out research in Geo-Sciences.

3.9.5 Career Opportunities

Employment opportunities exist for graduates of Geology in government agencies, environmental and geotechnical consulting, research laboratories and many key industries including mining, oil and gas.

3.9.6 Resource Requirement for Teaching and Learning

a) Academic and non-Academic Staff (See section 1.6)
b) Academic and Non-Academic Spaces (See section 1.6)
c) Academic and Administrative Equipment (See section 4)
d) Library and Information Resources (See section 1.6)

3.9.7 Course Structure

Course Structure at 100 Level Geology

Course Code	Course Title	Units	Status	LH	PH
BIO 101	General Biology I	3	R	45	-
CHM 101	General Chemistry I	3	R	45	-
CHM 102	General Chemistry II	3	R	45	-
CHM 107	General Chemistry Practical I	1	R	-	45
CHM 108	General Chemistry Practical II	1	R	-	45
CSC 101	Introduction to Computer Science	3	R	30	45
GEY 101	Introduction to Geology I	3	C	30	45
GEY 102	Introduction to Geology II	3	C	30	45
GST 111	Communication in English I	2	C	30	-
GST 112	Logic, Philosophy & Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills and ICT	2	C	30	-
MTH 101	Elementary Mathematics I	3	R	45	-
PHY 101	General Physics I	3	R	45	-
PHY 102	General Physics II	3	R	45	-
PHY 107	General Physics Practical I	1	R	-	45
PHY 108	General Physics Practical II	1	R	-	45
STA 111	Descriptive Statistics	4	R	60	-
	Total	**43**			

Course Structure at 200 Level Geology

Course Code	Course Title	Units	Status	LH	PH
CHM 212	Inorganic Chemistry I	3	R	30	45
CHM 213	Analytical Chemistry I	2	R	15	45
GEY 201	Physical Geology	2	C	15	45
GEY 202	Crystallography and Systematic Mineralogy	3	C	30	45
GEY 203	Introduction to Petrology	3	C	30	45
GEY 205	Invertebrate Palaeontology	2	C	15	45
GEY 206	Introduction to Igneous & Metamorphic Petrology	2	R	15	45
GEY 207	Principles of Stratigraphy	2	C	30	-
GEY 208	Mineral Resources and Environmental Geology	2	R	30	-
GEY 209	Introduction to Surveying	3	R	15	90
GEY 210	Geological Map Interpretation and Field Mapping	3	C	15	90
GEY 299	Industrial Attachment I	3	C		
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
PHY 210	Physics for Solid Earth	2	R	30	-
STA 202	Statistics for Physical Sciences & Engineering	4	E	60	-
		44			

Course Structure at 300 Level Geology

Course Code	Course Title	Units	Status	LH	PH
GEY 301	Geochronology & Precambrian Geology of Africa	2	R	30	-
CSC 201	Computer Programming I	3	R	30	45
GEY 302	Quaternary and Environmental Geology	2	E	30	-
GEY 303	Optical and Determinative Mineralogy	2	C	15	45
GEY 304	Igneous and Metamorphic Petrology	3	C	30	45
GEY 305	Sedimentary Depositional Environments and Basins of Africa	2	R	30	-
GEY 306	Marine Geology	2	R	30	-
GEY 307	Introduction to Applied Geology	2	R	15	45
GEY 308	Principles of Geophysics	2	R	30	-
GEY 310	Mapping & Industrial Techniques in Geology	2	C	-	90
GEY 312	Photogeology and Remote Sensing	2	R	15	45
GEY 313	Structural Geology	3	C	30	45
GEY 314	Sedimentology and Sedimentary Petrology	3	C	30	45

GEY 315	Geochemistry	2	R	15	45
GEY 316	Palaeobiology	2	R	30	-
GEY 399	Industrial Attachment II	3	C		
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
PGE 311	Drilling Methods	3	E	45	-
		46			

Course Structure at 400 Level Geology

Course Code	Course Title	Units	Status	LH	PH
GEY 401	Advance Mineralogy	2	E	15	45
GEY 402	Igneous Petrology	2	C	15	45
GEY 403	Metamorphic Petrology	2	R	15	45
GEY 404	Economic Geology	3	C	30	45
GEY 405	Applied Geochemistry and Isotope	2	R	30	-
GEY 406	Micropalaeontology and Palaecology	3	R	30	45
GEY 407	Advanced Sedimentary Petrology	2	R	15	45
GEY 408	Petroleum Geology	2	C	30	-
GEY 409	Applied Geophysics	3	C	30	45
GEY 410	Engineering Geology	2	R	30	-
GEY 411	Hydrogeology	2	R	30	-
GEY 412	Advanced Global Tectonics and Structures	2	R	30	-
GEY 413	Field Geology of Nigeria	2	C	-	90
GEY 414	Seminar in Geology	2	R		
GEY 415	Project in Geology	6	C	-	270
		37			

3.9.8 **Course Synopses:**

GEY 101: Introduction to Geology I **(3 Units: LH 30; PH 45)**
Elements of Physical geology and physiographic features of the Earth. Classification, properties and description of major minerals, rock types and occurrence of economic minerals. History of the Earth and Universe.

GEY 102: Introduction to Geology II **(3 Units: LH 30; PH 45)**
Theory of evolution of organism. Distribution and classification of major fossil groups and their occurrence and uses. Principles of historical geology, and stratigraphy.

GEY 201: Physical Geology **(2 Units: LH 15; PH 45)**
Planet Earth: its composition from core to crust. Minerals; rocks and weathering. Surface processes and landforms, major earth structures. Practical identification of common rock-forming minerals and rocks; interpretation of topographical and simple geologic maps.

GEY 202: Crystallography and Systematic Mineralogy (3 Units: LH 30; PH 45)
The main morphological properties, classification and mode of occurrence of rock forming minerals. Crystal system and identification.

GEY 203: Introduction to Petrology (3 Units: LH 30; PH 45)
The principal igneous, sedimentary and metamorphic rocks. Their characteristics features and microscopic textures and their identification.

GEY 204: Mineral Resources and Environmental Geology (2 Units: LH 30)
Elementary geology, distribution and utilization of metallic and non-metallic mineral resources, and energy resources. Fossil fuels; surface and underground water hydrology. Pollution and its sources, hazards, and control. Prediction and control of geologic hazards.

GEY 205: Invertebrate Palaeontology (2 Units: LH 15; PH 45)
Major invertebrate fossil groups, their classification, ecology, stratigraphic distribution and evolutionary trends. Origin of the atmosphere, hydrosphere and biosphere.

GEY 206: Introduction to Igneous & Metamorphic Petrology (2 Units: LH 15; PH 45)
Origin, occurrence, geologic setting and systematic description of igneous rocks. Metamorphism and description of metamorphic rocks, metamorphic minerals and textures of metamorphic rocks.

GEY 207: Principles of Stratigraphy (2 Units: LH 30)
Basic principles of stratigraphy applied to sedimentary sequences in geologic time, facies and facies changes.

GEY 208: Mineral Resources and Environmental Geology (2 Units: LH 30)
Metallic and non-metallic mineral resources – their composition, distribution and utilisation. Fossil fuels, surface and underground water hydrology. Pollution and its sources, hazards and control. Prediction and control of geologic hazards.

GEY 209: Introduction to Surveying (3 Units: L 15; P 90)
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, and geological and mining evaluation.

GEY 210: Geological Map Interpretation & Field Mapping (3 Units: LH 15; PH 90)
Practical – recording of geological features and base maps. Field techniques. Interpretation and simple geological maps.

GEY 299: Industrial Attachment I (12 Weeks) (3 Units)
Students should be attached to some industrial 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

GEY 301: Geochronology & Precambrian Geology of Africa (2 Units: LH 30)
Geology and evolution of Precambrian domains and rocks, with special reference to Africa. Radiometric age determination

GEY 302: Quaternary and Environmental Geology (2 Units: LH 30)
Nature, distribution and economic significance of superficial deposits, environmental monitoring and controls.

GEY 303: Optical and Determinative Mineralogy (2 Units: LH 15; P 45)
Principles of optics and crystallography, optical properties of the common rock forming minerals.

GEY 304: Igneous and Metamorphic Petrology (3 Units: LH 30; P 45)
Character and Origin of igneous and metamorphic rocks. Crystallization of magma and igneous suites. Control of metamorphism and facies concepts. Microscopic textures of igneous and metamorphic rocks.

GEY 305: Sedimentary Depositional Environments & Basins of Africa (2 Units: LH 30)
Physical, chemical and biological influence on marine and continental depositional environments and their sedimentation patterns. Analysis of the African sedimentary basins.

GEY 306: Marine Geology (2 Units: LH 30)
Character of oceans and continental margins. Basic oceanography and resources of the seas.

GEY 307: Introduction to Applied Geophysics (2 Units: LH 15; P 45)
Physical properties of rocks and materials, and their measurements. Application of geology to engineering and water problems.

GEY 308: Principles of Geophysics (2 Units: LH 30)
Introduction to seismic, gravity and magnetic methods, techniques of acquisition and interpretation of geophysical data.

GEY 310: Mapping and Industrial Techniques in Geology (2 Units: PH 90)
Field study of specific areas and production of geological maps and reports. Study and interpretation of geological maps. Industrial exposure in earth sciences.

GEY 312: Photogeology and Remote Sensing **(2 Units: LH 15; PH 45)**
Techniques of photogrametry, study, and interpretation of aerial photographs and satellite imageries; applications to mineral resources, and environmental evaluation.

GEY 313: Structural Geology **(3 Units: LH 30; PH 45)**
Dynamics of rocks, 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: Sedimentology & Sedimentary Petrology **(3 Units: LH 30; PH 45)**
Sources, transportation and deposition of sediments, diagenesis and lithification. Textures and structures of sediments and sedimentary rocks. Description and interpretation of ancient sediments.

GEY 315: Geochemistry **(2 Units: LH 15; PH 45)**
Abundance, classification and distribution of elements in rocks and materials. Aspect of geochemistry in relation to petrology, prospecting and environments.

GEY 316: Palaeobiology **(2 Units: LH 30)**
Palaeontology, sampling, palaeontologic principles and palaeobiologic models, macro and micro-evolution, statistical data analysis of palaeontologic data.

GEY 399: Industrial Attachment II (12 Weeks) **(3 Units)**
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 are to be assessed based on seminar presentation, their reports and assessment by supervisors

GEY 401: Advanced Mineralogy **(2 Units: LH 15; PH 45)**
Optical and X-ray properties and structures of minerals. Systematic mineralogy including crystal chemistry

GEY 402: Igneous Petrology **(2 Units: LH 15; PH 45)**
Igneous rocks, origin and differentiation of magmas, magmatic provinces and relation to crystal chemistry.

GEY 403: Metamorphic Petrology **(2 Units: LH 15; PH 45)**
Metamorphic facies and isograde, contact and regional metamorphic zones. High and low, pressure metamorphic belts and distribution in time and space.

GEY 404: Economic Geology **(3 Units: LH 30; PH 45)**
Principles and processes of formation of mineral deposits. Prospecting, exploration, mine development and mineral treatment. Ore reserve calculation and mineral economics.

GEY 405: Applied Geochemistry and Isotopes (2 Units: LH 30)
Controls and element distribution in relation to petrogenesis, and ore genesis. Mineral exploration, environmental monitoring and its implication to Health.

GEY 406: Micropalaeontology and Palaeoecology (3 Units: LH 30: PH 45)
Distribution, classification and stratigraphical application of major groups of microfossils; palaeoecological interpretations and models.

GEY 407: Advanced Sedimentary Petrology (2 Units: LH 15; PH 45)
Provenance of sediments, types, diagnosis and sedimentation processes, qualitative and statistical analysis of textural and compositional parameters and reconstruction of sedimentary environment.

GEY 408: Petroleum Geology (2 Units: LH 30)
Origin, occurrence and distribution of hydrocarbon deposits and fields.

GEY 409: Applied Geophysics (3 Units: LH 30; PH 45)
Fundamentals of seismic, gravity, and electrical methods, emphasizing the interpretation of geophysical data related to applied geology.

GEY 410: Engineering Geology (2 Units: LH 30)
Application of geology to engineering problems in roads, bridge and dam construction.

GEY 411: Hydrogeology (2 Units: LH 30)
Geology, nature, origin and occurrence of groundwater, regional groundwater resource evaluation.

GEY 412: Advanced Global Tectonics and Structures (2 Units: LH 30)
Study of the major structures of the Earth, continental separation, plate tectonics, and patterns of crystal evolution in specific region.

GEY 413: Field Geology of Nigeria (2 Units: PH 90)
Field study through excursion to major geological features and type localities within the basement complex and sedimentary domain of Nigeria.

GEY 414: Seminar in Geology (2 Units)
Literature search, write-up, and presentation on a topic in Geology.

GEY 415: Project in Geology (6 Units: PH 270)
Geological investigation and independent research involving field, laboratory and library studies.

PGE 311 Drilling Methods. (3 Units: LH 45)
Petroleum explorations methods and general teasing practices. Cable tool Drilling rotary Drilling, Rotary Drilling hydraulics. Factors affecting penetration, Rotary Drilling techniques including vertical drilling, directional drilling and fishing operations. Drilling fluids. Well logging Formulation damage. Well cementing and casing practices well completion.

3.10 APPLIED GEOPHYSICS (BSc)

3.10.1 Philosophy, Aims and Objectives of the Degree Programmes

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.

The specific objectives of the Programme are among others, to:

i) Impact basic and fundamental knowledge in all areas of Applied Geophysics.

ii) 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.

iii) 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.

iv) Develop the necessary manpower needed for industrial, technological, research, and academic development of the country in all aspects of Applied Geophysics.

v) Provide effective teaching, research and practical oriented/field work programme that is required in all the fields of Applied Geophysics.

vi) 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.

3.10.2 Admission and Graduation Requirements

The entry requirements for UTME candidates 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 School Certificate or its equivalent. In addition, an acceptable pass in the UTME (Unified Tertiary Matriculation Examination) is required.

Candidates with a minimum of two A level passes (graded A-E) at the GCE/IJMB Advanced Level in two relevant subjects (Chemistry, Mathematics and Physics) may be admitted into 200-level through Direct Entry.

3.10.3 Learning Outcomes

a **Regime of Subject Knowledge**

The range of knowledge to be covered is the various areas of exploration, processing and interpretation methods in order to equip the students with the knowledge of the earth in general and the available natural earth resources of Nigeria in particular.

b **Competencies and Skills**

At the bachelors honours level, geophysics students are expected to develop a wide range of different abilities and skills. These are divided into three broad categories as follows:

Geophysics – related cognitive abilities and skills

Geophysics – related practical skills

c **Behavioural Attitudes**

Transferable skills that may be developed in geophysics graduates are in addition to contain skills of a general nature and applicable in general problem solving of human development.

3.10.4 Attainment Levels

Graduates of Geophysics are expected to have the ability to apply knowledge and skills to solving theoretical and practical problems in the exploration and exploitation of natural earth resources and also be able to carry out research in Geo-Sciences.

3.10.5 Career Opportunities

Employment opportunities exist for graduates of Applied Geophysics in governmental agencies, environmental and geotechnical consulting, research laboratories and many key industries including mining, oil and gas and energy.

3.10.6 Resource Requirement for Teaching and Learning

a) Academic and non-Academic Staff (See section 1.6)
b) Academic and Non-Academic Spaces (See section 1.6)
c) Academic and Administrative Equipment (See section 4)
d) Library and Information Resources (See section 1.6)

PLEASE NOTE: Conclusive statement shall be made on the minimum CGPA of 1.5 for graduation after the forthcoming workshop on Grading System

3.10.7 Course Structure

Course Structure at 100 Level Applied Geophysics

Course Code	Course Title	Units	Status	LH	PH
CHM 101	General Chemistry I	3	R	45	-
CHM 102	General Chemistry II	3	R	45	-
CHM 107	General Chemistry Practical I	1	R	-	45
CHM 108	General Chemistry Practical II	1	R	-	45
CSC 101	Introduction to Computer Science	3	R	30	45
GEY 101	Introduction to Geology I	3	C	30	45
GEY 102	Introduction to Geology II	3	C	30	45
GST 111	Communication in English I	2	C	30	-
GST 112	Logic, Philosophy & Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills & ICT	2	R	30	-
MTH 101	Elementary Mathematics I	3	R	45	-
MTH 102	Elementary Mathematics II	3	R	45	-
PHY 101	General Physics I	3	R	45	-
PHY 102	General Physics II	3	R	45	-
PHY 107	General Physics Practical I	1	R	-	45
PHY 108	General Physics Practical II	1	R	-	45
	Total	**39**			

Course Structure at 200 Level Applied Geophysics

Course Code	Course Title	Units	Status	LH	PH
CSC 201	Computer Programming I	3	E	30	45
GEY 201	Physical Geology	2	R	15	45
GEY 209	Introduction to Surveying	3	R	15	90
GEY 210	Geological Map Interpretation & Field Mapping	3	R	15	90
GPH 201	Introduction to Earth Physics	2	C	30	-
GPH 202	Geomathematics	3	R	45	-
GPH 299	Industrial Attachment I (12 Weeks)	3	C		
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MTH 201	Mathematical Methods I	3	E	45	-
MTH 202	Elementary Differential Equations	3	E	45	-
PHY 201	General Physics III	3	R	45	-
PHY 202	Introduction to Electric Circuits & Electronics	3	R	30	45
PHY 204	General Physics IV	3	R	45	-
PHY 205	Thermal Physics	3	R	45	-
PHY 207	Practical Physics III	1	R	-	45
PHY 208	Practical Physics IV	1	R	-	45
	Total	**47**			

Course Structure at 300 Level Applied Geophysics

Course Code	Course Title	Units	Status	LH	PH
GEY 207	Principles of Stratigraphy	2	C	30	-
GEY 312	Photogeology and Remote Sensing	2	R	15	45
GEY 313	Structural Geology	3	C	30	45
GEY 314	Sedimentology and Sedimentary Petrology	3	C	30	45
GPH 305	Geophysical field method & Instrumental Analysis	2	R	15	45
GPH 307	Magnetic Prospecting Methods	3	R	30	45
GPH 308	Seismic Refraction Prospecting Methods	3	R	30	45
GPH 309	Gravity Prospecting Methods	3	R	30	45
GPH 311	Principles of Geophysics	2	R	30	-
GPH 312	Electrical & Electromagnetic Methods	3	R	30	45
GPH 399	Industrial Training II/ Field Work (12 Weeks)	3	C		
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
MET 204	Introduction to the Atmosphere	2	E	30	-
PHY 303	Electromagnetism	3	R	45	-
STA 202	Statistics for Physical Sciences & Engineering	4	E	60	-
	Total	**44**			

Course Structure at 400 Level Applied Geophysics

Course Code	Course Title	Units	Status	LH	PH
GEY 408	Petroleum Geology	2	C	30	-
GEY 410	Engineering Geology	2	R	30	-
GEY 413	Field Geology of Nigeria	2	C	-	90
GPH 401	Research Project	6	C	-	270
GPH 405	Engineering Geophysics	3	R	45	-
GPH 408	Geophysical Seminar	2	C		
GPH 409	Radiometrics and Well Logging Methods	3	R	30	45
GPH 410	Geophysics and Geothermal Energy	3	R	30	45
GPH 411	Seismic Reflection Prospecting Methods	3	R	30	45
GPH 412	Groundwater Geophysics	3	R	30	45
GPH 413	Borehole Geophysics	3	R	30	45
GPH 414	Environmental Geophysics	3	R	30	45
GPH 415	Geophysical Time Series Analysis	3	E	30	45
PHY 206	General Physics V (Energy and Environment)	1	E	15	-
	Total	**39**			

3.10.8 Course Synopses

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

GPH 202: Geomathematics (3 Units: LH 30)
Differential and integral calculus. Types of functions. Vector analysis, magnetic and Gravity potential theory representation. Matrix algebra, solution of Laplace equations and spherical harmonic analysis. Fourier analysis. Statistical regression analysis, curve fitting techniques and analysis of errors. Bessel equation and Legendre polynomials. Solution of Matrix equations.

GPH 299: Industrial Attachment I (12 Weeks) (3 Units)
Students should be attached to some industrial 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

GPH 305: Geophysical Field Methods and Instrumental Analysis: (2 Units: LH 30)
Study of the essential elements of geophysical data acquisition systems. Seismic surveys using explosives or surface sources. Signal amplification, multiplexed, etc. 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 (3 Units: LH 30: PH 45)
Introduction: Potentials: 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 Methods (3 Units: LH 30; PH 45)
Geophysics and Mineral Exploration activity. 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, static correction charts.

GPH 309: Gravity Prospecting Methods (3 Units: LH 30; PH 45)
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: LH 30)
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; Elect-interpretation.

GPH 312: Electrical Prospecting Methods (3 Units: LH 30; PH 45)
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 areas of known geology.

GPH 399: Industrial Attachment II/ Field Work (12 Weeks) (3 Units)
Students should be attached to some industrial organizations 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.

GPH 401: Research Project (6 Units: PH 270)
Geological investigation and independent research involving field, laboratory and library studies.

GPH 405: Engineering Geophysics (3 Units: LH 45)
Shallow geophysical techniques for evaluation of engineering parameters; elastic co-efficient, geologic structured, groundwater, seismic hazards and regulatory criteria.

GPH 408: Geophysical Seminar (2 Units)
Students are to make presentations on materials from personal investigation or on materials selected from geophysical literature

GPH 409: Radiometrics and Well Logging Methods (3 Units: LH 30; PH 45)
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, E, Dip-meter, etc. Porosity logs, Sonics, gamma ray, density, neutron logs, etc…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 (3 Units: LH 30; PH 45)
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 (3 Units: LH 30; PH 45)
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, NMO charts.

GPH 412: Groundwater Geophysics: (3 Units: LH 30; PH 45)
Applications 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 (3 Units: LH 30; PH 45)
Concepts of the logging techniques. Electrical logging methods. Resistively, self-potential, induced Polarization, E, Dipmeter, etc. Porosity logs-sonics, gamma ray, density, neutron logs, etc…Others-susceptibility, caliper, thermal, gravimetry logs. Instruments, data acquisition and interpretation of logs, application of geophysical logs in oil and ground water exploration.

GPH 414: Environmental Geophysics (3 Units: LH 30; PH 45)
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.

GPH 415: Geophysical Time Series Analysis: (3 Units: LH 30; PH 45)
Review of Fourier transform, convolution auto correction, impulse response; 2-transom, sampling theory, filter design, particular attention to geophysical application for each topic.

3.11 INDUSTRIAL CHEMISTRY (BSc)

3.11.1 Philosophy, Aims and Objectives of the Degree Programme

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. The specific objectives of the Industrial Chemistry Programme are as follows:

a. To provide students with a thorough grounding in principles and sound knowledge of scientific methods of the chemical sciences.

b. Arouse a sense of curiosity and enquiring mind, in order to encourage and develop creative thinking and research aptitudes.

c. 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.

d. To 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.

e. Inculcate in students appropriate skills and abilities to manage and administer technological operations within the field of chemistry and allied areas;

f. Prepare students for professional participation in chemical industries. It is intended that graduates of this programme will be able to adapt themselves to jobs which are problem solving or results oriented in the chemical, petrochemical, biochemical and allied technological fields e.g; food, environmental, textiles, polymer etc.

3.11.2 Admission and Graduation Requirements

The entry requirements shall be at least credit level passes in five subjects including English Language, Mathematics, Chemistry to form the core subjects with credit in Physics, and any other relevant science subject at the Senior Secondary School Certificate or its equivalent. In addition, an acceptable pass in the Unified Tertiary Matriculation Examination (UTME) is required for admission into 100-level.

Candidates with a minimum of two A level passes (graded A-E) at the GCE Advanced Level in relevant subjects (Chemistry, Mathematics and Physics, Biology) may be considered for admission into 200-level.

3.11.3 Learning Outcomes

All degree students in Industrial Chemistry are expected to develop the following abilities and skills:

(a) **Regime of Subject Knowledge**
Cognitive abilities and skills relating to solution of problems in industrial chemistry and other allied chemical industries.

(b) **Competencies and Skills**
Practical skills relating to the conduct of laboratory work in chemical industries.

(c) **Behavioural Attitudes**
General skills relating to non-subject specific competencies, communication, interpersonal, organization skills.

3.11.4 Attainment Levels

Graduates of industrial chemistry are expected to have the ability to apply knowledge and skills to solving theoretical and practical problems in industrial chemistry and allied industries in relation to national and societal needs.

3.11.5 Career Opportunities

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, textile, paper and wood, paint, and environmental as well as several other regulatory agencies. The programme is also designed to equip students for self employment.

3.11.6 Resource Requirement for Teaching and Learning

a) Academic and Non-Academic Staff (See section 1.6)
b) Academic and Non-Academic Spaces (See section 1.6)
c) Academic and Administrative Equipment (See section 4)
d) Library and Information Resources (See section 1.6)

PLEASE NOTE: Conclusive statement shall be made on the minimum CGPA of 1.5 for graduation after the forthcoming workshop on Grading System

3.11.7 Course Structure

Course Structure at 100 Level: Industrial Chemistry

Course Code	Course Title	Units	Status	LH	PH
BIO 101	General Biology I	3	R	45	-
BIO 102	General Biology II	3	R	45	-
BIO 107	General Biology Practical I	1	R	-	45
BIO 108	General Biology Practical II	1	R	-	45
CHM 101	General Chemistry I	3	C	45	-
CHM 102	General Chemistry II	3	C	45	-
CHM 107	General Chemistry Practical I	1	C	-	45
CHM 108	General Chemistry Practical II	1	C	-	45
CSC 101	Introduction to Computer Science	3	R	30	45
GST 111	Communication in English I	2	C	30	-
GST 112	Logic, Philosophy & Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills & ICT	2	C	30	-
MTH 101	General Mathematics I	3	R	45	-
MTH 102	General Mathematics II	3	R	45	-
PHY 101	General Physics I	3	R	45	-
PHY 102	General Physics II	3	R	45	-
PHY 107	General Physics Practical I	1	R	-	45
PHY 108	General Physics Practical II	1	R	-	45
	Total	**41**			

Course Structure at 200 Level: Industrial Chemistry

Course Code	Course Title	Units	Status	LH	PH
CHM 210	Physical Chemistry I	3	C	30	45
CHM 211	Organic Chemistry I	3	C	30	45
CHM 212	Inorganic Chemistry I	3	C	30	45
CHM 213	Analytical Chemistry I	3	C	30	45
CHM 214	Structure and Bonding	2	R	30	-
CHM 251	Process Science I	3	R	45	-
CHM 252	Process Science II	3	R	45	-
CHM 253	Macromolecular Chemistry I	3	R	45	-
*CHM 299	Industrial Attachment I (12 Weeks)	3	C		
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
PHY 202	Electric Circuits and Electronics	3	E	30	45
STA 202	Statistics for Physical Sciences and Engineering	4	E	60	-
	Total	**41**			

***CHM 299 is only for students in institutions running a 4-year industrial chemistry programme.**

Course Structure at 300 Level: Industrial Chemistry

Course Code	Course Title	Units	Status	LH	PH
CHM 301	Physical Chemistry II	2	C	15	45
CHM 302	Inorganic Chemistry II	3	C	30	45
CHM 303	Organic Chemistry II	3	C	30	45
CHM 304	Atomic & Molecular Structure & Symmetry	3	E	45	-
CHM 305	Petroleum Chemistry	2	R	30	-
CHM 310	Polymer Chemistry	3	R	30	45
CHM 312	Separation Methods and Analysis	3	C	30	45
CHM 316	Applied Spectroscopy	3	C	45	-
CHM 317	Industrial Raw Materials Resource Inventory	1	R	15	-
CHM 319	Environmental Chemistry	2	R	30	-
CHM 354	Management and Chemical Industry I	2	R	30	-
CHM 355	Introductory Material Science	2	R	30	-
CHM 356	Colour and Textile Chemistry	3	R	30	45
CHM 358	Management and Chemical Industry II	2	R	30	-
CHM 359	Glass Blowing Practical	1	R	-	45
*CHM 399	Industrial Attachment II (12 Weeks)	3	C		
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
	Total	**44**			

***CHM 399 is only for students in institutions running a 4-year industrial chemistry programme.**

Course Structure at 400 Level: Industrial Chemistry

Course Code	Course Title	Units	Status	LH	PH
CHM 400	Seminar in Chemistry	2	C		
CHM 401	Research Project	6	C	-	270
CHM 406	Reaction Kinetics	2	R	30	-
CHM 407	Electrochemistry	2	R	15	45
CHM 410	Analytical Chemistry II	2	R	15	45
CHM 419	Organic Synthesis	2	R	30	-
CHM 422	Physical Organic Chemistry	2	R	30	-
CHM 451	Special Laboratory Methods	3	R	45	-
CHM 452	Structure & Coordination Chemistry	3	R	45	-
CHM 453	Chemistry of Industrial Processes	3	R	45	-
CHM 454	Chemical Processes Technology	3	R	45	-
CHM 455	Macromolecular Chemistry II	3	R	45	-
*CHM 499	Industrial Attachment (36 Weeks)	9	C		
	Total	**42**			

*CHM 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.

Elective Courses: One or two may be selected from the list below.

Course Code	Course Title	Units	Status	LH	PH
CHM 404	Group Theory and Symmetry	2	E	30	-
CHM 409	Nuclear & Radiation Chemistry	2	E	30	-
CHM 415	Polymer Technology	2	E	30	-
CHM 420	Natural Product Chemistry	3	E	45	
CHM 423	Organometallic Chemistry	3	E	45	-
CHM 456	Medicinal Chemistry	3	E	45	-
CHM 457	Food Chemistry	3	E	45	-
CHM 458	Agrochemicals & Chemotherapeutic Agents	3	E	45	-
CHM 459	Photochemistry	3	E	45	-
CHM 460	Solid State Chemistry	3	E	45	-
CHM 461	X-ray Crystallography	3	E	45	-
CHM 462	Chemical Physics	3	E	45	-
CHM 462	Geochemistry	3	E	45	-
CHM 463	Mineral Processing	3	E	45	-

3.11.8 Course Synopses:

CHM 101: General Chemistry I **(3 Units: LH 45)**
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 **(3 Units: LH 45)**
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. Introduction to transition metal chemistry.

CHM 107: General Chemistry Practical I **(1 Unit: PH 45)**
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: PH 45)**
Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

CHM 210: Physical Chemistry I **(3 Units: LH 30; PH 45)**
Pre-requisite –CHM 101
Kinetic theory of gases; Behaviour 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 **(3 Units: LH 30; PH 45)**
Pre-requisite – CHM 102
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 **(3 Units: LH 30; PH 45)**

Pre-requisite – CHM 101; CHM 102

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 **(3 Units: LH 30; PH 45)**

Pre-requisite –CHM 101 and 102

Theory of Errors; and statistical treatment of data: Theory of sampling. Chemical methods of analysis including volumetric, gravimetric and physiochemical methods, Optical methods of analysis; separation methods.

CHM 214: Structure and Bonding **(2 Units: LH 30)**

Pre-requisite –CHM 101 and 102

Idea of quantum states, orbitals, shape; and energy. Simple valence theory, electron repulsion theory, atomic spectra. Methods of determining molecular shape, bond lengths and angles. The structure and chemistry of some representative main group element compounds.

CHM 251: Process Science I **(3 Units: LH 45)**

Pre-requisite: CHM 213:

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.

CHM 252: Process Science II **(3 Units: LH 45)**

Pre-requisite: CHM 251:

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.

CHM 253: Macromolecular Chemistry I **(3 Units: LH 45)**

Pre-requisite: CHM 101, CHM 102:

Classification of macromolecules; polymers and copolymers as natural, modified natural or synthetic substances. Polymer formation processes; methods, kinetics and mechanisms. The characterization of macromolecules; molar mass and distribution, molecular size and shapes, stereochemistry. Crystallinity and methods of determination. Structural classification in natural macromolecules. Bulk structure, crystalline, amorphous, glassy and rubbery states. Inter-relation of structure and properties.

CHM 299: Industrial Attachment I (12 Weeks) (3 Units)

Students should be attached to some industrial organizations for 12 Weeks at the 200 Level preferably during the long vacation for real-time relevant industrial experience. Students to be assessed based on seminar presentations, their reports and assessment by supervisors. This is only applicable in institutions that run a 4-year industrial chemistry programme.

CHM 301: Physical Chemistry II (2 Units: LH 15; PH 45)

Pre-requisite –CHM 210

A review of Gibbs Function. Chemical thermodynamics. Introduction to statistical thermodynamics. Ideal solutions and non-Ideal solutions. Properties of electrolytes. Colligative Properties.

CHM 302: Inorganic Chemistry II (3 Units: LH 30; PH 45)

Pre-requisite –CHM 212

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 (3 Units: LH 30; PH 45)

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 e.g. Beckmann, Baeyer-Villiger etc to illustrate various reaction mechanisms and types.

CHM 304: Atomic and Molecular Structure and Symmetry (3 Units: LH 45)

Schrödinger equation. Helium atom, ground and excited states, Spin and Pauli 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. Brief mention of other methods. Atomic spectra, Russell-Saunders coupling, orbital and spin angular momentum. Use of symmetry in Chemistry.

CHM 305: Petroleum Chemistry (2 Units: LH 30)

Petroleum in the contemporary energy scene. Nature, classification and composition of crude petroleum and natural gases. Distribution of petroleum and natural gas resources (the global and Nigerian situations). Natural product chemical markers of petroleum and geological sediments. Petroleum technology, survey of refinery products and process. Petrochemicals in industrial raw materials. Prospects for the petrochemical industry in Nigeria.

CHM 310: Polymer Chemistry (3 Units: LH 45:)

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.

CHM 312: Separation Methods and Analysis (3 Units: LH 30: P 45)

Intermediate theory and laboratory techniques in analytical and physical chemistry. Advanced data analysis methods and goodness-of-fit criteria Spectroscopic methods and instrumentation. Separation methods: ion exchange, gas, paper, liquid and column chromatography; electrophoresis. Atomic and molecular absorption, emission and fluorescence spectrophotometry. Electroanalytical techniques. Quantitative analysis. X-ray methods. Refractometry, Interferometry, Polarimetry, Polarography & Calorimetry.

CHM 316: Applied Spectroscopy (2 Units: LH 30)

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 NMR in medicine.

CHM 317: Industrial Raw Materials Resource Inventory (1 Unit: LH 15)

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 feedstock.

CHM 319: Environmental Chemistry (2 Units: LH 30)

Concepts of elementary cycles. Characteristics of the atmosphere. Sources, types and effects of environmental pollution. Waste water 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. Green Chemistry: 12 principles . Modern and unusual methods of pollution analysis. Biodegradable macromolecules including detergents.

CHM 354: Management and Chemical Industry I (2 Units: LH 30)

*Management Process and Methods***:** The nature of management and the role with the chemical industry: management theory. Managerial association and specialization. Line and staff structure: functions and relationship. The manager's role. Organizational structure and management structure. Authority and organization. Corporate policy and organizational constraints on management process. The decision process, managerial techniques and supportive information system.

Managerial Economics: Risk and uncertainty in decision making. The theory of production, Cost and Demand analyses and sales forecasting. Pricing. Investment decision: product diversifications. Theory of business behaviour.

CHM 355: Introductory Material Science **(2 Units: LH 30)**
Pre-requisite: CHM 212.
Classification and properties of industrial materials. Type of bonding and its influence on both structure and properties of materials. Manufacture and properties of solid solutions (alloys). Structure of crystalline materials, coordination number, Crystallography.
Stress-strain relationship in materials, elastic an inelastic regions, mechanical, thermal and electrical properties of materials. Crystal growth and imperfections (defects). Material transformation-deformation, strengthening, electroplating and corrosion.

CHM 356: Colour and Textile Chemistry **(3 Units: LH 30; PH 45)**
Pre-requisite: CHM 253.
Classification of dyes and textile fibres. Natural regenerated and synthetic fibres. Physical and structural properties of fibres. Preparatory processes: Singeing, desizing, scouring, bleaching, mercerization and optical brightening. Colour and constitution. Theory of dyeing. Dyeing preparation, structure, and application of dyes. After treatments and quality control: Colour fastness.

CHM 358: Management and Chemical Industry II **(2 Units: LH 30)**
Pre-requisite: CHM 354
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 359: Glassblowing Practical **(1 Unit: PH 45)**
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)**
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.

CHM 400: Seminar in Chemistry **(2 Units)**

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

(8) *Writing Research Proposals*: Methodology and Process
*Topics may be chosen from any three of the above in addition to (8) above,

CHM 401: Research Project **(6 Units: PH 270)**

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.

CHM 404: Group Theory and Symmetry **(2 Units: LH 30)**

Pre-requisite: CHM 301 and CHM 304

Review of molecular symmetry operations. Definition of groups. Molecular symmetry groups. Introduction to the mathematical structure of groups. Group representations. Detailed study of groups Cn, Dn, C∞v and full rotation group. Applications. General symmetry applications. Symmetry of crystal lattices, Block orbitals for infinite system.

CHM 406: Reaction Kinetics (2 Units: LH 30)
Pre-requisite –CHM 301
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 407: Electrochemistry (2 Units: LH 15; PH 45)
Pre-requisite: CHM 210 & CHM 301
Chemical Equilibria: Ionic equilibria, Conductance, theory and measurement, interpretation of data for strong and weak electrolytes, Conductance and transport processes. Thermodynamics and galvanic cells. Standard electrode potentials. Practical electrode. Molecular forces in solids and liquids: Dipole moments. Interaction potentials and . forces. Reversible galvanic cells, measurement of e.m.f. Electrode potentials and the electrochemical series. Standard state and the Nernst equation. Applications of e.m.f. measurements (excluding thermodynamic relationships). Potentiometric titration including measurement of pH. Redox reactions. The electrical double layer and its applications.

CHM 409: Nuclear and Radiation Chemistry (2 Units: LH 30)
Revision of proton-neutron nucleus, neutron excess, shell model and nuclear spin. Alpha, megatron, position, electron capture, gamma and internal conversion decay modes of the properties of particles produced – annihilation, range, shielding etc. Health effects, permissible dose level, risk estimates, kinetics of decay, half-life and decay curve. Detection systems, solid and liquid scintillation counting. Quenching and channels ratio correction. Natural radiations/radioactivity. Induced radioactivity – mass and energy balance including recoil. Binding energy. Fission and fusion. Reactor types classified by fuel, moderator coolant. Introduction to activation analysis. The use of isotopes in reaction mechanism and analysis.

CHM 415: Polymer Technology (2 Units: LH 30)
Large scale industrial polymerisation processes. Polymer characterization, criteria for polymer solubility, chain conformation, thermodynamics and phase equilibrium. Molecular weight size and distribution: Rheology of polymers: Mechanical properties and viscoelasticity, structure-property relationships. Polymer types. Polymer processing, injection, extrusion, compression and transfer moulding of thermoplastics. Polymer additives. Polymeric surface coatings and adhesives. Thermosetting elastomers, plasticizers, resins and extrusion, spinning, vulcanization and reinforcement. Casting, testing and quality control: Chemical analysis. Birefringence measurement physical testing.

CHM 419: Organic Synthesis (2 Units: LH 30)
Pre-requisite: CHM 303
Reduction methods. Catalytic hydrogenation. Reduction with boron and aluminum hydrides and their analogues and derivatives. Metal reductions. Selective reduction in polyfunctional compounds. Oxidation methods. Epoxidation, hydration and Hydroxylation

of alkenes, oxidative cleavage of glycol. Peroxyacids and coupling and relevance to biosynthesis. Survey of synthetic applications of organometallic compounds. Construction of synthetic routes (disconnection approach); molecular self assembly in synthesis. Hydroboration oxidation to ketones. Carboxylation reactions and protonolysis phosphorus halides and their applications. Enamines: synthesis and applications. Formation of polycyclic compounds. Aldol type reactivity and reaction of iminium salts with nucleophile. Synthesis of complex molecules. Pericyclic reactions. Methodology for the construction synthetic routes. Applications for synthesis of important and complex organic compounds.

CHM 420: Natural Products Chemistry **(3 Units: LH 45)**
Pre-requisite: CHM 211, CHM 303
General methods of isolation, separation, purification and structural determination of natural products. Classifications and biogenesis. Chemistry of terpenoids, steroids, alkaloids, antibiotics, flavonoids. Prostaglandins and chlorophylls. Other natural products of pharmaceutical importance. Cholesteryl benzoate, liquid crystals and digital displays in computer screens, etc.

CHM 422: Physical Organic Chemistry **(2 Units: LH 30)**
Pre-requisite: CHM 303
Stepwise and concerted reaction mechanism. Kinetic studies, non-kinetic studies, Nucleophilic displacement reactions. The mechanisms of S_N^1, S_N^2 processes. The effects of structure, environment, nature of the nucleophile, solvation factors, added salt etc on the course and rates of reactions, stereochemical concepts. Ester hydrolysis – unimolecular and bimolecular processes. Linear free energy relationships. The Hammet equation; determination of constituent and reaction constants; significance and use of the signs and symbols to + 6m/P+0+6+m/o application to evaluation of mechanistic pathways.

CHM 423: Organometallic Chemistry **(3 Units; LH 45)**
Pre-requisites: CHM 211, CHM 303
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 451: Special Laboratory Methods **(3 Units; LH 15; PH 90)**
Pre-requisite: CHM 211
Selected advanced chemistry laboratory exercises to enhance students' knowledge and manipulative skills in modern laboratory techniques and methods – viz. Ozonolysis, hydrogenation, hydroboration – oxidation, functional groups protection and de-protection, high vacuum distillation and other separation methods. Advanced qualitative organic and inorganic analysis.

CHM 452: Structure and Coordination Chemistry (3 Units, LH 45)
Pre-requisite: CHM 212
Nomenclature, coordination number. Isomerism and stability of complex compounds. Theories of structures i.e. valence bond theory, crystal field theory, molecular orbital and ligand field theories and their relations to bonding in coordination compounds. Kinetics and mechanism of complex formation. Electronic spectra of transition metal complexes as well as their magnetic properties. Preparations, reactions and structure of complexes with – acceptor ligands such as CN, CO and NO. Applications of infrared and nmr spectroscopy to problems of coordination chemistry. Introduction to non-aqueous solvent systems; classification of solvents. Solute-solvent interactions.

CHM 453: Chemistry of Industrial Processes (3 Units: LH 45)
Pre-requisite: CHM 251 & CHM 252
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.

CHM 454: Chemical Process Technology (3 Units: LH 45)
Pre-requisite: CHM 252
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.

CHM 455: Macromolecular Chemistry II (3 Units: LH 45)
Pre-requisite: CHM 253
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 456: Medicinal Chemistry (3 Units: LH 45)
Biochemical pharmacology: Introduction. Absorption and distribution. The blood-brain barrier; placental transfer of drugs. Biotransformation of drugs, their conjugation and excretion. Factors affecting metabolism. The microsomal enzymes system. Drug-receptor interactions. Bioassay of drugs, pharmacokinetics, the importance of plasma levels of a drug. Drug discovery, design and development. Drug Action: Neurohumoral transmission: Neuromuscular and ganglionic blockade sympathominetics; adrenaline receptors; adrenergic neuron antagonists. Autocoids; Histamine; Serotonin; polypeptides; prostaglandins and related substances; antiallergic, antinflamatory and antipyretic agents. Generally-acting drugs. Opiates, receptors and antagonists; Dopamine receptors and antipsychotic drugs; antidepressants; anti-anxiety drugs. Selective toxicity; The basis of selective toxicity. Survey of host defence mechanisms and the use of chemotherapy. The bacterial cell membrane, effect on its permeability – role of antifungals. Folic acid and the role of anti-metabolites. Drug resistance, protein synthesis and its interference. Protozoology – parasites, life cycle of material parasite – other example of protozoal infestations. Viruses, their definition and classification. The biochemistry of viral replication. The role of interferon and other antivirals. Neoplasia – role of anticancer agents.

CHM 457: Food Chemistry (3 Units: LH 45)
Pre-requisite: CHM 211
The nature of food; vitamins, additives and adulterants; chemistry and microbiology of production processes and control; food preservation and spoilage; processing and preservation of local food stuffs; formulation and practice of food standards.

CHM 458: Agrochemical & Chemotherapeutic Agents (3 Units: LH 45)
Pre-requisite: CHM 303
Pesticides, fungicides, and insect sex attractants. Survey of modern approaches to pest and fungal growth control. Naturally occurring pesticides – rotenoids, pyrethrenoids. Survey of synthetic chlorinated hydrocarbon insecticides. Insect pheromones – techniques of identification, isolation and structural determination and configuration – some synthetic analogues. Herbicides and growth regulation substances. Review of chemical groups used in growth control. Plant growth regulators. Some nitrogen containing herbicides – a review. Synthesis of selected nitrogen containing herbicides.
*Chemotherapeutic Agents***:** General antibiotic types. Their mode of activity. The tetracyclines or B-lactam antibiotics will be discussed with regard to source, synthetic routes, synthetic analogues, biosynthesis and mode of action. Prostaglandins. Biosynthesis of prostanoic acid, derivatives of E.F.A. and B series of prostaglandins. Synthetic approaches.

CHM 459: Photochemistry **(3 Units: LH 45)**
Pre-requisite: CHM 303
Energy levels. Absorption and emission of light. Interaction of radiation with matter. Spin conservation rules. Electronic excitation: Excitation of atoms in the phase, excitation of diatomic molecules, polyatomic molecules, complex polyatomic molecules and other complexes. Selection rules, deactivation routes, energy transfer, simple reactions of stable singlet and triplet states. Reactions of species produced photochemically. Sensitization and quenching. Conventional photolysis procedure. Flash photolysis. Photosynthesis, Chemiluminescence, vision and the photographic process

CHM 460: Solid State Chemistry **(3 Units: LH 45)**
Pre-requisite: CHM 301 & 302
Band structure of solids. Electrical, optical and magnetic properties of defects solids. Atom movement and diffusion processes. Surfaces of solids. Reactions of solids, types, kinetic characteristics and parameters. Gas-solid and solid-solid reactions. Application to pigments, semi-conductors and catalysis. Corrosion: Mechanism factors and method of monitoring, prevention and control or corrosion in petroleum and chemical industries. Introduction to stress corrosion concepts.

CHM 461: X-Ray Crystallography **(3 Units: LH 45)**
The nature of the crystalline state. Principles and uses of x-ray diffraction from single crystals, powders, and polycrystalline materials. X-ray fluorescence spectrometry – principles and industrial applications. Electron probe. Microanalysis. Electro diffraction and the electro microscope. Neutron diffraction.

CHM 462: Chemical Physics **(3 Units: LH 45)**
Pre-requisite: CHM 301
Theory of bonding in H_2^+ and H_2: Molecular Hamiltonian, exact solution for H_2^+, Linear combination of atomic orbitals method, valence bond theory, comparison of valence bond and molecular orbital theory, resonance. Coulomb and exchange integrals, evaluation of total energy. Rotation and Vibration of molecules: Rigid rotor, harmonic oscillator, morse potential, inharmonic oscillator, fundamental overtone for harmonic and inharmonic oscillators.
Heat capacities of crystals: Monatomic crystals, Einstein’s model, Einstein’s characteristic temperatures, Debye theory of crystals and heat capacity, complicated crystal structures.

CHM 463: Geochemistry **(3 Units: LH 45)**
Elements and its abundance. Geochemical classification of elements. Some aspects of isotope geochemistry. Introductory mineralogy and mode of occurrence of selected ores with reference to Nigeria. Physical and chemical analysis of ore. Some aspects of organic geochemistry mineral processing: practice of crushing. Sizing and concentration of mine products.

CHM 464: Mineral processing **(3 Units: LH 45)**
Physical processing of minerals and their classification. Mineral concentration. Liquid-solid separation and aggregation. Chemical processing of minerals – unit operations,

hydrometallurgical processes. Halogen processes and metallurgy; high temperature processes and metallurgical thermochemistry

CHM 499: Industrial Attachment (9 months) (9 Units)

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.

3.12 INDUSTRIAL MATHEMATICS (BSc)

3.12.1 Philosophy, Aims and Objectives of the Programme

Philosophy

The philosophy and principal aim of the programme is to prepare graduates for careers 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

(i) To prepare the students to meet the demand of mathematical professionals in both existing and emerging industrial sectors;

(ii) To instill in students a sense of enthusiasm for mathematics in general, and appreciation mastery of its application in different of industry in particular; and to involve them in an intellectually stimulating and satisfying experience of learning and studying;

(iii) To provide students a broad and balanced foundation in general undergraduate mathematics knowledge and practical skills in its applications in industry;

(iv) To develop in students the ability to apply their mathematics knowledge and skills to the solution of theoretical and practical problems in mathematics;

(v) To develop in students, through an education in mathematics, a range of transferable skills of value in mathematical related and non-mathematical related employment;

(vi) To 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

(vii) To generate in students an appreciation of the importance of mathematics in an industrial, economic, environmental and social context.

3.12.2 Basic Admission Requirements

There are three different pathways by which candidates can be admitted into the programmes in the discipline: the Unified Tertiary Matriculation (UTME), the Direct Entry, and Inter-University Transfer.

Unified Tertiary Matriculation Examination (UTME)

Admission through U.M.E. shall take the student to 100 level. To be eligible for admission, candidate is expected to pass both the UTME and the University screening test. The candidate must have in addition a minimum of credit pass 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/Agric. Science. The UTME subjects are: English Language, Physics, Mathematics and Chemistry.

Direct Entry

Candidates with two A level passes (graded A-E) at the Advanced Level in one or more relevant subjects (Mathematics, Further Mathematics, Physics and Chemistry) or good diploma in Mathematics, Physics and Engineering are eligible to undertake the three-year degree programme with entry at 200-level.

Inter-University Transfer Mode

Students can transfer into 200-Level courses provided they have the relevant qualifications and the requisite CGPA.

3.12.3 Learning Outcomes

All Bachelors honours degree students in Industrial Mathematics are expected to develop the following abilities and skills:

Regime of Subject Knowledge

All bachelors honours level, Industrial Mathematics graduates are expected to develop cognitive abilities and skills relating to intellectual tasks including problem solving in mathematics.

Skills and Competences

They should be able to demonstrate practical skills relating to the solution of mathematical problems and its applications, especially in industrial settings.

Behavioral Activities

They should be able to demonstrate general skills relating to non-subject specific competencies, computer literacy, communication skills, interpersonal skills, organization skills, IT skills and life-long learning skills.

3.12.4 Attainment Levels

Graduates of Industrial Mathematics are expected 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.

3.12.5 Course Structure

Course Structure at 100 Level: Industrial Mathematics

Course Code	Course Title	Units	Status	LH	PH
MTH 101	Elementary Mathematics I	3	C	45	
MTH 102	Elementary Mathematics II	3	C	45	
MTH 103	Elementary Mathematics III	3	C	45	
STA 101	Probability I	3	C	45	
PHY 101	General Physics I	3	C	45	
PHY 102	General Physics II	3	C	45	
PHY 103	General Physics III	3	C	45	
CHM 101	General Chemistry I	3	C	45	
BIO 101	General Biology I	3	C	45	
GST 101	Use of English	2	C	30	

CSC 101	Introduction to Computer Science	2	C	30	
LIB 101	Library Studies	2	C	30	
	Total	**33**			

Course Structure at 200 Level: Industrial Mathematics

Course Code	Course Title	Units	Status	LH	PH
MTH 201	Mathematical Methods I	3	C	45	
MTH 202	Elementary Differential equations I	3	C	45	
MTH 203	Sets Logic and Algebra I	3	C	45	
MTH 204	Linear Algebra I	2	C	30	
MTH 205	Linear Algebra II	2	C	30	
MTH 207	Real Analysis I	3	C	45	
CSC 201	Computer Programming I	4	C	60	
MTH 209	Introduction to numerical analysis	3	C	45	
STA 211	Probability II	4	C	60	
GST 01	Communication Skills	2	C	30	
GST 202	Nigerian People and Culture	2	C	30	
EPS 201	Entrepreneurship Studies I	2	C	30	
MTH 210	Vector Analysis	2	C	30	
	Total	**37**			

Course Structure at 300 Level: Industrial Mathematics

Course Code	Course Title	Units	Status	LH	PH
MTH 311	Introduction to Industrial Mathematics	3	C	45	
STA 321	Distribution Theory III	2	C	30	
MTH 302	Ordinary Differential Equations II	3	C	45	
MTH 315	Financial Mathematics	3	C	45	
MTH 316	Introduction to Operations Research	3	C	45	
MTH 312	Mathematical Computing I	3	C	30	15
MTH 319	Numerical Analysis I	3	C	30	15
MTH 308	Mathematical Modeling I	3	C	45	
MTH 320	SIWES	8	C	120	
EPS 301	Entrepreneurship Studies II	2	C	30	
	Total	**34**			
	Elective Courses				
MTH 309	Discrete Mathematics	3	E	45	
MTH 319	Mathematical Computing II	3	E	45	
STA 311	Probability III	3	E	45	

	Total	**9**			

Electives should be selected from Year III courses in Physics, Computer Science, Economics and Accounting.

Course Structure at 400 Level: Industrial Mathematics

Course Code	Course Title	Units	Status	LH	PH
MTH 425	Control Theory and Project Management	2	C	30	15
ST A 431	Statistical Inference III	2	C	30	
MTH 427	Classical Mechanics I	3	C	45	
MTH 423	Mathematical Modelling II	3	C	45	
MTH 401	Theory and Applications of Ordinary Differential Equations	3	C	45	
MTH 402	Theory and Applications of Partial Differential Equations	3	C	45	
MTH 424	Control Theory and Optimization	3	C	30	15
MTH 417	Numerical Analysis II	3	C	45	
MTH 424	Mathematical Computing II	3	C	45	
MTH 428	Classical Mechanics II	3	C	45	
MTH 404	Project	6	C	90	
MTH 427	Optimization Theory	3	C	45	
MTH 406	Special Topics in Industrial Mathematics	2	C	30	15
	Total	**39**			
	Elective Courses				
MTH 408	Classical Mechanics	3	E	45	
MTH 413	Fluid Dynamics	3	E	45	
MTH 414	Elasticity	3	E	45	
MTH 415	Systems Theory	3	E	45	
MTH 426	Theory and Applications of Neural Networks	3	E	45	
	Total	**15**			

Electives should be selected from Year IV courses in Mathematics, Physics, Computer Science, Economics and Accounting.

3.12.6 Course Descriptions

MTH 101 ELEMENTARY MATHEMATIC I: (3 Units LH 45)
(ALGEBRA AND TRIGONOMETRY)

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 formalae.

MTH 102 ELEMENTARY MATHEMATICS II: (3 Units LH 45)

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.

MTH 103 ELEMENTARY MATHEMATICS III: (3 Units LH 45)

(Vectors, geometry and dynamics)

Geometric representation of vectors in 1-3 dimensions, components, direction cosines. Addition of 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. Impact of two smooth sphere, and of a sphere on a smooth sphere.

MTH 201MATHEMATICAL METHODS 1: (3 Units LH 45)

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 or three variables. Partial derivatives chain rule, extrema, languages multipliers. Increments, differentials and linear approximations. Evaluation of line integrals. Multiple integrals.
Pre-requisite -MTH 103.

MTH 202 ELEMENTARY DIFFERENTIAL EQUATIONS: (3 Units LH 45)
(Equations 1): Pre-requisite -MTH 103

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 difference equations. Application to geometry and physics.

MTH 203 SETS, LOGIC AND ALGEBRA (3 Units LH 45)
Pre-requisite -MTH 101

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, semigroups, rings, integral domains fields. Homeomaphics. Number systems; properties of integers, rationals, real and complex numbers.

MTH 204 LINEAR ALGEBRA I: (2 Units LH 30)
Pre-requisite -MTH 101,102
Co-requisite -MTH 203

Vector space over the real field. Subspaces, linear independence, basis and dimension. Linear transformations and their representation by matrices - range, null space, rank. Singular and non-singular transformation and matrices. Algebra of matrices.

MTH 205 LINEAR ALGEBRA II: (2 Units LH 30)

Pre-requisite MTH 101, 102. Co-requisite MTH 203, 204.
Systems of linear equation change of basis, equivalence and similarity. Eigenvalues and eigenvectors. Minimum and characteristic polynomials of a linear transformation (Matrix). Caley -Hamilton theorem. Bilinear and quadratic forms, orthogonal diagonalisation. Canonical forms.

MTH 207 REAL ANALYSIS I: (3 Units LH 45)
Pre-requisite -MTH 101, 103
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 rearrangements. Completeness of reals and incompleteness of rationals. Continuity/and differentiability of functions R….) R. Rolle's and mean value theorems for differentiable functions Taylor series.

MTH 209 INTRODUCTION TO NUMERICAL ANALYSIS: (3 Units LH 45)
Pre-requisite -MTH 101, 103
Solution of algebraic and transcendental equations. Curve fitting. Error analysis. Interpolation and approximation. Zeros of non- linear equations 'to one variable'. Systems of linear equations. Numerical differentiation and integration. Initial value problems for ordinary differential equation.

MTH210, VECTOR ANALYSIS (2 Units LH 30)
Elementary Vector Algebra, Vector and 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 scalar products; senent frenent formulae; differential definition of curl, gradients, divergent and simple multiplication).

MTH 302 ORDINARY DIFFERENTIAL EQUATIONS II: (3Units LH 45)
[L30: P 0: T 0 15] Pre-requisite. - MTH 202.
Ordinary differential equations: linear dependence, wronskian, reduction order, variation of parameters, series solution about ordinary and regular points. Special functions: Gamma, Beta, Bessel, legendre, Hyper geometric. Laplace transform and applications to initial value problems

MTH 311 – Introduction to Industrial Mathematics (3 Units LH 45)
This course introduces the students to industrial mathematics and covers various problems that can be found in industry. A problem-based learning approach is recommended. Each problem studied motivates the need for learning the mathematical techniques necessary to solve the problem. Part of the course involves writing a report on a project and giving a presentation of the results. It is suggested that students learn to use appropriate computer packages. Previous problems include Monte Carlo methods for a financial application, circadian rhythm analysis, atmospheric refraction correction, and the Fourier synthesis of ocean scenes.

MTH 315: Financial Mathematics (3 Units LH 45)

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, exposed to risk formula selection. Multiple decrements, history and distinctive features of the principles 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 316 INTRODUCTION TO OPERATION RESEARCH: (3 Units LH 45)
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.

MTH 319 NUMERICAL ANALYSIS I: (3 Units LH 45)
Polynomial and splines approximation. Orthogonal polynomials and chebysev approximations. Direct and interactive methods for the solution of systems of linear equations. Eigen value problem – power methods, inverse power methods. Pivoting strategies.

MTH 308: Mathematical Modeling I (3 Units LH 45)
General Introduction to Modeling, definition, concepts of system identification, Deterministic vs Stochastic, classification of models, modeling deterministic systems and modeling uncertain systems, analysis of these models. 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. Application of mathematical models to physical, biological, social and behavioural sciences. Modeling via First Order Differential Equations: Modeling through First Order and Simple Higher Order Differential Equations, Linear Differential Equations (LDEs), systems of Ordinary Differential Equations (ODEs). Analysis of Solutions: Existence and uniqueness of solutions, continuation of solutions, dependence on initial conditions and parameters, linear systems of equations with constant and variable coefficients, autonomous systems, phase space, and stability, Interpretation of solutions in modeling. Modeling via Second Order Differential Equations: Mathematical Modeling through Second Order Differential Equations. Case Studies: Population ecology, chemical kinetics, traffic dynamics, Mechanics, Biology and Medicine, Pharmacokinetics, Economics, Engineering, Special topics in modeling.

MTH 319: Mathematical Computing I (3 Units LH 30 PH 15)
This course covers the following numerical techniques for solving mathematical problems on a computer: the internal representation of floating point numbers, interpolation, root finding, numerical integration, numerical differentiation, and function minimization. The

material is presented so that topics build on one another and applications are given to illustrate the use of the techniques.

MTH 312: Mathematical Computing II (3 units LH 30 PH 15)
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.

MTH401 THEORY OF ORDINARY DIFFERENTIAL EQUATIONS (3 Units LH 45)
Differential equations: existence and uniqueness theorems dependence of solution on initial data and parameters. Properties of solutions. Sturm comparison and Sonin-Polya theorems. Linear and non-linear systems. Floguet'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, Eigen function expansion with application.

MTH 402 THEORY OF PARTIAL DIFFERENTIAL EQUATIONS (3 Units LH 45)
Theory and solutions of first-order and second order linear equations. Classification, characteristics, canonical forms, Cauchy problems. Elliptic equations; Laplace's and poison's formulae, 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 problem.

MTH 423: Mathematical Modeling-II (3 Units LH 45)
Introductory Numerical Solutions of Differential Equations, Mathematical Modeling through Difference Equations, Further Study on Systems of Differential Equations with Matrices. Modeling with Partial Differential Equations (PDEs): The concept of a PDE, Method of separation of variables, Mass-Balance equation (The first method of obtaining PDE Models), Momentum-Balance Equation (The second method of obtaining PDE Models), Variation Principles (The third method of obtaining PDE Models), Probability Generating functions (The fourth method of obtaining PDE Models), Nature of PDEs Initial and Boundary Conditions. Topics in Mathematical Modeling of Life-Environmental relationships.

MTH 427: Classical Mechanics I (3 Units LH 45)

Frame of reference, Inertial frames, Forces, Velocity, Acceleration, Linear momentum, Angular velocity, Angular acceleration, Angular momentum, motion of a particle (Newton laws), motion of a system particles, Rotating coordinate systems, moments and products of inertia. Parallel axes theorem, perpendicular axes theorem for moments and products of inertia. Principle axes and principle moments of inertia of a system of particles, Rotating coordinate systems, Infinitesimal rotation, Euler equations, Generalized coordinates, Lagrange's formulations, Hamiltonian functions, Theory of small oscillation, Impulsive motion.

MTH 428: Classical Mechanics II (3 Units LH 45)

Theory of Forces and Couples

Basic definitions, Force acting at a point, Resultant of a system of Forces acting at a point, Condition for equilibrium of a system of Forces acting at a point, Vector moment of a Force, Couple, Moment of a Couple, Resultant of a system of Forces in 3D, Invariants, Wrench, Coplanar Systems of Forces, Varignon's Theorem of Moments, Parallel Systems, Conjugate forces. Bending of Beams: Shear and Bending moment in a beam, Relations among Load, Shear and Bending Moment, Thin Elastic Beams, Bernoulli-Euler Law, Macaulay's Notation, Clapeyron's equation for three moments. The Catenary: Flexibility, The common catenary, Parabolic chain, suspension bridge, Catenary of uniform strength, General equations of equilibrium of a string in one plane under given forces, Strings on rough curves, Variable chain hanging under gravity.

MTH 424: Computational Mathematics II (3 Units LH 30 PH 15)

This course covers the following numerical techniques for solving mathematical problems on a computer: numerical linear algebra (including the numerical solution of linear systems of equations and the algebraic eigenvalue problem) and the numerical solution of differential equations. The material is presented so that topics build on one another and applications are given to illustrate the use of the techniques. Prerequisites include advanced calculus, linear algebra, differential equations and knowledge of C++.

MTH 406 Special Topics in Industrial Mathematics. (3 Units LH 30 PH 15)

Topics vary from semester to semester. Prerequisite: Permission of instructor. Course may be taken more than once.

MTH 425 Control Theory and Project Management (3 Units LH 30 PH 15)

Introduction: definition, examples of control systems. Open-loop and closed-loop control systems. System modeling: Signal flow graph, block diagram. Network flow problems. Basic concept of projects, tasks, events, etc.; project planning and execution; critical path method (CPM); project evaluation and review technic (PERT).

MTH 426: Theory and Applications of Neural Networks (3 Units LH 30 PH 15)

Biological computers and their capabilities over digital computers, problem of classification and recognition, biological neurons, artificial neural networks, Mathematics of single-layer neural networks - the Perceptron, learning and training, learning rate, Perceptron training algorithm, Introducing Mathematical methods to adjust the learning rate, convergence of solutions, basins of attractions, Bayesian inference methods. Types of neural networks (feed-forward, back-propagation etc.) and algorithms for implementation. Monte-Carlo Methods, Hopfield network for optimization problems, e.g., travelling salesman problem, Applications in forecasting problems in finance, meteorology, particle physics.

MTH 427 OPTIMIZATION THEORY: (4 Units LH 60)

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 201, 202, 302, 303.

3.13 MARINE SCIENCE (BSc)

3.13.1 Preamble

In this document, the **Benchmarks** and Minimum Standards for the education and training of students studying for first degrees in the programme of the Marine Science programme 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.

3.13.2 Philosophy, Aims and Objectives of the Programme

Philosophy

The main philosophy of the programme is to provide world-class training and research in marine science and technology that will produce well-trained marine scientists qualified to practise in marine-based industries for national development. With the belief that marine environment is inextricably linked to human lives and to their future survival, it is the philosophy of the programme that only a multidisciplinary approach can cover the breadth and depth of issues involved in the exploration and exploitation of the marine environment.

Objectives of the Programme

The objectives of the programme are to:

(i) use a multi-disciplinary approach to impart basic and fundamental knowledge of marine science,

(ii) train students with the capability to explore and exploit the marine environment in a sustainable manner; and

(iii) equip the students with result–oriented research capability for industrial and academic development of the country.

3.13.3 Career Opportunities

Job opportunities for products of this programme exist in several areas of the national economy which include the following:

Coastal zone planning authorities; Dredging companies; Marine Engineering consultancy companies; Fishing industries; Insurance or salvage companies; Maritime Authority; Port/Harbour Authorities; Tourism industry; Water industry; Water sports/leisure associations and clubs; The Navy; Ministry of Science and Technology; Universities and Polytechnics, Marine-related Research institutes; Shipping companies; Ministries of Environment in all coastal areas.

3.13.4 Basic Admission Requirements

There are three different pathways by which candidates can be admitted into the programmes in the discipline: the Unified Tertiary Matriculation (UTME), the Direct Entry, and Inter-University Transfer.

Unified Tertiary Matriculation Examination (UTME)

Admission through U.M.E. shall take the student to 100 level. To be eligible for admission, candidate is expected to pass both the UTME and the University screening test. The candidate must have in addition a minimum of credit pass 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/Agric. Science. The UTME subjects are: English Language, Physics, Mathematics and Chemistry.

Direct Entry

Admission by direct entry is into second year (200 level) of the programme. In addition to the Senior School Certificate requirements for UTME admission, eligible student for direct entry should further possess good passes at GCE (advanced level) at one sitting in at least two of the following subjects: Physics, Mathematics and Chemistry or National Diploma (ND) at a minimum of Upper Credit level in Oceanography, Mineral Exploration, Mineral Resources Engineering, Geology, Geophysics, Meteorology, and Marine Biology from any recognized institution.

Inter-University Transfer Mode

Students can transfer into 200-Level courses provided they have the relevant qualifications and the requisite CGPA.

3.13.5 Learning Outcomes

All graduates of Marine Science are expected to exhibit the following abilities and skills:

Regime of Subject Knowledge

All bachelors honours level, Marine Science graduates are expected to develop cognitive abilities and skills relating to intellectual tasks including problem solving in marine science.

Skills and Competences

The graduate student should be able to demonstrate; Practical skills relating to the solution of marine science problems and expressed themselves in writing for professional and academic audience. Analytical; appraise key issues in marine environment exploration and exploitation and possess comparative tendencies. Synthesize concepts; ability to plan, design, construct and manage various criteria in exploration and exploitative procedures of the marine environment.

Behavioural Activities

They should be able to demonstrate general skills relating to non-subject specific competencies, computer literacy, communication skills, interpersonal skills, organization skills, IT skills and life-long learning skills. Swimming skills.

3.13.6 Attainment Levels

Graduates of Marine Science are expected to have the ability to apply knowledge and skills to solving theoretical and practical problems in Marine and other related areas in relation to national and societal needs. Interpreted meteorological and oceanographical complex information for marine scientific experimentation.

3.13.7 Course Structure

Course Structure at 100 Level: Marine Science

Course Code	Course Title	Units	Status	LH	PH
PHY 101	General Physics I	3	C	45	
PHY 103	General Physics III	2	C	30	
MTH 101	Introductory Mathematics I	3	C	45	
CHM 101	General Chemistry I	4	C	45	45
BIO 101	General Biology I	4	C	45	45
GST 101	Use of English I	2	C	30	
GST 103	Information Retrieval	1	C	15	
PHY 107	General Physics Laboratory I	1	C		45
CHM 102	General Chemistry II	4	C	45	45
CSC 102	Introduction to Computer Science	3	C	45	
MTH 102	Introductory Mathematics II	3	C	45	
MTH 104	Introductory Applied Mathematics	3	C	45	
PHY 102	General Physics II	3	C	45	
PHY 108	General Physics Laboratory II	2	C	30	
GST 102	Use Of English II	2	C	30	
	Total	**40**			

Course Structure at 200 Level: Marine Science

Course Code	Course Title	Units	Status	LH	PH
MST 201	Introductory Oceanography	2	C	30	
MST 203	Introduction to Weather and Climate	2	C	30	
MST 205	Atmospheric Chemistry I	2	C	30	
MST 207	Marine Biology	2	C	30	
MST 209	Diving and Swimming Skills	2	C	15	
MST 211	Marine Meteorological Instrumentation0	2	C	15	
AGY 201	Physical Geology	2	C	30	
AGY 203	Crystallography and Mineralogy	2	C	30	
AGY 205	Geological Map Interpretations	2	C	30	
CHM 211	Environmental Chemistry	2	C	30	
GST 101	Use of English I	2	E	30	
GST 103	Information Retrieval	1	E	15	45

MEE 101	Engineering Drawing I	1	E	15	45
MST 202	Oceanic Magmas and Volcanoes	2	C	30	
MST 204	Marine Aquaculture	2	C	30	
MST 206	Marine Ecology	2	C	30	
MST 208	Atmospheric Chemistry II	2	C	30	
MST 210	Sea Floor Map Interpretation	2	C	15	45
CHM 202	Analytical Chemistry I	2	C	30	
MTS 122	Statistics for Physical Sciences	2	C	30	
MET 204	Introduction to the Atmosphere	2	C	30	
AGY 212	Structural Geology	2	C	30	
GST 106	Logic and Philosophy	2	C	30	
MEE 102	Workshop Practice	2	C	30	
GST 102	Use of English II	2	E	30	
	Total	**48**			

Course Structure at 300 Level: Marine Science

Course Code	**Course Title**	**Units**	**Status**	**LH**	**PH**
MST 301	Oceanic Crust and Ocean Floor	2	C	30	
MST 303	Gravity and Magnetic Methods	2	C	30	
MST 305	Chemical Oceanography and Laboratory	2	C	15	45
MST 307	Coastal Processes and Geomorphology	2	C	30	
MST 309	Atmospheric and Oceanic Dynamics	2	C	30	
MST 311	Underwater Operations	2	C	30	
MST 313	Climatology	2	C	30	
AGY 307	Principles of Remote Sensing and G.I.S.	2	C	30	
AGY 311	Micropaleontology	2	C	30	
PMT 301	Entrepreneurship Development	2	C	30	
MST 302	S.I.W.E.S. – Industry Supervisor's Assessment	4	C	30	
MST 304	S.I.W.E.S. – Supervisor's Assessment	2	C	30	
MST 306	S.I.W.E.S.–Student's Report Presentation	4	C	60	
	Total	**30**			

Course Structure at 400 Level: Marine Science

Course Code	**Course Title**	**Units**	**Status**	**LH**	**PH**
MST 401	Deep-Sea Exploration	2	C	30	
MST 403	Atmospheric Modelling	2	C	30	
MST 405	Marine Pollution	2	C	30	
MST 407	Global Change	2	C	30	
MST 409	Marine Meteorology	2	C	30	
MST 411	Ocean Waves	2	C	30	

MST 413	Marine Fluid Dynamics	2	C	30	
MST 415	Final Year Students Project	6	C	90	
RSG 401	G.I.S. Application in Oceanography	2	C	15	45
MST 402	Marine Monitoring and Analysis	2	C	30	
MST 404	Chemical Modelling of Climate Change	2	C	30	
MST 406	Marine Seismic Methods	2	C	30	
MST 408	Marine Resources	2	C	30	
MST 410	Integrated Coastal Zone Management	2	C	30	
MST 412	Maritime Laws, Regulations and Policies	2	C	30	
MST 414	Physical Oceanography and Laboratory	2	C	15	45
MST 416	Marine Geochemistry	2	C	30	
	Total	**28**			

KEY
C – Compulsory
E – Elective

3.13.8 Course Descriptions

MST 201 Introductory Oceanography (2 units LH 30)
Geological, chemical, physical, and biological aspects of the ocean; Structure, formation and general morphological features of ocean basins; Seawater properties and their distribution – physical, chemical and biochemical characteristics; Currents, waves and tides – their occurrence, characteristics and activities; Characteristics of marine organisms – their main features, general habitat and behaviour; Marine ecological principles.

MST 202 Oceanic Magmas and Volcanoes (2 units LH 30)
Occurrence, structure and types of volcanoes on ocean floor. Distribution, formation, activities and eruptions of the marine volcanoes. Oceanic ridge systems – varieties, distribution, characteristic structures and features. Magma types and materials. Lava flows on sea floor – their characteristics, structures, features, mineral and rock types. Resources from marine volcanoes – economic minerals and associated biological species.

MST 203 Introduction to Weather and Climate (2 units LH 30)
The structure, physics, dynamics and thermodynamics of the atmosphere; Weather – major natural and artificial factors influencing weather, transient and steady conditions; Weather-forecasting – major factors to consider; 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.

MST 204 Marine Aquaculture (2 units LH 30)
Selection criteria for fish and shellfish in marine aquaculture. Sea cage construction and location. Water quality requirements for aquaculture species. Fish feed production and fish feeding in marine aquaculture. Fish seed production fish breeding in hatcheries. Fish harvesting in mariculture. Common diseases and parasites of aquaculture species.

MST 205 Atmospheric Chemistry I **(2 units LH 30)**
Basic composition and chemistry of the atmosphere – chemical zonation and mixing in the atmosphere; Chemical processes involved in local and regional air pollution; and acid rain; Health effects of air pollution; Global change in the composition and climate of the atmosphere; stratospheric ozone, and global warming.

MST 206 Marine Ecology **(2 units LH 30)**
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, 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 proteste. Hydrothermal vent discharges and deep-sea communities.

MST 207 Marine Biology **(2 units LH 30)**
Marine plants and animals: classification, structure, physiology, ecology and adaptations to the marine environment. Overview of marine nekton including bony and cartilaginous fishes, cephalopods, reptiles and mammals. A survey of the taxonomy, anatomy/functional morphology and physiology of these groups including aspects of their relationships with humans. The role of microorganisms in the economy and productivity of the sea.

MST 208 Atmospheric Chemistry II **(2 units LH 30)**
Physical and chemical processes of importance in the Earth's atmosphere: atmospheric transport, chemical kinetics and radiation; box models and geochemical cycles; The greenhouse effect, stratospheric ozone depletion and climate change – natural and artificial processes involved; Anthropogenic perturbations to the oxidizing capacity of the troposphere. Pollution chemistry and atmospheric aerosols – types, sources, characteristics, distribution and attenuation of the pollutants and aerosols.

MST 209 Diving and Swimming Skills **(2 units LH 30)**
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, will be carried out in the deeper waters. Basic materials and principles of swimming. Different swimming techniques. Acquisition of skills. Regular swimming practices in freshwater pools and rivers.

MST 210 Sea Floor Map Interpretation **(2 units LH 30)**
Introduction to maps of the ocean floor. Description of sea floor features and their recognition on maps. Ocean ridges and lava features, etc.

MST 301 Oceanic Crust and Ocean Floor **(2 units LH 30)**
Geology and geochemistry of the oceanic crust. 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.

MST 302/304/306: Students Industrial Work Experience Scheme (2 units LH 30)
Supervised field- and industry-based practical course, with grading based on industry and FUTA supervisors' assessments as well as the student's report and seminar presentation. The course lasts six months, covering the second semester and the long vacation.

MST 303 Gravity and Magnetic Methods (2 units LH 30)
Theory of attraction and potential with applications to simple mass distributions. Green and Gauss theorems. Green's formulae and Equivalent surface layers, Instrumentation and data acquisition. Gravity data reduction; Regional, residual anomaly separation. Interpretation of gravity anomalies; Dead and total mass estimates. Application of gravity method in ocean floor and deep-sea explorations. Fundamentals of magnetic dipole interactions with applications to simple mass distributions**,** Gauss Theorem. Instrumentation and data acquisition procedures. Reduction of magnetic data. Anomaly separation and interpretation. Air-borne and sea-borne magnetic surveys. Data acquisition and Interpretation. Application of magnetic methods in ocean floor and deep-sea explorations.

MST 305 Chemical Oceanography and Laboratory (2 units LH 30)
An introduction to the chemistry of the oceans. Descriptive chemical oceanography of the components of ocean waters (metals, gases, 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. In-class field trips required.

MST 307 Coastal Processes and Geomorphology (2 units LH 30)
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, shoreline changes. Effects on coastal flows of coastline geometry, bottom topography, friction, and density stratification. Coastal hydraulics: groundwater-seawater interactions.

MST 309 Atmospheric and Oceanic Dynamics (2 units LH 30)
Derivation and scaling of the equations of atmospheric motion; hydrostatic and geostrophic balance; circulation and vorticity. Dynamical equations governing steady oceanic currents; the Rossby and Ekman numbers and characteristic values in some observed currents. Geostropohic currents – barotropic and baroclinic mass transports. Specific heat and thermal conductivity of sea-water: heat sources and exchanges; ocean heat budget;

diffusion of heat and salt by turbulent mixing. Changes in oceanic salt distribution by vertical mixing and horizontal advection. Forces and the relationship to the structure of the ocean. Influence of climate change on ocean dynamics and vice versa.

MST 311 Underwater operations (2 units: LH 30)

Survey of manned under sea activities in oceanography. The tools of underwater operations: decompression chambers, habitats, submarssible diving apparatus, pertinent design criteria and applications as based on human hyperbaric physiology and performance

MST 401 Deep-Sea Exploration (2 units LH 30)

Historical background of deep-sea exploration. Instrumentation for exploration; Sound Navigation and Ranging (SONAR); Oceanographic submersibles. Modern techniques of investigating the physical, chemical and biological conditions at the bottom of the ocean for scientific and commercial purposes. Application of seismic reflection and refraction techniques; Direct drilling and recovered core sample analyses. In-class field trip is required.

MST 402 Marine Monitoring and Analysis (2 units LH 30)

A laboratory course using the established international standard 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.

MST 403 Atmospheric Modelling (2 units LH 30)

Basic equations for physical and chemical processes in the atmosphere, with emphasis on the solution of photochemical "box" models with multiple constituents, aerosol models, aqueous chemistry models, and multi-box models of biogeochemical cycling. Discretization and numerical approximations for the solution of the relevant differential equations. Analysis of implications and limitations of model results, and comparison of observations. The course includes a computer lab to run diverse models. Student project will be computer-based, either in the analysis of atmospheric measurements with an existing model, or developing a simple computer model of a particular process.

MST 404 Chemical Modelling of Climate Change (2 units LH 30)

Processes incorporated into multidimensional models used to assess changes in the chemistry and climate of the atmosphere on the global scale. Existing global models, such as a stratospheric two-dimensional model, stratospheric/ tropospheric three-dimensional chemistry-transport model, and climate models will be utilized to simulate different perturbation scenarios. Implications of model results to assessment of policy alternatives; ozone depletion potentials and global warming potentials. Emphasis on computer laboratory for model simulations and analysis of model results.

MST 405 Marine Pollution (2 units LH 30)

Different types and sources of pollutants in the marine environment – effluent inflow, organised dumping in the high seas and subduction zone areas. Geochemical activities involved in the transformation of the pollutants in the ocean. Transport paths and effects of contaminants on marine environments. Contaminants' attenuation mechanisms. Biological and ecological changes in the aquatic environment resulting from domestic, industrial, radioactive and agricultural wastes. Beach erosion and coastal management.

MST 406 Marine Seismic Methods (2 units LH 30)

Deep-sea seismic exploration techniques; 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, static correction charts. Propagation of seismic waves. Analytical treatment of elementary seismic reflection problems. Oil exploration in the deep sea: field techniques; processing and interpretation of seismic reflection sections, NMO charts.

MST 407 Global Change (2 units LH 30)

Historical aspects of global change. Principal components of global change – the types, genesis and intensities. Impacts of the components on the marine environment – physical, chemical, biological and climatic aspects. Interdisciplinary nature of global change and interrelationships to biological, physical, anthropological, economic, and political concepts. Current trends in monitoring of global change.

MST 408 Marine Resources (2 units LH 30)

A survey of human use of the marine environment including physical, biological and geological resources; emphasis on marine fisheries and maricultural resources like molluscs, crustaceans, etc. Marine minerals:– fossil-derived, chemically-precipitated and minerals within the oceanic crust. Energy resources of sea water:- chemical and fossil-derived, wave and tide energies and other sources of kinetics in the ocean; The use of coastal lands and waste disposal in the sea.

MST 409 Marine Meteorology (2 units LH 30)

Atmospheric radiation; absorption and scattering principles of remote sensing of the atmosphere; cloud microphysics; nucleation, coalescence, ice crystal growth, atmospheric electricity and lightning. Air-Sea Interaction/ocean-atmosphere coupling: Walker circulation. Air-sea interaction; wind-driven currents in the Ekman layer; the Ekman spiral. Ekman transport; the thermocline; swells and tides. Climate change with special focus on the oceans. The El Nino and ENSO; dynamical and statistical/empirical methods; teleconnections.

MST 410 Integrated Coastal Zone Management (2 units LH 30)

The Coastal zone: Importance of coastal zone and the need for management. Concept of sustainability. Processes for sustainable management of the coast, including geographical and political boundaries. Integrated approach and coastal management framework. Dynamic, multidisciplinary and iterative processes of information collection, planning, decision making, management and monitoring of implementation. Balancing environmental, economic, social, cultural and recreational objectives within limits set by natural dynamics. Integration of terrestrial and marine components of target territory. Constraints of coastal zone management. Case studies.

MST 411 Ocean Waves **(2 units LH 30)**
General properties of waves; surface gravity, capillary, inertia-gravity, internal, Kelvin, Rossby; continental shelf and coastal-trapped waves; many illustrations of how ocean variability can be described by free and forced waves. Ocean currents and circulation. Forced and unforced Equatorial Ocean waves, reflection of equatorial waves from ocean boundaries, equatorial currents, Southern Oscillation dynamics.

MST 412 Maritime Laws, Regulations and Policies **(2 units LH 30)**
State and Federal laws governing maritime activities. International laws on maritime services and co-operations. Maritime organizations and their responsibilities – at state, national and international levels. Concept of territorial and international waters – historical background, the rules and regulations. Marine Insurance. Federal and International policies on marine resource exploration and exploitation. National and international regulations on usage of marine environment, e.g. for waste disposal, industrial and recreational activities, etc. UN Law of the Sea Convention (UNCLOS).

MST 413 Marine Fluid Dynamics **(2 units LH 30)**
Shallow-water theory, Poincare, Kelvin, and Rossby waves; boundary layer theory; wind driven ocean circulation models; quasigeostrophic motion on a sphere, thermocline problem; stability theories. Classical linear stability theory of fluid flows with examples and applications in geophysical fluid dynamics. Specific topics include inviscid, viscous, and stratified parallel shear flow, thermal convection, double-diffusive systems, and rotating systems.

MST 414 Physical Oceanography and Laboratory **(2 units LH 30)**
Ocean dimensions, physical properties of seawater, salt, water and heat budgets of the ocean. Distribution of water characteristics in the ocean; dynamics of circulation and water masses of the ocean; wave characteristics including formation, propagation, dispersion and refraction; dynamic and equilibrium theories of tides as well as tsunamis, seiche, and internal waves; sound and optics; 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 salinity, temperature, dissolved oxygen, and surface and deep circulation. Light and sound in seawater – their propagation and attenuation – measurement techniques; Wave dynamics and tides – measurements and classification, plankton sampling and identification. In-class field trips required.

MST 415 Final Year Student Project **(2 units LH 30)**
Every final year student will undertake supervised individual research project which will involve independent data gathering 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.

MST 416 Marine Geochemistry (2 units LH 30)

Introduction to geochemistry of earth with emphasis on processes controlling elemental cycling between the earth's crust, oceans, and atmosphere. Geochemistry of and geochemical activities in the oceanic crust and sediment. Controls on the geochemical composition of seawater and its geological history. Occurrence and transformation of organic substances in the marine environment – the processes involved. The role of marine microbes in geological and geochemical processes. Geochemical cycle in the ocean.

MST 417 Atmospheric Electricity (2 units: LH 30)

Atmospheric ions and charging Mechanisms; fair weather electric field; stormy electric fields; air conductivity and transfer of charge; charge separation; role of air dynamics; the lightening discharge and its effects upon precipitation processes,

MST 418 Satellite Meteorology (2 units: LH 30)

Topics selected from characteristics of Meteorological satellite orbits and of instruments used for the measurements of meteorological parameters using visible infrared and microwave radiation. Application of satellite measurements to earth's radiation balance and albedo, surface temperature, atmospheric structure, cloud height and types, minor atmospheric constituents, aerosols and precipitation, winds and circulation.

MST 419 Climatology (2 units: LH 30)

Climatic classification schemes; the physical basis of climates in terms of long-term equilibrium of the earth atmosphere-ocean system; the global distribution of energy balance components; the influence of atmosphere and oceanic circulation on climate.

3.14 MATHEMATICS (BSc)

3.14.1 Philosophy, Aims and Objectives of the Degree Programme

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 specialized 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.

3.14.2 Admission and Graduation Requirement

The entry requirements shall be at least credit level passes in five subjects including English Language, Mathematics, Physics to form the core subjects with credit in any other two relevant science subjects at the Senior Secondary School Certificate 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.

3.14.3 Learning Outcomes

a) *Regime of Subject Knowledge*
All bachelors honours level, Mathematics graduates are expected to develop cognitive abilities and skills relating to intellectual tasks including problem solving in mathematics

b) *Competencies and Skills*
They should be able to demonstrate practical skills relating to the solution of mathematical problems and its applications.

c) *Behavioural Attitudes*
They should be able to demonstrate general skills relating to non-subject specific competencies, computer literacy, communication skills, interpersonal skills, organization skills, IT skills and life-long learning skills.

3.14.4 Attainment Levels

Graduates of Mathematics are expected 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.

3.14.5 Resource Requirement for Teaching and Learning

a) Academic and Non-Academic Staff (See Section 1.6)
b) Academic and Non-Academic Spaces (See Section 1.6)
c) Academic and Administrative Equipment (See section 4)
d) Library and Information Resources (See section 1.6)

3.14.6 Course Structure

Course Structure at 100 Level Mathematics

Course Code	Course Title	Units	Status	LH	PH
BIO 101	General Biology I	3	E	45	-
CHM 101	General Chemistry I	3	R	45	-
CSC 101	Introduction to Computer Science	3	R	30	45
CSC 102	Introduction to Problem Solving	3	R	30	45
GST 111	Communication in English I	2	C	30	-
GST 112	Logic, Philosophy and Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills and ICT	2	R	30	-
MTH 101	Elementary Mathematics I	3	C	45	-
MTH 102	Elementary Mathematics II	3	C	45	-
MTH 103	Elementary Mathematics III	3	C	45	-
PHY 101	General Physics I	3	R	45	-
PHY 102	General Physics II	3	R	45	-
PHY 107	General Practical Physics I	1	R	-	45
PHY 108	General Practical Physics II	1	R	-	45
STA 112	Probability I	4	R	60	-
	Total	**41**			

Additional Electives may be chosen from courses in 100 Level Physics, Chemistry, Biology, Economics or Computer Science.

Course Structure at 200 Level Mathematics

Course Code	Course Title	Units	Status	LH	PH
CSC 201	Computer Programming I	3	E	30	45
CSC 202	Computer Programming II	3	E	30	45
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MTH 201	Mathematical Methods I	3	C	45	-
MTH 202	Elementary Differential Equations	3	R	45	-

MTH 203	Sets Logic and Algebra I	3	R	45	-
MTH 204	Linear Algebra I	2	R	30	-
MTH 205	Linear Algebra II	2	R	30	-
MTH 207	Real Analysis I	3	R	45	-
MTH 209	Introduction to Numerical Analysis	3	R	45	-
MTH 210	Vector Analysis	2	R	30	-
MTH 299	Industrial Training I (12 Weeks)	3	C		
PHY 201	General Physics III	3	E	45	-
PHY 202	Introduction to Electric Circuits and Electronics	3	E	30	45
	Total	**44**			

Course Structure at 300 Level Mathematics

Course Code	Course Title	Units	Status	LH	PH
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
MTH 300	Abstract Algebra I	3	R	45	-
MTH 301	Metric Space Topology	3	R	45	-
MTH 302	Ordinary Differential Equations	3	R	45	-
MTH 303	Vector and Tensor Analysis	3	R	45	-
MTH 304	Complex Analysis I	3	R	45	-
MTH 305	Complex Analysis II	3	R	45	-
MTH 306	Abstract Algebra II	3	R	45	-
MTH 307	Real Analysis II	3	R	45	-
MTH 308	Introduction to Mathematical Modelling	3	R	45	-
MTH 310	Mathematical Methods II	3	C	45	-
MTH 311	Theory of Modules	3	R	45	-
MTH 320	Computational Techniques in Mathematics	3	R	45	-
MTH 399	Industrial Attachment II (12 Weeks)	3	C		
	Total	**45**			

Electives

Course Code	Course Title	Units	Status	LH	PH
MTH 309	Discreet Mathematics	4	E	60	-
MTH 312	Optimization Theory	4	E	60	-
MTH 313	Geometry	3	E	45	-
MTH 314	Analytical Dynamics	3	E	45	-
MTH 315	Dynamics of a Rigid Body	3	E	45	-
MTH 316	Introduction to Operations Research	3	E	45	-
MTH 317	Differential Geometry	3	E	45	-
MTH 319	Numerical Analysis I	3	E	45	-
STA 311	Probability III	4	E	60	-
STA 312	Distribution Theory I	3	E	45	-

Course Structure at 400 Level Mathematics

Course Code	Course Title	Units	Status	LH	PH
MTH 401	Theory of Ordinary Differential Equations	3	R	45	-
MTH 402	Theory of Partial Differential Equations	3	R	45	-
MTH 403	Functional Analysis	3	R	45	-
MTH 404	Project	6	C		
MTH 405	General Topology	3	R	45	-
MTH 406	Lebesque Measure and Integration	3	R	45	-
MTH 418	Advanced Algebra	3	R	45	-
MTH 419	Complex Analysis	3	R	45	-
	Total	**27**			

Electives: A minimum of 6 units from the following courses:

Course Code	Course Title	Units	Status	LH	PH
MTH 407	Mathematical Methods III	3	E	45	-
MTH 408	Quantum Mechanics I	3	E	45	-
MTH 409	General Relativity	3	E	45	-
MTH 410	Electromagnetism	3	E	45	-
MTH 411	Analytical Dynamics II	3	E	45	-
MTH 412	Field Theory	3	E	45	-
MTH 413	Fluid Dynamics	3	E	45	-
MTH 414	Elasticity	3	E	45	-
MTH 415	Systems Theory	3	E	45	-
MTH 416	Measure Theory	3	E	45	-
MTH 417	Numerical Analysis II	3	E	45	-

3.14.7 Course Synopses:

MTH 101: Elementary Mathematic I (3 Units: LH 45)
(Algebra and Trigonometry)

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 (3 Units: LH 45)
(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.

MTH 103: Elementary Mathematics III (3 Units: LH 45)
(Vectors, Geometry and Dynamics)
Pre-requisite –MTH 101

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. Elementary Mathematics IV. Impact of two smooth sphere, and of a sphere on a smooth sphere.

MTH 201: Mathematical Methods 1 (3 Units: LH 45)
Pre-requisite –MTH 103.

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 or three variables. Partial derivatives chain rule, extrema, languages multipliers. Increments, differentials and linear approximations. Evaluation of line, integrals. Multiple integrals.

MTH 202: Elementary Differential Equations (3 Units: LH 45)
Pre-requisite –MTH 103

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 difference equations. Application to geometry and physics.

MTH 203: Sets, Logic and Algebra I (3 Units: LH 45)
Pre-requisite –MTH 101

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: LH 30)
Pre-requisite –MTH 101, 102
Co-requisite – MTH 203

Vector space over the real field. Subspaces, linear independence, basis and dimension. Linear transformations and their representation by matrices – range, null space, rank. Singular and non-singular transformation and matrices. Algebra of matrices.

MTH 205: Linear Algebra II (2 Units; LH 30)
Pre-requisite MTH 101, 102. Co-requisite MTH 203, 204.

Systems of linear equation change of basis, equivalence and similarity. Eigenvalues and eigenvectors. Minimum and characteristic polynomials of a linear transformation (Matrix). Cayley –Hamilton theorem. Bilinear and quadratic forms, orthogonal diagonalisation. Canonical forms.

MTH 207: Real Analysis I **(3 Units: LH 45)**
Pre-requisite –MTH 101, 103
Bounds of real numbers, convergence of sequence of numbers. Monolone sequences, the theorem of nested Intervals. Cauchy sequences, tests for convergence of series. Absolute and conditional convergence of series and rearrangements. Completeness of reals and incompleteness of rationals. Continuity/and differentiability of functions R….) R. Rolles' and mean value theorems for differentiable functions Taylor series.

MTH 209: Introduction to Numerical Analysis **(3 Units: LH 45)**
Pre-requisite –MTH 101, 103
Solution of algebraic and transcendental equations. Curve fitting. Error analysis. Interpolation and approximation. Zeros or non- linear equations 'to one variable'. Systems of linear equations. Numerical differentiation and integral equations. Initial value problems for ordinary differential equation.

MTH 210:Vector Analysis **(2 Units: LH 30)**
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)

MTH 299: Industrial Attachment II **(12 Weeks) (3 Units)**
Students should be attached to some industrial organizations for 12 Weeks at the 200 Level preferably during the long vacation for industrial experience. Students to be assessed based on seminar presentation, their reports and assessment by supervisors

MTH 300: Abstract Algebra I **(3 Units: LH 45)**
Pre-requisite –MTH 101, 203
Group: definition, examples including permutation grounds. Subgroups, Cosets. Lagrange's theorem and applications. Cyclic, groups. Rings: definition examples including Z, Zn, rings of polynomials and matrices. Integral domains, fields. Polynomial rings, factorization. Euclidean algorithm for polynomials H.C.F. and L.C.M. of polynomials.

MTH 301: Metric Space Topology **(3 Units: LH 45)**
Pre-requisite –MTH 202.
Sets, matrices, and examples. Open spheres (or balls). Open sets and neighbourhoods. Closed sets. Interior, exterior, frontier, limit points and closure of a set. Dense subsets and separable space. Convergence in metric space homeomorphisms. Continuity and compactness, connectedness.

MTH 302: Ordinary Differential Equations **(3 Units: LH 45)**
Pre-requisite.- MTH 202.
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 theorom, Hyper geometric. Laplace transform and applications to initial value problems

MTH 303: Vector and Tensor Analysis **(3 Units: LH 45)**
Pre-requisite –MTH 201, 204
Vector differentiation and applications. Gradient, divergence and curl. Vector integrate, 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 **(3 Units: LH 45)**
Pre-requisite –MTH 203, 207
Functions of a complex variable. Limits and continuity of functions of a complex variable. Derivating the Cauchy-Riemann equations. Analytic functions. Bilinear 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 **(3Units: LH 45)**
Pre-requisite –MTH 203, 207
Co-requisite –MTH 307
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 **(3 Units: LH 45)**
Pre-requisite –MTH 203, 206
Normal subgroups and quotient groups. Monomorphic isomorphism theorems. Cayley's theorems. Direct products. Groups of sma1l order. Group acting on sets. Sylow theorems. Ideal and quotient rings. P.I.D. 8, U.F.D 'S Euclides rings. Irreducibility; Field extensions, degree of an extension, minimum polynomial. Algebraic and transcendental extensions. Straight edged and compass constructions.

MTH 307: Real Analysis II **(3 Units: LH 45)**
Pre-requisite –MTH 207
Riemann integral of functions R…..)R, continuous monopositive functions. Functions of bounded variation. The Riemann Stieltjes integral. Pointwise and uniform convergence of sequences and series of functions R….)R. Effects on limits (sums) when the functions are continuous differentiable or Riemann integrable power series.

MTH 308: Introduction to Mathematical Modelling (3 Units: LH 45)
Pre-requisite –MTH 201, 202, 204
Co-requisite –MTH 302, 303
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. Application of mathematical models to physical, biological, social and behavioural sciences.

MTH 309: Discreet Mathematics (4 Units: LH 60)
Pre- requisites – MTH -201, 202, 308.
Groups and subgroups; Group Axioms, Permutation Group, Cosets, Graphs; Directed and un-directed graphs, subgraphs, cycles, connectivity, Application (flow Charts) and state transitiongraphs; lattics and Boolean Algebra, Finite fields: Minipoly- nomials. Irreducible polynomials,poly-nomial roots, Application (error-correcting codes, sequences generators).

MTH 310: Mathematical Methods II (3 Units: LH 45)
Sturm – Liouville problem. Orthogonol 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 311: Theory of Modules (3 Units: LH 45)
Modules, direct sum product submodules; quotient modules, isomorphism theorems. Polynomials and power series in several variables, symmetric polynomials. Finitely generated modules over principal ideal domains with application to abelian groups.

MTH 312: Optimization Theory (4 Units: LH 60)
Pre-requisites – MTH 201, 202, 302, 303.
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 313: Geometry (3 Units: LH 45)
Co-ordinate in R3. Polar co-ordinates; Distances between points, surfaces and curve in space. The plane, straight line. Basic projective Geometry, Affine and Euclidean Geometries.

MTH 314: Analytical Dynamics (3 Units: LH 45)
Degrees of freedom. Holonomic and nonholonomic constraints. Generalised co-ordinates Lagrange's equations for holonomic systems; face dependent on co-ordinates only, force obtainable from a potential. Impulsive force.

MTH 315: Dynamics of a Rigid Body **(3 Units: LH 45)**
General motions of a rigid body as a translation plus a rotation. Moment, and products of inertia in three dimensions. Parallel, and perpendicular axes theorems. Principal axes, Angular momentum, kinetic energy of a rigid body. Impulsive motion. Examples involving one and two dimensional motion of simple systems. Moving frames of reference; rotating and translating frames of reference. Coriolis force. Motion near the Earth's Surface. The Foucault's pendulum. Euler's dynamical equations for motion of a rigid body with one point fixed. The symmetrical top. Procession.

MTH 316: Introduction to Operation Research **(3 Units: LH 45)**
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.

MTH 317: Differential Geometry **(3 Units: LH 45)**
Vector functions of a real variable. Handedness. Limits. Continuity and differentiability. Functions Cm. Taylor's Formulae. Analytic functions. Curves: regular, differentiable and smooth. Curvature and torsion. Tangent line and normal plans Vector: Functions of Vector Variable: Linear continuity and limits. Directional functions of Class Cm. Taylor's theorem and inverse function theorem. Concept of a surface; parametric representation, tangent plane and normal lines. Topological properties of simple surfaces. MTH -313.

MTH 319: Numerical Analysis I **(3 Units: LH 45)**
Polynomial and splines approximation. Orthogonal polynomials and Chebyshev approximations. Direct and interactive methods for the solution of systems of linear equations. Eigen value problem – power methods, inverse power methods. Pivoting strategies.

MTH 320: Computational Techniques in Mathematics **(3 Units: LH 45)**
Use of software packages
Use of appropriate software packages to analyse Operations Research Models; analyse mathematical equations which are not tractable; evaluate definite integrals and inversion of large matrices; for obtaining extremum valves for constrained and unconstrained non-linear optimization problems; for obtaining statistical information such as variance, standard deviation, etc. for Operational Research Models.

MTH 399: Industrial Attachment II (12 Weeks) **(3 Units)**
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

MTH401: Theory of Ordinary Differential Equations **(3 Units: LH 45)**
Differential equations: existence and uniqueness theorems dependence of solution 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 (3 Units: LH 45)
Theory and solutions of first-order and second order linear equations. Classification, characteristics, 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 problem.

MTH 403: Function Analysis (3 Units: LH 45)
Hilbert Spaces, bounded linear functionals, operators and Banach spaces, topological vector spaces, Banach algebra

MTH 404: Project: (6 Units: PH 270)
A research project and dissertation to be undertaken on any topic of mathematical interest.

MTH 405: General Topology (3 Units: LH 45)
Pre-requisite –MTH 301.
Topological spaces, definition, open and closed sets neighbourhoods. Coarser, and finer topologies. Basis and sub- bases. Separation axioms, compactness, local compactness, connectedness. Construction of new topological spaces from given ones; Sub-spaces, quotient spaces. Continuous functions, homeomorphics, topological invariants, spaces of continuous functions: Pointwise and uniform convergence.

MTH 406: Lebesgue Measure and Integrals (3 Units: LH 45)
Pre-requisite –MTH 207, MTH 307.
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 (3 Units: LH 45)
Pre-requisite – MTH -201, 301, 405, 406.
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: Quantum Mechanics (3 Units: LH 45)
Particle wave duality. Quantum postulates. Schrödinger equation of motion. Potential steps and wells in 1-dim Heisenberg formulation. Classical limit of Quantum mechanics. Computer brackets. Linear harmonic oscillator. Angular momentum. 3-dim square well potential. The hydrogen atom collision in 3- dim. Approximation methods for stationery problems.

MTH 409: General Relativity **(3 Units: LH 45)**
Particles in a gravitational field: Curvilinear coordinates, intervals. Covariant differentiation; Christofell symbol and metric tensor. The constant gravitational field. Rotation. The Curvature tensor. The action function for the gravitational field. The energy momentum tensor. Newton's law. Motion in a centrally symmetric gravitational field. The energy moment pseudo-tensor. Gravitational waves. Gravitational fields at large distances from bodies. Isotropic space. Space-time metric in the closed and in the open isotropic models.

MTH 410: Electromagnetism **(3 Units: LH 45)**
Maxwell's field equations. Electromagnetic waves and Electromagnetic theory of lights. Plane electromagnetic waves in non –conducting media, reflection and refraction at place boundary. Waves guides and resonant cavities. Simple radiating systems. The Lorentz-Einstein transformation. Energy and momentum. Electromagnetic 4-vectors. Transformation of (E.H.) fields. The Lorentz force.

MTH 411: Analytical Dynamics II **(3 Units: LH 45)**
Lagrange's equations for non-holonomic systems. Lagrangian multipliers. Variational principles: Calculus of variation, Hamilton's principle. Lagrange's equation from Hamilton's Principles. Canonical transformations. Normal modes of vibrations. Hamilton-Jacobi equations.

MTH 412: Field Theory **(3 Units: LH 45)**
Pre-requisite – MTH -300
Gradient, divergence and curl: Further treatment and application of the differential definitions. The integral definition of gradient, divergence and curl: Line, surface and volume integrals: Green's Gauss' and Stoke's theorems. Curvilinear coordinates. Simple notion of tensors. The use tensor of notation..

MTH 413: Fluid Dynamics **(3 Units: LH 45)**
Pre-requisite – MTH -314.
Real and Ideal fluids. Differentiation following the motion of fluid particles. Equations of motion and continuity for incompressible inviscid fluids. Velocity potentials and Stoke's Stream functions. Bernoulli's equation with application to flow along curved paths. Kinetic energy. Sources, sinks, doubles in 2-and-3-dimensions, limiting streamlines. Images and rigid planes.

MTH 414: Elasticity **(3 Units: LH 45)**
Particle gravitational field: Curvilinear coordinates, intervals. Covariant differentiation. Christofell symbol and metric tensor. The constant gravitational field. Rotation.

MTH 415: Systems Theory **(4 Units: LH 60)**
Lyapunov Theorems. Solution of Lyapunov stability equation ATP + PA = Q. Controllability and observability. Theorem on existence of solution of linear systems of differential operations with constant coefficients.

MTH 416: Measure Theory **(4Units: LH 60)**
Abstract integration Lp-Spaces.

MTH 417: Numerical Analysis II **(3 Units: LH 60)**
Finite difference equation and operations; Discrete variable methods for solution of IUPS – ODES. Discrete and continuous Tan methods for solving IUP – ODES, error analysis. Partial differential equation. Finite difference and finite elements methods. Stability convergence and error analyses.

MTH 418: Advanced Algebra **(3 Units: LH 45)**
Lattice theory, Noetherian and Artirian modules and rings. Hilbert basis theorem, Chinese remainder theorem. Semi-simple modules and rings. Prime spectrum of a commutative ring.

MTH 419: Complex Analysis **(3 Units: LH 45)**
Meromorphic functions. Zeros and poles Argument principle, Rouche’s theorem. Summation of series. Mittag-Leffler’s theorem. Maximum principle. Principle of analytical continuation. Schwartz reflection principle. Univalent functions. Schwartz-Christoffel transformation. Boundary value problems.

3.15 METEOROLOGY (BSc)

3.15.1 Philosophy, Aims and Objectives of the Degree Programmes

a. Provide students with a broad and balanced foundation and practical skills in Meteorology.

b. Develop in students the ability to apply knowledge and skills to the solution of theoretical and practical problems in Meteorology.

c. Develop in students, a range of transferable skills and attitudes that are of value in Meteorological and non-Meteorological employment.

d. 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.

e. Generate in students an appreciation of the importance of Meteorology in an agricultural, socio-economic, environmental and technological development.

f. 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).

g. Instil in the student the capability to carry out and disseminate application-oriented research in the areas (i) – (iii) above.

3.15.2 Admission and Graduation Requirements

UTME: The entry requirements shall be at least credit level passes in five subjects including English Language, Mathematics, Physics to form the core subjects with credit in any other two relevant science subjects at the Senior Secondary School Certificate 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 a minimum of two GCE A level passes (graded A-E) at the GCE Advanced Level in two relevant subjects (Mathematics, Physics and Chemistry) may be admitted into 200-level.

3.15.3 Learning Outcomes

a *Regime of Subject Knowledge*

All bachelors honours level, Meteorology graduates are expected to develop cognitive abilities and skills relating to agro-meteorology, hydro-meteorology and space meteorology.

B *Competencies and Skills*
They should be able to demonstrate practical skills relating to the solution on meteorological problems and its applications.

C *Behavioural Attitudes*
They should be able to demonstrate general skills relating to non-subject specific competencies, ICT capability, communication skills, interpersonal skills and organization skills.

3.15.4 Attainment Levels

Graduates of Meteorology are expected 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.

3.15.5 Resource Requirement for Teaching and Learning

a) Academic and Non-Academic Staff (See Section 1.6)
b) Academic and Non-Academic Spaces (See Section 1.6)
c) Academic and Administrative Equipment (See section 4)
d) Library and Information Resources (See section 1.6)

3.15.6 Course Structure and Synopses

Course Structure at 100 Level Meteorology

Course Code	Course Title	Units	Status	LH	PH
BIO 101	General Biology I	3	R	45	-
BIO 102	General Biology II	3	R	45	-
BIO 107	General Biology Practical I	1	R	-	45
BIO 108	General Biology Practical II	1	R	-	45
CHM 101	General Chemistry I	3	R	45	-
CHM 102	General Chemistry II	3	R	45	-
CHM 107	General Chemistry Practical I	1	R	-	45
CHM 108	General Chemistry Practical II	1	R	-	45
CSC 101	Introduction to Computer Science	3	R	30	45
GST 111	Communication in English I	2	C	30	-
GST 112	Logic, Philosophy and Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills and ICT	2	C	30	-
MET 101	Introduction to Meteorology	2	R	30	-
MTH 101	Elementary Mathematics I	3	R	45	-
MTH 102	Elementary Mathematics II	3	R	45	-
PHY 101	General Physics I	3	R	45	-
PHY 102	General Physics II	3	R	45	-
PHY 107	General Physics Practical I	1	R	-	45
PHY 108	General Physics Practical II	1	R	-	45
	Total	**43**			

Course Structure at 200 Level Meteorology

Course Code	Course Title	Units	Status	LH	PH
CSC 201	Computer Programming I	3	R	30	45
CSP 201	General Agriculture I	2	E	30	-
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MET 201	Codes, Observations & Plotting Practice	2	C	30	-
MET 202	Instrumentation & Environ. Measurement	2	C	30	-
MET 204	Introduction to the Atmosphere	2	R	30	-
MTH 201	Mathematical Methods I	3	R	45	-
MTH 202	Elementary Differential Equations	3	R	45	-
MTH 209	Introduction to Numerical Analysis	3	R	45	-
PHY 202	Electric Circuits & Electronics	3	R	30	45
PHY 204	General Physics IV (Waves & Optics)	3	R	45	-
PHY 209	Introduction to Space Science	2	R	30	-
PHY 210	Physics of Solid Earth	2	R	30	-
	Total	**38**			

Course Structure at 300 Level Meteorology

Course Code	Course Title	Units	Status	LH	PH
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
MET 302	Dynamic Meteorology	3	R	45	-
MET 303	Atmospheric Physics Experiment I	2	R	-	90
MET 304	Synoptic Analysis & Current Weather I	2	R	30	-
MET 305	Atmospheric Thermodynamics	2	R	30	-
MET 306	Atmospheric Physics Experiment II	2	R	30	-
MET 307	Fluids Dynamics	2	R	30	-
MET 308	Cloud Physics & Weather Modification	2	R	30	-
MET 309	Atmospheric Radiation	3	R	45	-
MET 310	World Climatology	3	R	45	-
MTH 301	Metric Space Topology	3	R	45	-
	Total	**30**			

Course Structure at 400 Level Meteorology

Course Code	Course Title	Units	Status	LH	PH
MET 403	Agrometeorology	3	R	45	-
MET 405	Tropical Meteorology	2	R	30	-
MET 407	Boundary Layer & Turbulence	3	R	45	-
MET 409	Satellite Meteorology	2	C	30	-
MET 411	Aeronautical Meteorology	2	R	30	-
MET 413	Synoptic Analysis & Current Weather II	2	C	30	-
MET 415	Hydrometeorology	2	R	30	-
MET 499	Industrial Training (24 Weeks)	6	C		
	Total	**22**			

Electives

Course Code	Course Title	Units	Status	LH	PH
CHM 319	Environmental Chemistry	2	E	30	-
FWT 409	Biometrics	3	E		

Course Structure at 500 Level Meteorology

Course Code	Course Title	Units	Status	LH	PH
CSP 501	Crop/Soil Water Management	3	R		
MET 500	Case Study of Met. Phenomena (Seminar)	2	C		
MET 501	Research Project	6	C	-	270
MET 503	West African Meteorology	3	R	45	-
MET 504	Meso-Scale Weather Systems	3	R	45	-
MET 505	Marine and Physical Oceanography	3	R	45	-
MET 506	Dynamical Oceanography and Air/Sea Interaction	3	R	45	-
MET 507	Computer Application in Meteorology	3	R	45	-
MET 508	Advanced Dynamical Meteorology & Numerical Weather Prediction	3	R	45	-
	Total	**29**			

3.15.7 Course Synopses

MET 101: Introduction to Meteorology **(2 Units: LH 30)**

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.

MET 201: Codes, Observations and Plotting Practice (2 Units: LH 30)
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: LH 30)
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 measurement water current, water table. Observation system: Automatic stations, marine, aircraft and satellite observations.

MET 204: Introduction to the Atmosphere (2 Units: LH 30)
Detailed treatment of atmospheric variables (pressure, temperature, etc); their variations in time and space. Moisture variables – mixing ratio, specific humidity etc. Pressure systems. Pressure gradient and Coriolis force. Atmospheric motion: geostrophic, gradient and thermal wind. Lapse rates – environment, dry and wet adiabatic lapse rates; the effect of latent heat release. Types and characteristics of atmospheric stability. Relationship between lapse rates, stability and clouds. Types of clouds and their classification. Types of precipitation associated with clouds. Scales of motion in atmosphere. Air masses and source regions. Air masses affecting tropical and temperate regions. ITD and ITCZ. The polar front and fronted slopes. Life cycles of frontal depressions. Frontal cross-sections. Introduction to divergence and vorticity. Atmospheric optics with applications to rainbow, halo and other optical phenomena, transparency of atmosphere and visual range.
The Universe: Galaxies, stars and the sun. The solar system: Gravitation; the planets; the moons, comets and meteors. The sun: solar atmosphere; activity regions: sunspots, solar flares, solar wind, solar radiation and the Earth's atmosphere.

MET 302: Dynamic Meteorology (3 Units: LH 45)
Pre-requisite – MET 204, IMC 302, 303
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: PH 90)
Basic techniques of laboratory and field research in Meteorology. Use and care of meteorological instruments. Experiments are designed to obtained 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 I (2 Units: LH 30)
The concept of Divergence and Vorticity. Scalar analysis of all meteorological variables (temperature, pressure, weather, visibility etc). The meaning of all isolines (isobar, isohyet etc). Streamline to isogon 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: LH 30)
Pre-requisite – MET 204
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 306: Atmospheric Physics Experiment II (2 Units: PH 90)
A series of experiments to illustrate meteorological phenomena using physical and/or electrical analogues of soil heat waves, free and forced convection, aerodynamic drag coefficients in fluids, turbulence spectrum, fluid dynamics. Fields measurements of vertical wind profile, grounds heat flux, solar radiator, Bowen ratio, rain-drop size analysis, etc.

MET 307: Fluids Dynamics (2 Units: LH 30)
Pre-requisite – IMC 302, 303.
Introduction and definitions: Properties of fluids, Continuum theory; Short and long-range body forces. Viscosity and thermal conductivity and their importance in meteorology. Laminar and turbulent motion – transition from one to the other. Reynolds number.

Boundary layer: General momentum, heat and vapour transport. Drag coefficient and roughness parameter. The equation of motion; Eulerian and Lagrangian description. Heat transfer in the fluids. Mass conservation equation. Fluid motion in an inertia system on a rotating earth. Coriolis and Centrifugal forces. Bernoullis equation: expansion and spin in a fluid. Concept of the vorticity equation in a rotating fluid; relevance in dynamic Meteorology.

MET 308: Cloud Physics and Weather Modification (2 Units: LH 30)
Pre-requisite – MET 204, 305.
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 309: Atmospheric Radiation (3 Units: LH 45)
Pre-requisite – MET 305, 308.
Electromagnetic spectrum and radiation laws. Black body radiation and characteristics. The sun: solar constant and its measurement. Absorption, scattering and transmission of radiation. Attenuation of radiation and radiative transfer. Solar spectral radiation under cloudy and cloudless conditions. Main absorption bands; Simpson and other empirical methods of estimation. Terrestrial radiation and energy budget. Simple radiation and climate models. Vegetation and ground heat fluxes. The greenhouse effect. Derivation of heating and cooling rates. The Elsasser radiation diagram and its uses.

MET 310: World Climatology (3 Units: LH 45)
Scope and definition of climatology. Climatic elements. Decomposition of climatic elements into zonal, meridional, standing and transient circulations. Mean global atmospheric circulations as represented by the wind, temperature, pressure, humidity etc. Jet stream climatology. Synoptic and dynamic considerations for their formation and maintenance. Jet streams of the world (poles, mid-latitudes and tropics).
Global energy budget and heat transfer. Angular momentum consideration and implications for energy and Jet stream maintenance. Mechanisms of achieving global balance in the various climatic elements; the roles of the eddies in the general circulation. Climatic trends and climatological forecasting techniques.

MET 320: Field Trip (During Long Vacation) (3 Units)

MET 403: Agrometeorology (3 Units: LH 45)
Pre-requisite – MET 204, 202, IMC 208.
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 405: Tropical Meteorology **(2 Units: LH 30)**
Pre-requisite – MET 301, 302.
The mean state of the tropical atmosphere. Winter and summer situations. Major motion systems: ITD, ITCZ (in detail), monsoons, TEJ, AEJ, Instability of tropical flows; structure and dynamics of easterly waves and vortices. Upper level flows. The westerly jet in winter. Usefulness of Global efforts and experiments for the tropics – GATE, FGCE, MONEX and WAMEX. Present forecasting methods and difficulties in the tropics: El Nino, ENSO, dynamical and statistical/empirical methods. Climate change with special focus on the tropics. Influence of ocean dynamics. Future prospects.

MET 407: Boundary Layer and Turbulence **(3 Units: LH 45)**
Pre-requisite – MET 305, 307; IMC 302.
Simplifications used in describing the boundary layer. Constant and variable eddy viscosity. Wind profile near the surface; Ekman spiral. Log and power laws for neutral stability Roughness length. Stability parameters: Richardson's number (Ri), and its flux form; Monin-Obukhov parameter, Z/L, and its relation to Ri. Similarity theory. Dispersion of pollutants in boundary layer (e.g. smoke, dust). Specification of turbulent fields: velocity correlation and cross-correlations (with temperature and moisture). Turbulent energy equation. Eddy transfer coefficients. Turbulent transports of heat, moisture and momentum. Flux profiles. Bowen ratio and Penman's formula for heat and evaporation estimates. Importance of eddy transports especially for agriculture and tropical weather systems.

MET 409: Satellite Meteorology **(2 Units: LH 30)**
Satellite orbits, types of satellites, visible and infrared imagery. Surface temperature measurements; upper air temperature and moisture soundings; determination of upper winds. 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.
Pre-requisite – **MET 305, 308 & 401**

MET 411: Aeronautical Meteorology **(2 Units: LH 30)**
Pre-requisites (MET 201 AND MET 304).
Advanced Streamline and isobaric analysis (Emphasis on Africa and her sub-regions). Contour heights analysis. Frontal analysis and X-sections. Ascent analysis emphasising convective systems.
<u>CODES :</u> METAR, TAFOR, ARFOR, ROFOR, & FIFOR.

MET 413: Synoptic Analysis & Current Weather II (2 Units: LH 30)
Pre-requisite – MET 304.
LOW LEVEL FORECASTING : forecast for take-off forecast for landing, wind shear and turbulence forecasting. Sutcliff development areas. A-geostrophic systems and their implications in forecasting. Forecasting of all meteorological parameters and systems (wind, visibility, fog, turbulence squall lines, Thunderstorms etc). Flight documents preparations. Briefing, de-briefing and use of AIREP. Role of jet streams in forecasting. Forecasting indices.

MET 415: Hydrometeorology (2 Units: LH 30)
Pre-requisite – MET 204.
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 an 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 effect on ground water movement and table. Hydrometeorological practice & forecasting; present techniques and trends in the tropics.

MET 499: Industrial Attachment (24 Weeks) (6 Units)
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.

MET 501: Research Project (6 Units: 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 (3 Units: LH 45)
Pre-requisite – MET 302, 405.
West African Climatology: the pressure, wind, temperature and moisture regimes; the ITD; the inter and summer situations of the distributions. The AEJ and TEJ. Weather system 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/extratropical 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 (3 Units: LH 45)
Pre-requisite – MET 302.
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 505: Marine and Physical Oceanography (3 Units: LH 45)

The major ocean currents; characteristics, similarities and connection with atmospheric general circulation. Under-water topography and effects on upwelling and sea surface temperatures and hence climate, with special reference to the Gulf Stream, El Nino and the Gulf of Guinea currents etc. sea fogs. Definition of water masses by temperature and salinity. Oceanic gyres, eddies and fronts; comparison with synoptic meteorology; cross-sections across oceanic fronts. Stratification in the Oceans: the creation, growth and decay of transient and seasonal thermoclines; Tracer (dye) studies of thermoclines, internal waves on thermoclines. Ocean convection: measurement of vertical currents; slicks and windrows; importance of convection and stratification in relation to ocean pollution. Instrumentation: the bathy thermography, the temperature salinity bridge, sea surface temperature measurements of sea and swell-salinity: Instrumented buoys. Oceanographic forecasting – importance to fishermen, oil companies and the Navy. Sea surface temperature maps.

MET 506: Dynamical Oceanography & Air/ Sea Interaction (3 Units: LH 45)
Pre-requisite – MET 302, 505

Horizontal and vertical extent of oceans. Changes in salinity by molecular diffusion. Specific heat and thermal conductivity of sea-water: heat sources and exchanges; ocean heat budget; diffusion of heat and salt by turbulent mixing. Changes in oceanic salts distribution by vertical mixing and horizontal advection. Forces and the relationship to the structure of the ocean. Dynamical equations governing steady oceanic currents; the Rossby and Ekman numbers and characteristic values in some observed current. Geostropohic currents – barotropic and baroclinic mass transports. Air-sea interaction; winds and waves; wind-driven currents in the Ekan layer; the Ekman spiral. Ekman transport; the thermocline; swells and tides.

MET 507: Computer Applications in Meteorology (3 Units: LH 45)

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 (3 Units: LH 45)
Pre-requistie – MET 302, IMC 302, 413.

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.

3.16 MICROBIOLOGY (BSc)

3.16.1 Philosophy, Aims and Objectives

The programme has been designed to provide a sound understanding of the concepts of micro-organisms in relation to mankind and the environment. The programme will elaborate the importance of micro-organisms in industry, health and environmental sectors of the society. The Microbiology programme will also emphasis the traditional biotechnology and the linkage to the current modern biotechnology. The main objectives of the programme are to broadly educate students for positions in the industry, health sectors, research institutes and to prepare them for graduate and professional studies in the life applied areas of microbiology.

3.16.2 Admission and Graduation Requirement

UTME

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 courses, Biology, Chemistry, and Physics at the Senior Secondary School Certificate 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 GCE/IJMB A level passes (graded A-E) at the Advanced Level in two relevant subjects (Biology, Botany, Chemistry, Geography, Mathematics and Physics) may be admitted into 200-level.

3.16.3 Learning Outcomes

All Bachelors honours degree student in Microbiology are expected to develop the following abilities and skills:

a *Regime of Subject Knowledge*
Cognitive abilities and skills relating to solution of problems in Microbiology

b *Competencies and Skills*
Practical skills relating to the conduct of laboratory and industrial work in Microbiology

c *Behavioural Attitudes*
General skills relating to non-subject specific competencies, communication, ICT knowledge, interpersonal, organization skills and ethical standards.

3.16.4 Attainment Levels

Graduates of Microbiology are expected to have the ability to apply knowledge and skills to solving theoretical and practical problems in Microbiology in relation to national and societal problems.

3.16.5 Resource Requirement for Teaching and Learning

a) Academic and non-academic staff. (See section 1.6)
b) Academic and Non-Academic Spaces (See section 1.6)
c) Academic and Administrative Equipment (See Appendix)
d) Library and Information Resources (See section 1.6)

PLEASE NOTE: Conclusive statement shall be made on the minimum CGPA of 1.5 for graduation after the forthcoming workshop on Grading System

3.16.6 Course Structure and Synopses

Course Structure at 100 Level Microbiology

Course Code	Course Title	Units	Status	LH	PH
BIO 101	General Biology I	3	C	45	-
BIO 102	General Biology II	3	C	45	-
BIO 107	General Biology Practical I	1	C	-	45
BIO 108	General Biology Practical II	1	C	-	45
CHM 101	General Chemistry I	3	R	45	-
CHM 102	General Chemistry II	3	R	45	-
CHM 107	General Chemistry Practical I	1	R	-	45
CHM 108	General Chemistry Practical II	1	R	-	45
CSC 101	Introduction to Computer Science	3	R	30	45
GST 111	Communication in English	2	C	30	-
GST 112	Logic, Philosophy & Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills & ICT	2	R	30	-
MCB 121	Introductory Microbiology	3	C	30	45
MTH 101	General Mathematics I	3	R	45	-
MTH 102	General Mathematics II	3	R	45	-
PHY 101	General Physics I	3	R	45	-
PHY 102	General Physics II	3	R	45	-
PHY 107	General Physics Practical I	1	R	-	45
PHY 108	General Physics Practical II	1	R	-	45
	Total	**44**			

Course Structure at 200 Level Microbiology

Course Code	Course Title	Units	Status	LH	PH
BIO 202	Introductory Ecology	2	R	15	45
BIO 204	Biological Techniques	2	R	15	45
BIO 205	Introductory Developmental Cell Biology	3	R	30	45
CHM 210	Physical Chemistry I	3	R	30	45
CHM 211	Organic Chemistry I	3	R	30	45
CHM 212	Inorganic Chemistry I	3	R	30	45
GST 123	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MCB 221	General Microbiology	3	C	30	45
MCB 231	Basic Techniques in Microbiology	2	C	-	90

MCB 299	Industrial Attachment I (12 Weeks)	3	C		
STA 201	Statistics for Agriculture & Biological Sciences	4	R	60	-
FST 302	Introduction to Food Technology	2	R	30	-
ZOO 211	Invertebrate Zoology	3	E	30	45
ZOO 212	Chordate Zoology	3	E	30	45
	Total	**44**			

Course Structure at 300 Level Microbiology

Course Code	Course Title	Units	Status	LH	PH
BOT 305	Mycology	3	R	30	45
CSC 201	Computer Programming I	3	E	30	45
CSC 204	Fundamentals of Data Structures	3	E	30	45
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
MCB 307	Immunology	3	C	30	45
MCB 309	Food Microbiology	3	C	30	45
MCB 322	Bacterial Diversity	3	R	30	45
MCB 324	Microbial Ecology	3	R	30	45
MCB 325	Soil Microbiology	3	R	30	45
MCB 326	Introductory Virology	3	R	30	45
MCB 328	Biodeterioration	2	R	15	45
MCB 399	Industrial Attachment II (12 Weeks)	3	C		
ZOO 312	Biology of Tropical Parasites	3	E	30	45
	Total	**41**			

Course Structure at 400 Level Microbiology

Course Code	Course Title	Units	Status	LH	PH
MCB 401	Essays in Microbiology	3	R		
MCB 403	Pharmaceutical Microbiology	3	R	30	45
MCB 404	Advanced Food Microbiology	3	R	30	45
MCB 405	Principles of Epidemiology & Public Health Management	3	R	30	45
MCB 407	Pathogenic Microbiology	3	R	30	45
MCB 412	Microbial Genetics	3	R	30	45
MCB 423	Industrial Microbiology	3	R	30	45
MCB 424	Microbial Physiology & Metabolism	3	R	30	45
MCB 430	Microbiological Quality Assurance	2	R	15	45
MCB 482	Virology & Tissue Culture	3	R	30	45
MCB 491	Research Project	6	C		
ZOO 412	Principles of Parasitology	4	R	45	45
	Total	**39**			

Electives

Course Code	Course Title	Units	Status	LH	PH
BOT 417	Plants and Environmental Pollution Monitoring	3	E	30	45
BOT 418	Host-Pathogen Relations & Plant Disease Management	3	E	30	45
BOT 419	Introduction to Mushroom Growing Technology	3	E	30	45
MCB 425	Environmental Microbiology	3	E	30	45
MCB 431	Petroleum Microbiology	3	E	30	45

3.16.7 Course Synopses

MCB 121: Introductory Microbiology (3 Units: LH 30; PH 45)
History of the Science of Microbiology. Sterilization and disinfection; Structure, ecology and reproduction of representative microbial genera. Cultivation of micro-organisms. Isolation of micro-organisms; isolation of bacteria, viruses.

MCB 221: General Microbiology (3 Units: LH 30; PH 45)
Nutrition and biochemical activities of micro-organisms. Antigens and antibodies. Identification and economic importance of selected microbial groups. Microbial variation and heredity.

MCB 231: Basic Techniques in Microbiology (2 Units: PH 90)
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.

MCB 299: Industrial Attachment I (12 Weeks) (3 Units)
Students will be posted to industrial establishments such as food processing, brewing, distillery, pharmaceutical; research institutes or medical and health institutions. A report to be submitted for grading.

MCB 307: Immunology (3 Units: LH 30; PH 45)
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.

MCB 309: Food Microbiology **(2 Units: LH 15; PH 45)**
Pre-requisite: MCB 221/231
The distribution, role and significance of micro-organisms in food; intrinsic and extrinsic parameters of foods that affect microbial growth, food spoilage and food borne diseases. Micro-organism. Indices of food sanitary growth and food microbiology standards. Disease of animal transmittable to man via food products.

MCB 322: Bacterial Diversity **(3 Units: LH 30; PH 45)**
The morphology, life cycle and biochemical characteristics of bacteria. Systematic study of bacteria and other prokaryotes, their nature, characteristics, identification and isolation.

MCB 324: Microbial Ecology **(3 Units: LH 30; PH 45)**
Microbes and ecological theory. Physiological, morphological and genetic adaptations of micro-organisms to their environment. Microbial interactions; micro-organisms in natural ecosystems. The life of micro-organisms in air, springs, rivers, lakes and seas. Cycling of elements in water and sediments.

MCB 325: Soil Microbiology **(3 Units: LH 30; PH 45)**
The characteristics of soil environment; microbial flora and fauna of soil; microbial activities in soil; Nitrogen cycle, mineral transformation by micro-organisms. Ecological relationship among soil pathogens. Effect of pesticides on soil micro-organisms. Biodegradation and biofuels generation. Microbiology of the rhizosphere.

MCB 326: Introductory Virology **(3 Units: LH 30; PH 45)**
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 328: Biodeterioration **(2 Units: LH 15; PH 45)**
Principles of microbial deterioration of materials. Materials subject to microbial deterioration: Foods, Jet fuels, paper, paints, textiles and leather, metals etc. Factors favouring deterioration of materials. Major microbial groups involved in deterioration. Impact of processing and new technologies on biodeterioration. Biodeterioration Control.

MCB 399: Industrial Attachment II (12 Weeks) **(3 Units)**
Students will be posted to industrial establishments such as food processing, brewing, distillery, pharmaceutical; research institutes or medical and health institutions. A report to be submitted for grading.

MCB 401: Essays in Microbiology **(2 Units)**
Detailed literature search followed by presentation at a departmental Seminar of a scientific topic, which must be of microbiological or biotechnological interest.

MCB 403: Pharmaceutical Microbiology **(3 Units: LH 30; PH 45)**
Concepts of growth and death in micro-organisms. The chemistry of synthetic chemotherapeutic agents and antibiotics. Production and synthesis of antibiotics and antiseptics. Relationship of antimicrobial agents to different microbial groups: Gram positives, Gram negatives, spore-formers etc . The mode of action and assay of antibiotics and antiseptics. Sensitivity and resistance as related to microbial physiology. Microbiological quality control in the Pharmaceutical industry.

MCB 404: Advanced Food Microbiology **(3 Units: LH 30; PH 45)**
Advanced 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 405: Principles of Epidemiology & Public Health Microbiology
(3 Units: LH 30; PH 45)
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.

MCB 407: Pathogenic Microbiology **(3 Units: LH 30: PH 45)**
Study of some microbial pathogens of plants and animals 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 of specific bacterial, viral and fungal pathogens of man.

MCB 412: Microbial Genetics **(3 Units: LH 30; PH 45)**
Principles of genetic analysis. Plasmids 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. Genetic recombination in prokaryotes including transformation, transduction, phage conversion and conjugation. 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: LH 30; PH 45)**
Fermentation systems; design and use of fermenters. Micro-organisms of Industrial importance. Classification of microbial products by use. Relationship between primary and secondary metabolism; characteristics, sources and strain improvement of industrial micro-organisms. 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: LH 30; PH 45)
Dynamics of growth. 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. 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: LH 30; PH 45)
Impact assessment of microbial contamination of soil, water and air in relation to the deterioration of the environment. Soil, air and water pollution. Waste disposal and management. Methods of water and sewage treatment with emphasis on specific micro-organisms involved. Disease transmission by water. Biological and Chemical Oxygen

MCB 430: Microbiological Quality Assurance (2 Units: LH 15; PH 45)
A theoretical and practical consideration of the management of microbiological quality assurance. HACCP, cleaning and sanitation. Microbiological specifications and regulations. Local and international approaches to obtaining safe food. Management and quality assurance in the microbiology laboratory.

MCB 431: Petroleum Microbiology (3 Units: LH 30; PH 45)
Biogenesis of fossil fuels with emphasis on the role of micro-organisms. Petroleum prospecting and secondary 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.

MCB 482: Virology & Tissue Culture (3 Units: LH 30; PH 45)
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.

MCB 491: Research Project (6 Units: PH 270)
A research project and dissertation to be undertaken on any topic of microbiological and/or biotechnological interest.

FST 302: Introduction to Food Technology (2 Units: LH 30)
Review of global food situation with special emphasis on Nigeria. Introduction to the microflora of foods. Physical, chemical and biological principles of food processing and preservation. Introduction to the concept of engineering units and dimensions applicable to the food industry.

3.17 PETROLEUM CHEMISTRY

3.17.1 Philosophy, Aims and Objectives of the Programme

3.17.2 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.

3.17.3 Main Aim and Objectives of the Programme

The aim of the programme is to provide candidates with basic knowledge and skills of the chemical processes in the oil and gas industry and prepare them for advance studies in the area to enable them contribute to overall industrial development of the nation.

The objectives of the programme are to:

i. Instill, 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.

ii. Establish, in students, an appreciation of the importance of the chemical sciences in an industrial, academic, economic, environmental and social context.

iii. 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.

iv. Develop, in students, the ability to apply standard methodologies to the solution of problems in chemical processes.

v. Provide students with knowledge and skills to enable them work efficiently in multi-disciplinary environment involving chemistry.

vi. Provide students with enough basic knowledge and skills to enable them further their studies in chemistry and multi-disciplinary fields involving chemistry.

vii. 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.

viii. Provide a broad and balanced training in laboratory and research skills.

3.17.4 Admission Requirements

There are three different pathways by which candidates can be admitted into the programme: the Unified Tertiary Matriculation (UTME), the Direct Entry, and Inter-University Transfer.

Unified Tertiary Matriculation Examination (UTME)
Admission through U.M.E. shall take the student to 100 level. To be eligible for admission, candidate is expected to pass both the UTME and the University screening test. The candidate must have in addition a minimum of credit level pass in five subjects at not more than two sittings in SSCE, NECO or GCE (ordinary level). 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 through JAMB include passes at prescribed levels in "A" level or equivalent in chemistry and physics or mathematics as well as fulfilling the "O" level entry requirements.

Inter-University Transfer Mode
Students can transfer into 200-Level courses provided they have the relevant qualifications and the requisite CGPA.

3.17.5 Learning Outcomes
The programme is aimed at producing graduates that are sufficiently grounded in the various areas of petroleum chemistry as categorized into the following;

Regime of Subject Knowledge
Have adequate knowledge and understanding of relevant concepts in Chemistry and specifically in petroleum and related chemical processes.

Competences and skills
Have suitable skills to apply standard methodologies to proffer solutions to theoretical and practical chemical problems in the contemporary petroleum and allied industries.

Behavioural Activities
Have ability to work efficiently in multi-disciplinary environment involving chemistry and to impart acquired knowledge and skills to others through oral and written presentations

3.17.6 Attainment Levels
Graduates of petroleum chemistry are expected to be adequately equipped for direct entry into the job market or self-employment.

3.17.7 Course Structure

Course Structure at 100 Level : Petroleum Chemistry

Course Code	Course Title	Units	Status	LH	PH
CHM 101	General Chemistry I	3	C	45	-
CHM 102	General Chemistry II	3	C	45	-

CHM 107	General Chemistry Practical I	1	C	-	45
CHM 108	General Chemistry Practical II	1	C	-	45
PHY 101	General Physics I	3	R	45	-
PHY 103	General Physics III	3	R	45	-
PHY 107/108	Practical Physics I	2	R	-	90
BIO 101	Introductory Biology I	3	R	45	-
BIO 102	Introductory Biology II	3	R	45	-
MAT 101	General Mathematics I	3	R	45	-
MAT 102	General Mathematics II	3	R	45	-
STA 113	Basic Statistical Methods	3	R	45	-
GST 111	Communication in English I	2	R	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library and Study Skills & ICT	1	R	15	-
GST 123/124	Communication in other international language	2	R	30	-
	Total	**38**			

LH = Lecture Contact Hours; PH = Practical Contact Hours.
Electives to be determine by each University.

Course Structure at 200 Level : Petroleum Chemistry

Course No.	Course Title	Units	Status	LH	PH
PCM 201	Origin and Formation of Petroleum	2	C	30	-
PCM 202	Classification and Properties of Petroleum	2	C	30	-
PCM 203	Natural Gas I	2	C	30	-
PCM 204	Petroleum Chemistry Lab I	1	C	-	45
PCM 205	Petroleum Chemistry Lab II	1	C	-	45
CHM 201	Practical Chemistry I	1	C	-	45
CHM 202	Practical Chemistry II	1	C	-	45
CHM 210	Physical Chemistry II	2	R	30	-
CHM 211	Organic Chemistry II	2	R	30	-
CHM 212	Inorganic Chemistry II	2	R	30	-
CHM 213	Analytical Chemistry I	2	R	30	-
MAT 201	Mathematical Methods I	3	R	45	-
STA 202	Statistics for Physical Sci. And Engr.	4	R	60	-
GST 122	Communication in English II	2	R	30	-
GST 112	Logic, Philosophy & Human Existence	2	R	30	-
GST 222	Peace and Conflict Resolution	2	R	30	-
Total (core)		**31**			

Electives to be determined by each University

Course Structure at 300 Level: Petroleum Chemistry

Course No.	Course Title	Units	Status	LH	PH
PCM 301	Introduction to Petroleum Exploration & Recovery	2	C	30	-
PCM 302	Introduction to Petroleum Geochemistry	3	C	45	-
PCM 303	Polymer Chemistry	3	C	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	-
CHM 301	Physical Chemistry III	2	R	30	-
CHM 303	Organic Chemistry III	4	R	60	-
CHM 316	Applied Spectroscopy	2	R	30	-
CHM 318	Industrial Chemical Processes I	2	R	30	-
CHM 319	Environmental Chemistry	2	R	30	-
CHM 320	Industrial Chemical Technology I	2	R	30	-
CHM 321	Chemical Literature in Research	1	R	15	-
CHM 322	Industrial Chemical Lab.	1	R	15	-
CHM 323	Practical Chemistry IV	1	R	15	-
ESP 223	Introduction to Entrepreneurial Skills	2	R	30	-
ESP 311:	Entrepreneurship	2	R	30	-
	Total (Core)	**34**			

Electives to be determined by each University

Course Structure at 400 Level: Petroleum Chemistry

Course No.	Course Title	Units	Status	LH	PH
PCM 400	Seminar	1	C	-	45
PCM 401	Research Project	6	C	-	270
PCM 402	Students' Work Experience Scheme	4	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 410	Petroleum Operations and Environment	1	C	15	-
CHM 410	Analytical Chemistry	2	R	30	-
CHM 413	Industrial Chemical Technology II	2	R	30	-
CHM 415	Polymer Technology	2	R	30	-
CHM 428	Quality Control & Industrial Safety	2	R	30	-
LAW 411	Oil and Gas Law I	2	R	30	-
	Total (Core)	**32**			

Electives to be determined by each University

3.17.8 **Course Synopses**

CHM 101: General Chemistry I **(3 Units: LH 45)**

Atoms, Molecular and Chemical reaction. Chemical equations and stoichiometry. Atomic Structure and periodicity. Modern electronic theory of atom. Radioactivity. Chemical Bonding. Introduction to properties of gases: (Compressibility, Expandability, Volumes of Gases Versus Volumes of Liquids or Solid***),*** Review of ideal gas laws. Equilibria and Thermodynamics. Introduction to Chemical Kinetics: Order and molecularity of chemical reactions, kinetics of first order reactions. Introduction to electrochemistry.

CHM 102: General Chemistry II **(3 Units: LH 45)**

Historical survey of the development of organic chemistry. Nomenclature and classes of organic compounds. Homologous series. Introduction to functional groups. Isolation and purification of organic compounds. Quantitative organic chemistry. Stereochemistry (Conformational and configurational). Determination of structure of organic compounds. Electronic theory in organic chemistry. Saturated hydrocarbons. Unsaturated hydrocarbons. Periodic Table and Periodic properties (Size, Ionization Energy, Electron Affinity, Electronegativity, Lattice and Hydration Energies). Valence Forces; structure of solids. The chemistry of selected metals and non-metals;

CHM 107: General Chemistry Practical I **(1 Unit: LH 45)**

Preparation of standard solutions. Dilutions. Simple volumetric exercises; (Inorganic Titrations). Qualitative inorganic analysis (cations and anions). Distribution of solute in two immiscible solvents (without association). Determination of pH. Heat of neutralization (strong acid-strong base). Heat of dissociation of weak acid. Heat of solution (NH_4NO_3, $CaCl_2$). Basicity of an acid by thermochemical method.

CHM 108: General Chemistry Practical II **(1 Units: LH 45)**

Applications of volumetric analysis (Organic). Determination of solubility products. Qualitative organic analysis (functional group identification). Simple organic preparations. Purification of organic compounds.

BIO 101 GENERAL BIOLOGY I **(4 Units: LH 60)**

Cell structure and organization: functions of cellular organelles; diversity: characteristics and classification of living things general reproduction. Interrelationships of organisms; heredity and evaluation; elements of ecology and types of habitats.

BIO 102 GENERAL BIOLOGY II (4 Units: LH 60)

A generalized survey of the plant and animal kingdoms based mainly on study of similarities and differences in the external features: ecological adaptation of these forms.

MAT 101: Elementary Mathematics I (3 Units: LH 45)

Elementary set theory: subjects, 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, trigonometric functions of angles of any magnitude, addition and factor formulae.

MAT 102: Elementary Mathematics II (3 Units: LH 45)

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.

STA 113: Basic Statistical Methods (3 Units: LH 45)

Time series, demographic measures and index numbers. Estimation and tests of hypothesis. Design of experiments. Analysis of variance and covariance. Simple regression and correlation. Contingency tables. Some non-Parametric tests. Applications.

PHY 101 GENERAL PHYSICS I: (Mechanics) (3 Units: LH 45)

Space and Time, frames of reference, Units and dimension, Kinematics; Fundamental Laws of Mechanics, statics and dynamics; Galilean invariance; Universal gravitation; work and energy, rotational dynamics and angular momentum; Conservation laws. (Pre-requisite – Credit in O.L. Physics and Mathematics. (Co-requisite – MTH 101).

PHY 103 GENERAL PHYSICS III (2 Units: LH 30)

Molecular treatment of properties of matter elasticity; Hooke's law, Young's shear and bulk moduli. Hydrostatics; Pressure; buoyancy, Archimedes' Principles. Hydrodynamics; Streamlines, Bernooulli and continuity equations, turbulence, Reynolds's number. Viscosity; laminar flow, Poiseuille's equation. Surface tension; adhesion, cohesion, capillarity, drops and bobbies. Temperature; the Zeroth law of thermodynamics; heat; gas laws; laws of thermodynamics; kinetic theory of gases, Applications. (Pre-requisites – Credit in O.L. Physics and Mathematics).

PHY 107/108 GENERAL PHYSICS LABORATORY (2 Units: LH 90)

This introductory course emphasizes quantitative measurements, the treatment of measurement errors, and graphical analysis. A variety of experimental techniques will be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, viscosity, etc., covered in PHY 101, 102 and PHY 103.

PCM 201: Origin and Formation of Petroleum (2 Units: LH 30)

Definitions: petroleum, crude oil, bitumen, tar sand, natural gas, and coal; **Origin**: theories of origin of petroleum and the evidences of each; Biogenic theory: detail discussion of the biogenic theory of petroleum formation, stages of transformation of sedimentary organic matter and their distinguishing characteristics. **Occurrence**: world distribution of petroleum & 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: LH 30)

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: LH 30)

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 of): 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: LH 45)

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: LH 45)

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 201: Practical Chemistry I (1 Unit: LH 45)

Kinetics of First Order reaction. Redox titration: (a) Iodometry (b) Fe^{2+} / $K_2Cr_2O_7$. Synthesis of organic compounds requiring basic skills such as heating under reflux, distillation, crystallisation, extraction, filtration, chromatography, melting point determination and spectroscopic (IR, UV) analysis. Dissociation constants of weak acid, base. Conductometric titration: acid-base. Potentiometric titration: acid-base. Kinetics of catalytic decomposition of H_2O_2. Kinetics of acid-catalysed hydrolysis of sugar. Determination of relative strengths of two acids by the kinetics of acid-catalysed ester hydrolysis. Kinetics of enzymatic reaction (starch-amylase system).

Note: *Additional e*xperiments may be added subject to availability of time and facilities.

CHM 202 Practical Chemistry II (1 Units : LH 45)

Basic techniques in volumetric and gravimetric analyses. Introduction to methods for preparing and purifying organic compounds.Determination of viscosity coefficients of liquids. Complexometric titrations**:** Zn^{2+}, Mg^{2+}, Ca^{2+}, Fe^{2+} with EDTA; Hardness of water. Iodimetric titration. Determination of emf of simple cells; conductance; simple organic syntheses. Qualitative organic analyses. ***Preparation of Organic Compounds:*** (i) m-dinitrobenzene, (ii) Acetanilide, (iii) Bromoacetanilide, (iv) Oxidation of primary. alcohols-Benzoic acid from benzylacohol, (v) azo dye ***Preparation of Inorganic Compounds:*** (i) Potassium trioxalato chromate (III); (ii) $CoHg(SCN)_4$; (iii) Cu(I) thiourea complex (iv) Bis (2, 4-pentanedionate) zinc hydrate; (v) Double salts (Chrome alum/ Mohr's salt).

CHM 210 Physical Chemistry II: (2 Units: LH 30)

Kinetic theory of gases and ideal gas laws. Behaviour of real gases - the van der Waal's equation.**First** Law of thermodynamics and internal energy, state and non-state functions, enthalpy changes at constant volume and constant pressure, heat capacities for ideal gases. Thermodynamic quantities (w, q, U, H) of ideal gases and their relationships. *Van der Waals* equation and critical state. Principle of corresponding states. Entropy changes in reversible and irreversible processes. Joule-Thomson effect. Pseudo order. Kinetic law for second order reactions. Factors affecting rate of reaction: Introduction to collision and transition state theories in bimolecular reactions and its comparison with Arrheninus equation. Mechanism and theories of elementary processes. Introduction to photochemical reactions. Basic electrochemistry.

CHM 211 Organic Chemistry II **(2 Units: LH 30)**

Factors affecting structure and physical properties of organic compounds. Factors affecting the availability of electrons. Energy of activation and free radical substitution reactions in alkanes. Chemistry of alcohols, ethers, epoxides, amines, enols and alkylhalides. Nucleophilic Substitution reactions, Mechanisms of substitution reactions (SN1, SN2,). Aromaticity. Various organic reactions e.g Addition, free radical, elimination reaction etc.

CHM 212 Inorganic Chemistry II: **(2 Units: LH 30)**

Periodic trends and properties of the 1st row transition metals. Use of redox potential and reaction feasibility. Chemistry of *s* and *p*-block elements: (Alkali and alkaline earth metals: Hydrides and Complexation tendencies. Structural features of hydrides, halides, oxides and oxyacids). Chemistry of first row transition metals (Salient features, characteristic properties of 3*d*-elements with reference to oxidation states, colour, magnetic behaviour, and complex formation tendency). Introduction to coordination Chemistry including elementary treatment of Crystal field theory. Elementary introduction of Organometallic Chemistry. Role of metals in biochemical systems.

CHM 213 Analytical Chemistry I **(2 Units: LH 30)**

Theory of errors. Statistical treatment of data (determination of mean, median, mode; Deviations, accuracy and precision, confidence limits, rejection of results and significant figure convention). Theory of sampling. Chemical methods of analysis; including volumetric (preparation of solutions inclusive) and gravimetric and physicochemical methods, Optical methods. Introductory to Spectroscopic methods of analysis. Separation methods (solvent extraction and different types of chromatographic methods).

MAT 201: Mathematical Methods I **(3 Units: LH 45)**

Real – valued function of a real variable. Review of differentiation and integration and their applications. Mean value theorem. Taylor series. Real valued functions of two or more variables. Partial derivatives. Chain rule. Extreme. Langranges Multipliers. Increments, differentials and linear approximations. Evaluation of line integrals. Multiple integrals. Pre – requisite – MAT 103

MAT 204: Linear Algebra I **(2 Units: LH 30)**

Vector space over the real field. Sub-spaces, linear independence, basis and dimension. Linear transformations and their representation by matrices. Range, null space and rank. Singular and non-singular transformations and matrices. Algebra matrices.

MAT 205 Linear Algebra II **(2 Units: LH 30)**

Systems of linear equation, change of basis, equivalence and similarity .Eigenvalues and eigenvectors. Minimum and characteristics polynomials of a linear transformation (Matrix).

Cayley-Hamilton theorem. Bilinear and quadratic forms, orthogonal diagonolisation. Canonical form.

STA 202: Statistics For Physical Sciences And Engineering (4 Units: LH 60)

Measure of location and dispersion in simple and grouped data, Elements of probability and probability distributions: Normal, binomial, Poisson, geometric, negative binomial distributions. Estimations and tests of hypothesis concerning the parameters of distributions. Regression, correlation and analysis of variance. Contingency tables Non-parametric inference. Pre-requisites: O' level pass in Mathematics.

PHY 201 GENERAL PHYSICS V: (Elementary Modern Physics) (3 Units: LH 45)

Special Relativity; Defects in Newtonian Mechanics; the speed of light; the Lorenz 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; Schrödinger's equation and simple applications. (Pre-requisite – PHY 102).

PHY 204 GENERAL PHYSICS IV (3 Units: LH 45)

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. (Pre-requisite **– PHY 101, PHY 102 and MTH 102)**.

PHY 205 THERMAL PHYSICS (3 Units: LH 45)

The Foundations of classical thermodynamics including the zeroth and definition of temperature; the first law, work heat and internal energy; Carrot 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. (Pre-requisites – PHY 103 and MTH 102).

PHY 206 GENERAL PHYSICS VI (1 Units: LH 15)

Energy and Power; Principles, demands and outlook; transformation of energy and its costs; thermal pollution; electrical energy from fossil fuels; hydroelectric generation: Principles and problems. Costs, capacity, storage, reserves, efficiency, new environmental effects. Electrical energy from nuclear creators; energy in the future breeder reactors; fusion power, solar power, geothermal power, tidal power; etc. Promise and problems. Lectures (15) Excursions.

GES 222: Peace and Conflict Resolution (2 Units: LH 30)

Basic Concepts in peace studies and conflict resolution, Peace as vehicle of unity and development, Conflict issues, Types of conflict, e. g. Ethnic/religious/political/ economic conflicts, Root causes of conflicts and violence in Africa, Indigene/settler phenomenon, Peace – building, Management of conflict and security. Elements of peace studies and conflict resolution, Developing a culture of peace, Peace mediation and peace-keeping, Alternative Dispute Resolution (ADR).

Dialogue/arbitration in conflict resolution, Role of international organizations in conflict resolution, e.g. ECOWAS, African Union, United Nations, etc.

PCM 301: Fundamentals of Petroleum Exploration and Recovery (2 Units: LH 30)

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: LH 30)

Definitions: petroleum, source rock, carrier bed, reservoir, caprocketc; 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: LH 45)

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 Units: LH 45)

Determination of; Correlation Index, Density, 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), Sulfur content. [At least ten practicals per semester]

PCM 305: Petroleum Refining (2 Units: LH 30)

Crude oil pretreatments: 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: LH 30)

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: LH 30)

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 Units: LH 15)

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: LH 30)

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. General oil field chemicals, Green chemicals (Environmentally friendly chemicals). International guidelines.

CHM 301 PHYSICAL CHEMISTRY III (4 Units: LH 60)

Ideal solutions and non-ideal solutions. Properties of electrolytes. Introduction to Statistical thermodynamics: Diffusion, probability, classical mechanics, microcanonicalensambles, Gibbs Entropy Formula, Boltzmann's principle. ***Thermodynamics:*** Second Law of Thermodynamics, Carnot cycle, Free energy and its concept, Gibbs and Helmholtz free energies and their relationship, variation of free energy with temperature and pressure. Free energy and equilibrium constant. Maxwell's relations, Gibbs-Helmholtz equations, its application for the determination of G, H, S of a reversible cell reaction. Criteria for reversible and irreversible processes based on entropy and free energy. Partial molal quantities, chemical potential, the Gibbs-Duhem equation, determination of partial molal quantities, variation of chemical potential with temperature and pressure, chemical potential in case of a system of ideal gases. ***Phase Equilibria***: Thermodynamics of phase transition-Clapeyron-Clausius equation and its applications. Phase rule, phase, component, degree of freedom, thermodynamic derivation of phase rule, phase diagrams of one-component system (water), two component systems (phenol-water, lead-silver). The distribution law, applications to cases of dissociation and association of solutes in one of the phases, solvent extraction, equilibrium constant from distribution coefficient ($KI + I_2 = KI_3$). ***Electrochemical Cells*****:** Reactions in reversible cells, free energy and *emf*of reversible cell. Single electrode potential (Nernst equation), its measurement and sign convention. Standard electrode potential. *Emf*of reversible cell from electrode potentials. Types of reversible electrode, reference electrodes. Applications of emf measurements: determination of ionic activities, pH, and equilibrium constant. Potentiometric titration. Concentration cells with and without transference. Liquid junction potential and its elimination.

CHM 303 Organic Chemistry III (4 Units: LH 60)

Chemistry of carbonyl compounds (aldehydes, ketones carboxylic acids and carboxylic acids derivatives). Reactions of carbanions. Carbonanions of and β - unsturated compounds. Review of Aromaticity (Theory, Characteristics of aromatic-aryl compounds). Aromatic electrophilic and nucleophilic substitution reactions. The chemistry of phenols. Heterocyclic Chemistry; Nomenclature, classification and reaction of 5-membered heterocycles.

CHM 306 Organometallic Chemistry I (1 Units: LH 15)

Definition, nomenclature and Classification of Organometallic compounds. Preparation, structure and reactions including abnormal behaviour of organometallic compounds. Synthetic utility of organometallics. Generation and detection of free-radicals from Organometallic compounds.

CHM 316 Applied Spectroscopy: (2 Units: LH 30)

Principles and application of UV, IR, NMR and Mass spectroscopic techniques in the determination and elucidation of structures of organic compounds. Ultraviolet; chromophores, λ_{max} and e, Woodward-Fieser rules for dienes and enones, rules for polyenes and Scotts rules for calculation of λ_{max} of the ET (electron transfer) band of aromatic carbonyl compounds. Interpretation of UV spectra. Infrared and Raman spectroscopies; Basis. Use as fingerprint and identification of major groups using correlation tables. Characteristic frequencies. NMR; chemical shifts (^{1}H and ^{13}C), integrals, coupling patterns and coupling constants and their use, interpretation and prediction of spectra. Spin half nuclei, abundances, sensitivities, operating frequencies, Fermi contact, coupling, satellites. Quadrupolar nuclei, coupling patterns. Mass Spectrometry; use of EI and CI spectra, important fragmentation processes.

CHM 317 Industrial Raw Materials Resources Inventory (1 Units: LH 15)

Survey of the raw material requirement of Nigeria's industries. Solid Mineral Chemistry. Fossils fuels and their uses. Plant and animal products. Nuclear, Solar and hydrodynamic and renewable sources of energy. Potentials and applications of locally available raw materials as industrial feedstocks.

CHM 318 Industrial Chemical Processes I (2 Units: LH 30)

Introduction to the industrial chemical processes. Structure of the chemical industry. Raw materials for the chemical industry. Production of primary intermediates. Industrial processes for the production of organic chemicals such as polymers, adhesives, dyes, explosives insecticides, pesticides, herbicides, flavouring agents and pharmaceuticals. Introduction to industrial fermentation processes.

CHM 319 Environmental Chemistry: (2 Units: LH 30)

Concept of elementary cycles. Characteristics of the atmosphere. Sources, types, effects and control of environmental pollution. Waste water treatment. Composition of domestic waste (handling of solid waste). Water chemistry and analysis. Chemical and physical instrumentation in environmental sciences. Global warming: its causes, effects and remedies. Green Chemistry: Principles and concept of green chemistry, atom economic and noneconomic reactions, reducing toxicity, a few examples of environmental friendly reactions and reaction media.

CHM 320 -Industrial Chemical Technology: (3 Units: LH 45)

Processes and processes variables. Material balances: the flowsheet, general balance equation; material techniques; multiple unit balances; chemical reactions. Energy balances: energy balance equations; estimation of enthalpy changes; reactive systems; energy balance techniques. Fluid flow: types of fluid; flow regimes; balance equations; flow in pipes. Heat transfer: mechanism; heat exchangers. Separation processes: characteristics; phase equilibria; fundamental concept and practical techniques for solving problems relating to equilibria stage processes; mixing and agitation; crystallization, filtration and drying; grinding and sieving; binary distillation, solvent extraction, solid-liquid extraction; leaching and liquid-liquid extraction.

CHM 321 Chemical Literature in Research **(1 Units: LH 15)**

Primary and secondary sources of chemical data. Chemical Abstracts and other chemical data banks. Research methodology in chemistry (with particular emphasis on project writing); Retrieval of information, use of computer (online searching). Steps in planning and conducting research, collecting data, processing data and writing report. Basic statistics in data description and presentation, applications of t-test, ANOVA, etc in chemical data analysis**.**

CHM 322 - Industrial Chemistry Laboratory (1 Units: LH 45)

Making soaps and detergents. Production of shoe polish, pomade, plant juice drinks, chocholates etc. Recycling of polythene products. Bioethanol production and analysis. Dyeing of different fabric materials. Making a plastic from potato starch. Making rayon from cellulose. Making a photographic print. Synthesis of Aspirin from salicylic acid. Analysis of acetyl salicylic acid in analgesic drugs. Determination of saponification value of oil. Determination of percentage CaCO3 in limestone. Production of glue. Testing the quality of petroleum products. [At least ten practicals from the following in a semester].

Note: Experiments may be added/deleted subject to availability of time and facilities.

CHM 323 Practical Chemistry IV (1 Units: LH 45)

Chromatographic separation of metal ions. Gravimetric estimation of Cations/Anions. Use of ion-exchange resins. Flame-photometry. Beer's Law - Determination of concentration of solution by colorimetry. Identification of organic functional groups by I.R. spectroscopy. Spectral and magnetic characterization of compounds.

Note: Additional *experiments* may be added/deleted subject to availability of time and facilities

CHM 324 Practical Chemistry V (1 Units: LH 45)

Preparation of coordination compounds. (i) Potassium trioxalato chromate (III); (ii) $CoHg(SCN)_4$; (iii) Cu(I) thiourea complex (iv) Bis (2, 4-pentanedionate) zinc hydrate; (v)

Double salts (Chrome alum/ Mohr's salt). Analysis of inorganic complexes and materials. Preparation of the following compounds: Suphanilic acid, dibenzal acetone, methyl orange, aspirin, m-dinitrobenzene from benzene, synthesis of azlactone, phthalimide. Determination of Surface Tension of liquids.

ESP 223: Introduction to Entrepreneurial Skills (2 Units: LH 30)

Introduction to entrepreneurship and new venture creation; Entrepreneurship in theory and practice; The opportunity, Forms of business, Staffing, Marketing and the new venture; Determining capital requirements, Raising capital; Financial planning and management; Starting a new business, Feasibility studies; Innovation; Legal Issues; Insurance and environmental considerations. Possible business opportunities for a Petrochemist in Nigeria

ESP 311: Introduction to Entrepreneurship Studies (2 Units: LH 30)

Some of the ventures to be focused upon include the following:

1. Soap/Detergent, Tooth brushes and Tooth paste making
2. Photography
3. Brick
5. Rope making
6. Plumbing
7. Vulcanising
8. Brewing
9. Glassware production/Ceramic, production
10. Paper production
11. Water treatment/Conditioning/Packaging
12. Food processing/packaging/preservation
13. Metal working/Fabrication – Steel and aluminum door and windows
14. Training industry
15. Vegetable oil/and Salt extractions
16. Fisheries/Aquaculture
17. Refrigeration/Air conditioning
18. Plastic making
19. Farming (crop)
20. Domestic Electrical wiring
21. Radio/TV repairs
22. Carving
23. Weaving
24. Brick laying/making
25. Bakery
26. Tailoring
27. Iron welding
28. Building drawing
29. Carpentry

30. Leather tanning
31. Interior decoration
32. Printing
33. Animal husbandry (Poultry, Piggery, Goat etc)
34. Metal Craft – Blacksmith, Tinsmith etc
35. Sanitary wares
36. Vehicle maintenance
37. Bookkeeping

PCM 403: Introduction to Catalysis (2 Units: LH 30)

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: LH 30)

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: LH 30)

The prospects of petrochemical industry in Nigeria; Basic reactions of hydrocarbons: oxidation, halogenations, sulphonation and nitration; Chemistry & technology of production of C4-C5 and BTX streams from petroleum fractions; Chemistry & technology of production of chemicals and polymers from (a) C4-C5 streams, and (b) BTX stream; Potential non-petroleum sources of petrochemicals.

PCM 406: Coal & Oil Shale Chemistry (2 Units: LH 30)

Formation, occurrence and potentials; classifications; coal & oil shale mining techniques; coal & 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: LH 30)**

Definitions; 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: 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) **(1 Unit: LH 15)**

Definitions, occurrence and distribution, importance as future energy source, conditions for formation and stability; Potential extraction techniques.

PCM 410: Petroleum Operations and Environment **(2 Unit: LH 30)**

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. Methods of controlling the environmental impacts of oil and gas industry. Nigerian experiences on environmental effects of oil and gas operations. Current affairs.

CHM 406 Reaction Kinetics: **(2 Units: LH 30)**

Review of first, second and third order rate equations. Rate constants. Collision theory, transition state theory, reaction coordinates. Unimolecular reaction theory, bimolecular mechanisms, chain reaction mechanisms. Catalysis and heterogenous reactions. Photochemical reaction mechanisms.

CHM 410 Analytical Chemistry II: **(2 Units: LH 30)**

Statistical analysis of data (ANOVA, comparison of results, F-test and correlation of result). Use of excel and other software packages in data treatment (e.g. spss and minitab). Potentiometer and pH methods. Conductometric methods. Electrolytic methods. Radiochemical methods. Chromatography.

CHM 413 Industrial Chemical Technology II: **(2 Units: LH 30)**

Process development for large-scale production; technical and economic principles of processes and product routes. Cost calculations. Methods of storing materials; transport of liquids and gases; equipment for mass transfer. An introduction to the scope of different types of equipment used in chemical industry: distillation columns, extractors, pumps, mills, mixers & agitators, dryers, and crystallisers. Reactors: types; characteristics & choice; advantages and disadvantages; selection for catalysts. Dialysis; reverse osmosis; electrodialysis. Process control: objectives; the control loop; measuring devices; the controller; computer control. Case

Studies: the cases chosen should emphasize process and product development in the Nigerian chemical industry.

CHM 415 Polymer Technology: (2 Units: LH 30)

Advanced Polymer processing-Concept of size, shape and their distribution, behaviours and properties of powders in relation to particle size, types of additives, their role in product properties, broad description of various polymer processing-mixing, extrusion, injection and blow moulding, compression and transfer moulding, calendaring, vacuum forming and various coating processes, joining, plating and finishing. Practical rheometry. Polyurethane technology. Detailed treatment of Copolymerisation techniques. Technology of adhesives and composites productions. (7) Detailed surface coating. (8) Introduction to nanotechnology.

CHM 427 Fuel Chemistry: (2 Units: LH 30)

Definition and classification of fuels. Solid fuels: Structure, Petrography, Classification, Chemical composition, Analysis, pyrolysis, Liquefaction and gasification of coal. Chemical composition, Enrichment, processing and utilisation of nuclear fuels. Other solid fuels e.g. Oil shale, wood etc. Liquid fuels: Origin, Composition and Physical Processing of Crude Petroleum. Secondary liquid fuels from petroleum. Sources and utilisation of ethanol as fuel. Analysis of liquid Fuels. Gaseous fuels: Harnessing processing and utilisation of Natural Gas and Liquefied Petroleum Gas. Definition, composition, generation, purification and utilisation of biogas. Generation, composition and usage of syngas. Hydrogen as fuel gas. Methods of determination of calorific values of fuels. Comparison between the different types of fuels. Chemicals obtainable from fossil fuels. Review of other energy sources – solar, nuclear, geothermal etc.

CHM 428 Quality Control And Industrial Safety: (2 Units: LH 30)

Sampling and sample treatment. Preparation of standard solution, calibration and standardization. Raw material analysis, production line inspection, sampling and analysis, final product sampling and analysis. Fire chemistry: fire triangle, tetrahedron and pentagon; Classification of fire base on fuel type, firefighting and mitigation. Toxic substances and poisonous gases, acute and chronic exposition, maximum working place concentration. Inflammable chemicals. Handling high pressure equipment. Protective clothing and sanitary aminitier for employees.

LAW 411: Oil and Gas Law I (2 Units: LH 30)

The origin and occurrence of oil and natural gas. Theory of ownership in oil and gas. United Nations and natural resources. Interests in oil and gas concessions, effect of rights of concessionaries on natural gas. Expropriation of rights in oil and gas. Oil and gas pipeline nature, legal status, conditions for grants, rights and obligation of the licenses.

3.18 PHYSICS (BSc)

3.18.1 Philosophy, Aims and Objectives of the Programme

a. To provide students with a broad and balanced foundation of Physics knowledge and practical skills.

b. To instil in students a sense of enthusiasm for Physics, and appreciation of its applications in different contexts.

c. To involve the students in intellectually simulating and satisfying experience of learning and studying.

d. To develop in students the ability to apply their knowledge and skills in Physics to the solution of theoretical and practical problems.

e. To develop in students through an education in Physics a range of transferable skills of value in physics and other areas.

f. To provide students with a knowledge and skills base for further studies in Physics or multi-disciplinary areas involving physics.

3.18.2 Admission Requirements

UTME

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 School Certificate 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 two passes (graded A-E) at the GCE/IJMB Advanced Level in two relevant subjects (Biology, Botany, Chemistry, Geography, Mathematics and Physics) may be admitted into 200-level.

3.18.3 Learning Outcomes

All Bachelors honours degree students in Physics are expected to develop the following abilities and skills:

a *Regime of Subject Knowledge*

Cognitive abilities and skills relating to solution of problems in Physics and Physics related disciplines.

b *Competencies and Skills*

Practical skills relating to the conduct of laboratory and industrial work in Physics.

c *Behavioural Attitudes*
General skills relating to non-subject specific competencies, communication, ICT knowledge, interpersonal, organization skills and ethical standards.

3.18.4 Attainment Levels

Graduates of Physics are expected to have the ability to apply knowledge and skills to solving theoretical and practical problems in Physics in relation to national and societal problems.

3.18.5 Resource Requirement for Teaching and Learning

a) Academic and non-academic staff. (See section 1.6)
b) Academic and Non-Academic Spaces (See section 1.6)
c) Academic and Administrative Equipment (See section 4)
d) Library and Information Resources (See section 1.6)

3.18.6 Course Structure

Course Structure at 100 Level Physics

Course Code	Course Title	Units	Status	LH	PH
CSC 101	Introduction to Computer Science	3	R	30	45
CSC 102	Introduction to Problem Solving	3	R	30	45
CHM 101	General Chemistry I	3	E	45	-
GST 111	Communication in English I	2	C	30	-
GST 112	Logic. Philosophy & Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills & ICT	2	R	30	-
MTH 101	General Mathematics I	3	R	45	-
MTH 102	General Mathematics II	3	R	45	-
PHY 101	General Physics I	3	C	45	-
PHY 102	General Physics II	3	C	45	-
PHY 107	General Physics Practical I	1	C	-	45
PHY 108	General Physics Practical II	1	C	-	45
STA 111	Descriptive Statistics	4	E	60	-
STA 112	Probability I	4	E	60	-
STA 131	Statistical Computing	2	E	-	90
	Total	**41**			

Course Structure at 200 Level Physics

Course Code	Course Title	Units	Status	LH	PH
CSC 201	Computer Programming I	3	R	30	45
GST 122	Communications in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-

PLEASE NOTE: Conclusive statement shall be made on the minimum CGPA of 1.5 for graduation after the forthcoming workshop on Grading System

MTH 201	Mathematical Methods I	3	R	45	-
MTH 202	Elementary Differential Equations	3	R	45	-
PHY 201	General Physics III (Modern Physics)	3	C	45	-
PHY 202	Introduction to Electric Circuits & Electronics	3	C	45	-
PHY 204	General Physics IV (Waves and Optics)	3	C	45	-
PHY 205	Thermal Physics	3	C	45	-
PHY 206	General Physics V (Energy & Environment)	1	R	15	-
PHY 207	Practical Physics III	1	R	-	45
PHY 208	Practical Physics IV	1	R	-	45
PHY 209	Introduction to Space Science	2	R		
PHY 210	Solid Earth Physics	2	R	30	-
PHY 299	Industrial Attachment I (12 Weeks)	3	C		
STA 202	Statistics for Physical Sciences & Engineering	4	R	60	-
	Total	**43**			

Course Structure at 300 Level Physics

Course Code	**Course Title**	**Units**	**Status**	**LH**	**PH**
GST 222	Peace Studies & Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
PHY 301	Analytical Mechanics I	3	R	45	-
PHY 302	Analytical Mechanics II	3	R	45	-
PHY 303	Electromagnetism	3	R	45	-
PHY 304	Electromagnetic Waves and Optics	3	R	45	-
PHY 305	Quantum Physics	3	R	45	-
PHY 306	Statistical and Thermal Physics	3	R	45	-
PHY 307	Practical Physics III	1	R	-	45
PHY 308	Practical Physics IV	1	R	-	45
PHY 311	Mathematical Methods for Physics I	3	R	45	-
PHY 312	Mathematical Methods for Physics II	3	R	45	-
PHY 314	Solid State Physics	3	R	45	-
PHY 315	Classical Physics III	2	R	30	-
PHY 316	Electronics II	2	R	15	45
PHY 317	Acoustics	2	R	30	-
PHY 318	Semiconductor Devices	2	R	30	-
PHY 320	Workshop Practice	2	R	-	90
PHY 399	Industrial Attachment II (12 Weeks)	3	C		
	Total	**48**			

Course Structure at 400 Level Physics

Course Code	Course Title	Units	Status	LH	PH
PHY 401	Quantum Mechanics I	3	R	45	-
PHY 402	Quantum Mechanics II	3	R	45	-
PHY 403	Mathematical Methods in Physics I	3	R	45	-
PHY 404	Mathematical Methods in Physics II	3	R	45	-
PHY 406	Modern Optics	2	R	30	-
PHY 407	Computational Physics	3	R	45	-
PHY 408	Practical Physics VII	2	C	-	90
PHY 423	Solid State Physics II	3	R	45	-
PHY 424	Atomic and Molecular Spectroscopy	3	R	45	-
PHY 455	Research Project	6	C	-	270
Total		**31**			

Electives

PHY 411	Nuclear and Particle Physics I	2	E	30	-
PHY 412	Nuclear and Particle Physics II	2	E	30	-
PHY 413	Advanced Physics of Earth Interior	2	E	30	-
PHY 414	Industrial Geophysics	2	E	30	-
PHY 415	Radiation Instruments	2	E	30	-
PHY 416	Medical Nuclear Physics	2	E	30	-
PHY 417	Astronomy	2	E	30	-
PHY 418	Meteorology	2	E	30	-
PHY 419	Stellar Structure and Galaxies	2	E	30	-
PHY 420	Modern Cosmology & High Energy Astrophysics	2	E	30	-
PHY 421	Biophysics I	2	E	30	-
PHY 422	Biophysics II	2	E	30	-
PHY 426	Ionospheric Physics	2	E	30	-

3.18.7 Course Synopses

PHY 101: General Physics I **(3 Units: LH 45)**

(Mechanics, Thermal Physics and Waves)

Space and time; units and dimension, kinematics; Fundamental laws of mechanics, statics and dynamics; work and energy. Conservation laws. Moments and energy of rotation; simple harmonic motion; motion of simple systems; Elasticity; Hooke's law, Young's shear and bulk moduli, hydrostatics; Pressure, buoyancy, Archimedes' principles. Surface tension; adhesion, cohesion, capillarity, drops and bubbles. Temperature; heat, gas laws; Laws of thermodynamics; kinetic theory of gases. Sound; Types and properties of waves as applied to sound and light energies. Superposition of waves. Propagation of sound in gases, solids and liquids and their properties. The unified spectra analysis of waves. Applications.

PHY 102: General Physics II **(3 Units: LH 45)**
(Electricity, Magnetism and Modern Physics)
Electrostatics; conductors and currents; dielectrics; magnetic fields and electro- magnetic induction; Maxwell's equations; electromagnetic oscillations and waves; Coulomb's law; methods of charging; Ohm's law and analysis of DC circuits; AC voltages applied to inductors, capacitors and resistance.

PHY 107: General Practical Physics I **(1Unit: PH 45)**
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: PH 45)**
This is a continuation of PHY 107

PHY 201: General Physics III: **(3 Units: LH 45)**
(Elementary Modern Physics)
Pre-requisite -PHY 101 and PHY 102
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; Compton effect; thermionic emission; radioactivity; measurement and detection of charged particles (including the treatment of detectors); x-rays: nature and spectra.

PHY 202: Introduction to Electric Circuits and Electronics (3 Units: LH 30; PH 45)
Pre-requisite -PHY 102
D.C. Circuits; Kirchhoff's Laws, sources of end and current, network analysis and circuit theorems. A.C. Circuits. Inductance, capacitance, the transformer, sinusoidal wave-forms runs and peak values, power, impedance and admittance series RLC circuit, Q factor, resonance, Network analysis and circuit theorems, filters. Electronics; semiconductors, the pn-junction, Amplification and the transistor; field effect transistors, bipolar transistors, Characteristics and equivalent circuits, amplifiers, feedback, oscillators; signal generators. There should be alternate week laboratory work.

PHY 204: General Physics IV **(3 Units: LH 45)**
(Waves and Optics)
Pre-requisites -PHY 101, PHY 102, and MTH 102
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 and applications of lenses in optical instruments e.g. microscopes, telescopes, etc. ; mirrors and prisms; lens maker's formula, Polarization. Photometry and light spectrum analysis.

PHY 205: Thermal Physics **(3 Units: LH 45)**
Pre-requisites -PHY 103 and MTH 102
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 constant, Maxwell-Boltzmann's Law of distribution of velocities, simple applications of the distribution law.

PHY 206: General Physics V **(1 Unit: LH 15)**
(Energy and Environment)
Energy and Power; Principles, demands and outlook; transformation of energy and its costs; thermal pollution; electrical energy from fossil fuels; hydroelectric generation: Principles and problems. Costs, capacity, storage, reserves, efficiency, new environmental effects. Electrical energy from nuclear, reactors; energy in the future breeder reactors; fusion power, solar power, geothermal power, tidal power, etc. Promise and problems.

PHY 207/208: Practical Physics III & IV **(2 Units: PH 90)**
Pre-requisite -PHY 107/108
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 technique and the analysis of famous and challenging experiments.

PHY 209: Introduction to Space Science **(2 Units: LH 30)**
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.

PHY 210: Physics of Solid Earth **(2 Units: LH 30)**
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 213: Classical Physics I **(2 Units: LH 30)**
Introduction to classical mechanics; space and time; straight line kinematics; motion in a plane; forces and equilibrium; particle dynamics; universal gravitation; collisions; conservative forces; inertia forces and non-inertia frames; central force motions; rigid bodies and rotational dynamics; kinetic theory, equi-partition of energy; diffusion rate; mean free path; viscosity; heat transfer; measurement of temperature.

PHY 214:Classical Physics II **(2 Units: LH 30)**
(Electromagnetism)
Electrostatics and field concepts; electric currents and magnetic fields; properties of electromagnetic waves; electromagnetic wave spectrum and applications; Interference: Young's slit, Lloyd's mirror and Newton's rings; Thick lens optics.

PHY 299: Industrial Attachment I (12 Weeks) **(3 Units)**
Students should be attached to some relevant organizations for 12 Weeks at the 200 Level preferably during the long vacation for industrial experience. Students to be assessed based on seminar presentation, their reports and assessment by supervisors

PHY 301: Analytical Mechanics I **(3 Units: LH 45)**
Pre-requisites -MTH 201, and MTH 204
Newtonian Mechanics; motion of a particle in one, two and three dimensions; systems of particles and collision theory; Newtonian gravitation; conservative forces and potentials, oscillations, central force problems; accelerated frames of reference; rigid body dynamics; generalized motion; mechanics of continuous media; Galilean relativity; Relativistic kinematics and dynamics.

PHY 302: Analytical Mechanics II **(3 Units: LH 45)**
Pre-requisite -PHY 301
Degrees of freedom; Generalized coordinates Lagrange's formulation of mechanics, Applications. The Calculus of variations and the action principle. Hamilton's formulation of mechanics, Application. Invariance and conservation laws. Oscillatory systems, including damped, forced and coupled oscillations; Normal modes.

PHY 303: Electromagnetism **(3 Units: LH 45)**
Pre-requisites -PHY 201 and MTH 204
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 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: LH 45)**
Pre-requisite -PHY 303
Maxwell's equations and electromagnetic potentials. The wave equation. Propagation of plane waves. Reflection and refraction. Transmission lines, waves gides and resonant cavities; Radiation, Geometrical optics, Interference of waves. Diffraction. Dispersion in dielectrics.

PHY 305: Quantum Physics **(3 Units: LH 45)**
Pre-requisite-PHY201
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 and reactions, fission and fusion; magnetic resonance; elementary particles; Familiar wave phenomena and their associated wave equation; 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; hydrogen atom; harmonic oscillator.

PHY 306: Statistical and Thermal Physics I **(3 Units: LH 45)**
Pre-requisites -PHY 102 and PHY 305
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; Liouville theorem; Boltzmann's equation. Applications.

PHY 307/308: Experimental Physics V & VI **(2 Units: PH 90)**
Pre-requisite-PHY207/208
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: Mathematical Methods for Physics I: **(3 Units: PH 45)**
Pre-requisites -MTH 202, MTH 204 and MTH 305
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; Laplace transform. Applications of transform methods to the solution of elementary differential equations of interest in physics and engineering.

PHY 312: Mathematical Methods for Physics II **(3 Units: LH 45)**
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 314: Solid State Physics I **(3 Units: LH 45)**
Pre-requisite -PHY 305
Basic concepts of the quantum theory of solids; the free electron model; weak and tight binding approximations; energy band structures in metal, semiconductors and insulators; Physics of Schottky and surface devices; use of photo-electric emission in the study of

PLEASE NOTE: Conclusive statement shall be made on the minimum CGPA of 1.5 for graduation after the forthcoming workshop on Grading System

solids; Crystal structure and crystal binding. Elastic properties; lattice vibrations. Super-conductivity.

PHY 315: Classical Physics III **(2 Units: LH 30)**
Mechanical vibrations and waves; superposition; forced vibrations and resonance; coupled oscillations and normal modes; vibrations of continuous systems; reflection and refraction; string instruments; brass and woodwinds; Doppler effect; phase and group velocity; Fraunhofer diffraction; gratings; Fresnel zone plates; plane wave solution of Maxwell's equation; polarization; brief-ringent materials; circular polarized light.

PHY 316: Electronics II **(2 Units: LH 15; PH 45)**
Thermionic emission and the cathode ray tube; semi-conductor device characteristics; amplification at high frequencies; low frequency signals; power supply and power control; pulse handling and time constraints; integrated circuit building; positive feedback circuits and signal generators; logic, counters and timers.

PHY 317: Acoustics **(2 Units: LH 30)**
General discussion of sound generation and propagation in elastic media. Conversion between acoustical, electrical and mechanical energy. Lumped-parameter approximations. Sound in rooms, microphones, loud speakers, and audio communications systems. Sound and man.

PHY 318: Semiconductor Devices **(2 Units: LH 30)**
The physics, modelling and application of selected semiconductor devices; brief 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; light emitting diodes and photo-detectors.

PHY 399: Industrial Attachment II (12 Weeks) **(3 Units)**
Students should be attached to some relevant 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

PHY 401: Quantum Mechanics I **(3 Units: LH 45)**
Pre-requisites -PHY 305 and MTH 202
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. Multi-electron atoms; Variational approximation; Harmonic oscillator; Constraints Hamilton's principle and Lagrange's equations; Hamilton's equations.

PHY 402: Quantum Mechanics II **(3 Units: LH 45)**
Pre-requisites -PHY 401 and MTH 202.
Time-independent and time-dependent perturbation theory. Scattering theory: elastic potential scattering; Green's function and partial wave methods. Selected phenomena from each of atomic physics, molecular physics, solid-state physics, and nuclear physics are

described and then interpreted using quantum mechanical models (this should include the study of properties and spectra of hydrogen-like atoms); Pauli exclusion principles; periodic table of elements; Zeeman and stark effects; selection rules; introduction to group theory.

PHY 405: Classical mechanics (3 Units: LH 45)

Basic Concepts of Mechanics Inertial frames of reference, space time mass, force. Types of forces. Equations of motion; non-inertial frames of reference. Conservation laws for closed systems. Planetary motion. Harmonic oscillator. Macroscopic objects: Constraints Hamilton's principle and Lagrange's equations. Rigid body dynamics. Coupled oscillators Green's functions. Normal modes, continuum, limit; Elastic strings, solid, field, canonical variables, Hamilton's equations.

PHY 406: Modern Optics (2 Units: LH 30)

Coherence and interference. Michelson and Fabry-Perot interference filters. Fourier interference spectroscopy. Fraunhofer and Fresnel diffraction, diffraction gratings, Laser, holograph. Optics of solids propagation of light in anisotropic solids, the index ellipsoid, double refraction, optical activity, electro-optic effects. Introduction to non-linear optics.

PHY 407: Computational Physics (3 Units: LH 45)

Use of numerical methods in Physics; various methods of numerical integration, differentiation, numerical solutions of some differential equations in physics, Statistical analysis of experimental data; numerical solution of non-linear algebraic equations; polynomials and zeros of polynomial; numerical solution of systems of linear algebraic equations; interpolation; least squares and curve fitting.

PHY 408 Experimental Physics VII (2 Units: PH 90)

Continuation of PHY 308. Additional experiments chosen to illustrate the basic principles of Physics.

PHY 411: Nuclear and Particle Physics I (2 Units: LH 30)
Pre-requisite -PHY 305

Nuclear structure: Nuclear properties, nuclear size, nuclear masses; Nuclear forces, nuclear -nucleon scattering; the deuteron. Nuclear models. Radio-active decay: alpha, beta, gamma decays. Nuclear reactions; x-ray spectra; liquid drop model; the shell and collective models.

PHY 412: Nuclear and Particle Physics II (2 Units: LH 30)
Pre-requisite -PHY 401

Nuclear Instrumentations and radiation detection techniques; detectors. Nuclear spectroscopy. Neutron physics: Production, detection of neutrons. Fission and fusion. Nuclear reactor and nuclear energy. Elementary particles: Conservation laws, particle classification. Strong, electromagnetic and weak interactions. Resonances.

PHY 413: Advance Physics of Earths Interior (2 Units: LH 30)

Structure of Earth, conductivity, heat flow, Elasticity, dynamo theory, magnetic field; The interaction of the solar plasma with the earth's magnetic field; magnetic observatories.

PHY 414: Industrial Geophysics (2 Units: LH 30)
Introduction to seismic structure of the earth's interior seismicity; earth's tremors and earthquake mechanism; theory of seismometers; palaeomagnetism; seismology, gravitational, magnetic/electrical induced polarization, protecting for economic minerals, solution of civil engineering problems.

PHY 415: Radiation Instruments (2 Units: LH 30)
Ionization Chamber, Geiger counter, scintillation counter, X-ray equipment, Solid state detectors, Gamma ray Cameras.

PHY 416: Medical Nuclear Physics (2 Units: LH 30)
Production of isotopes , nuclear scanning and tracers, nuclear magnetic resonance. Interaction of radiation with matter, (X-ray and gamma rays), Thomson scattering photoelectric effect, Compton scattering, pair production, neutron diffusion theory, Fermi age equation; 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); radiation protection: principles and methods; personnel monitoring using TLD and film.

PHY 417: Astronomy (2 Units: LH 30)
Composition of atmosphere, solar terrestrial interactions magnetic fields and storms. Fair weather atmospheric electricity and global atmospheric electric circuit.

PHY 418: Meteorology (2 Units: LH 30)
Meteorological parameters and their measurement temperature, pressure, wind etc. Weather and climate. Thermodynamics and dynamics of atmospheric motion; solar and terrestrial radiation.

PHY 419: Stellar Structure and Galaxies (2 Units: LH 30)
Hydrostatic and thermal equilibrium, Energy transport, stellar models; introduction to the physics of galaxy and the universe; studies of the interactions of several bodies with emphasis on their collective effects.

PHY 420: Modern Cosmology and High Energy Astrophysics (2 Units: LH 30)
Hubbles' law, gravity, luminosity and red shift. High energy particles, cosmic rays, solar wind shock waves, supernovae, neutron stars, pulsars.

PHY 421: Biophysics I (2 Units: LH 30)
Ionization of biomolecules, thermodynamic principles; Energy transfer in living systems Bioelectricity – ion channels, action potentials nerve impulse transmission. Study of the electric cell.

PHY 422: Biophysics II (2 Units: LH 30)

Optics of the eye, photoenergy transduction in vision, sound waves receive and the ear; learning aids, Human voice, Ultrasound/applications Fluid flow and viscosity – applications; blood pressure, osmotic pressure, centrifugation, surface tension and applications.

PHY 423: Solid State Physics II (3 Units: LH 45)
Pre-requisite -PHY 401

Dielectric properties. Magnetism: Paramagnetism and diamagnetism; ferromagnetism and antiferromagnetism; Magnetic resonance. Imperfections in solids; dynamics of electrons in solids; transport phenomena (e.g. electrical and thermal conductivities with applications to metals and semi-conductors); optical properties of solids with applications to metals, semi-conductors and insulators); thin film and application of electron microscope in thin film research.

PHY 424: Atomic and Molecular Spectroscopy (3 Units: LH 45)
Pre-requisite –PHY 402.

The hydrogen atom; relativistic effects and spin. Identical particles and symmetry. Many electron atoms. Coupling schemes and vector model. Zeeman effect. Hyperfine structure. The diatomic molecule; the Frank-Condon principle. X-ray diffraction. Microwave methods. Resonance phenomena; ESR, NMR, and optical pumping and Mossbauer scattering.

PHY 426: Ionospheric Physics (2 Units: LH 30)

The neutral atmosphere. Production of ionospheric layers, Chapman theory. Transport processes. Morphology of the ionosphere. Ionospheric phenomena such as solar flare effects. Sporadic E, Spread F and other irregularities, ionospheric storms. Ionospheric measurements. Geomagnetism and the ionosphere.

PHY 455: Research Project (6 Units: PH 270)

The course offers students the opportunity to do research in contemporary physics, under the supervision of staff. A detailed report on the research is presented by the student when the project is completed.

3.19 SCIENCE LABORATORY TECHNOLOGY (BSc)

3.19.1 Philosophy, Aims and Objectives of the Degree Programme

The Science Laboratory Technology Programme provides its students with a broad based knowledge of theoretical, technological and practical knowledge in the multi-disciplinary field of Laboratory Technology.

The programme provides five-year training to candidates that meet the minimum entry requirements for university education in Nigeria. It provides students with a broad and balanced foundation of the knowledge of Science Laboratory Technology and practical skills in the areas of:

(i) Management of institutional, industrial and research laboratories and workshops to meet the technological needs of Nigeria.
(ii) Designing, execution and coordination of science –based experiments and research in laboratories and workshops
(iii) Maintenance of stock of laboratory and workshop materials.

3.19.2 Admission Requirements

(a) **UTME**

Five (5) credit level passes in SSCE (WAEC or NECO)/GCE O/L in Physics, Chemistry, Biology, Mathematics and English Language obtained at not more than two (2) sittings. Equivalent qualifications such as NABTEB are acceptable. An acceptable pass at the UTME is also required

(b) Direct Entry:

OND at Upper Credit Level in minimum of two relevant science subjects plus the required credit level passes at SSCE/GCE O/L or equivalent.

Learning Areas

(i) Biology/Microbiology/Biotechnology Techniques
(ii) Chemistry/Biochemistry Techniques
(iii) Physics/Electronics Techniques
(iv) Geology/Mining Techniques
(v) Physiology/Pharmacology Techniques
(vi) Chemical/Petroleum Technology Techniques

Course Codes

(i)	SBI	-	Biology
(ii)	SMB	-	Microbiology
(iii)	SCH	-	Chemistry
(iv)	SBC	-	Biochemistry
(v)	SPE	-	Physics with Electronics
(vi)	SGE	-	Geology/Mining
(vii)	GLT	-	General Laboratory
(viii)	SPP	-	Physiology/Pharmacology
(ix)	SCP	-	Chemical/Petroleum Technology

3.19.3 Learning Outcomes

All students in Science Laboratory Technology are expected to develop the following abilities and skills:

a. *Regime of Subject Knowledge*
Cognitive abilities and skills relating to solution of problems in Science Laboratory Technology.

b. *Competencies and Skills*
Practical skills relating to the conduct of laboratory and industrial work in Science Laboratory Technology.

c. *Behavioural Attitudes*
General skills relating to non-subject specific competencies, communication, ICT knowledge, interpersonal, organization skills and ethical standards.

3.19.4 Attainment Levels

Graduates of Science Laboratory Technology are expected to have the ability to apply knowledge and skills to solving theoretical and practical problems in Science Laboratory Environment in relation to national and societal problems.

3.19.5 Resource Requirement for Teaching and Learning

a) Academic and non-academic staff. (See section 1.6)
b) Academic and Non-Academic Spaces (See section 1.6)
c) Academic and Administrative Equipment (See section 4)
d) Library and Information Resources (See section 1.6)

3.19.6 Course Structure and Synopses: Science Laboratory Technology

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. These are courses in the core basic science subjects of biology, chemistry, mathematics and physics, as well as courses in general laboratory techniques and general studies. This is to ensure that all students of Science Laboratory Technology Degree Programme have adequate knowledge of the broad spectrum of basic science irrespective of the technique of specialisation. However the course structures for the different techniques differ from 200 Level when the students commence their specialization.

3.19.7 Course Structure and Synopses of Common Courses (Science Lab. Tech. Options)

The course structure of common courses at the 100 Level is shown in Table 3.18.1 while the course structure of the few common courses at the higher levels is shown in Table 3.18.2 below.

Course Structure at 100 Level: Science Laboratory Technology Programme

Course Code	Course Title	Units	Status	LH	PH
GLT 101	Hazards & Safety in the Laboratory/Laboratory Maintenance & Fittings	3	C	30	45
GLT 102	Workshop Technology and Practice	2	C	15	45
GLT 104	Glass-Blowing Technology	2	C	15	45
GST 111	Communication in English I	2	C	30	-
GST 112	Logic, Philosophy & Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills & ICT	2	C	30	-
MTH 101	General Mathematics I	3	R	45	-
MTH 102	General Mathematics II	3	R	45	-
BIO 101	General Biology I	3	R	45	-
BIO 102	General Biology II	3	R	45	-
BIO 107	General Biology Practical I	1	R	-	45
BIO 108	General Biology Practical II	1	R	-	45
CHM 101	General Chemistry I	3	R	45	-
CHM 102	General Chemistry II	3	R	45	-
CHM 107	General Chemistry Practical I	1	R	-	45
CHM 108	General Chemistry Practical II	1	R	-	45
PHY 101	General Physics I	3	R	45	-
PHY 102	General Physics II	3	R	45	-
PHY 107	General Physics Practical I	1	R	-	45
PHY 108	General Physics Practical II	1	R	-	45
	Total	**45**			

LH = Lecture contact hours, PH = Practical contact hours, C = Compulsory, R = required, E = Elective

Course Structure of Common Courses at 200 – 500 Levels: Science Laboratory Technology

Course Code	Course Title	Units	Status	LH	PH
GLT 201	Instrument Maintenance I	2	C	15	45
GLT 401	Laboratory Organisation & Management I	3	C	30	45
GLT 501	Photography and Illustrations	2	C	15	45
GLT 508	Laboratory Organisation & Management II	3	C	30	45
		10			

3.19.8 Course Synopses of Common Courses

GLT 101: Hazards & Safety in the Laboratory/Laboratory Maintenance & Fittings (2 Units: LH 15; PH 45)

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 fire fighting 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 faults 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: LH 15; PH 45)

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: LH 15; PH 45)

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.

GLT 201: Instrument Maintenance I (2 Units: LH 15; PH 45)
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.

GLT 401: Laboratory Organisation and Management I (3 Units: LH 30; PH 45)
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 501: Photography and Illustrations (2 Units: LH 15; PH 45)
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.

GLT 508: Laboratory Organisation and Management II (3 Units: LH 30; PH 45)
Management Techniques and Functions: The concept and relevance of management to laboratory practice. Meeting of organisation; Supervisory skills and management functions; Planning; organizing; 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. Organization of laboratory services in Nigeria – public and private laboratories. Professional code of ethics. Types of business organization. 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; organization of laboratory safety – line management, safety officers, safety committees, codes of practice, general attitude to laboratory safety, accident books and records, notable accidents; the 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.

3.19.9 Course Structure of Biology Techniques

Course Structure at 200 Level: Biological Sciences Techniques

Course Code	Course Title	Units	Status	LH	PH
CSC 101	Introduction to Computer Science	3	C	30	45
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development				
GST 223	Introduction to Entrepreneurship	2	R	30	-
STA 201	Statistics for Agriculture & Biological Sciences	4	R	60	-
SBI 201	Genetics I	2	C	30	-
SBI 202	Introductory Ecology	2	C	15	45
SBI 203	General Physiology I	2	C	30	-
SBI 204	Biological Laboratory Techniques I	2	C	15	45
SBI 205	Introductory Developmental Cell Biology	3	E	30	45
SBI 208	Cell Biology and Histology	3	R	30	45
SBI 209	Lower Invertebrates	2	R	15	45
SBI 211	Seed Plants	2	R	15	45
SBI 213	Basic Principles in Botany	3	R	30	45
SCH 203	Organic Chemistry I	3	R	30	45
SMB 207	General Microbiology I	3	R	30	45
	Total	**42**			

Course Structure at 300 Level: Biological Sciences Techniques

Course Code	Course Title	Units	Status	LH	PH
BCH 201	General Biochemistry I	3	R	45	
BCH 202	General Biochemistry II	3	R	45	
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
SBI 301	Genetics II	3	C	30	45
SBI 302	Industrial Field Course I	1	C	15	-
SBI 303	General Cytology	3	R	30	45
SBI 304	General Ecology	3	R	30	45
SBI 305	Molecular Biology	3	R	30	45
SBI 306	General physiology II	3	R	30	45
SBI 310	General Entomology	3	R	30	45
SBI 313	Biological Laboratory Techniques II	2	C	15	45
SBI 315	Seedless Plants	3	R	30	45
SMB 306	Mycology	2	R	15	45
SMB 314	Microbial Genetics and Molecular Biology	2	R	15	45
	Total	**40**			

Course Structure at 400 Level: Biology Techniques

Course Code	Course Title	Units	Status	LH	PH
SBI 401	Population Genetics	2	E	30	-
SBI 402	Industrial Attachment (24 Weeks)	6	C		
SBI 403	Cytogenetics of Plants	3	R	30	45
SBI 411	Principles of Storage Engineering	2	R	15	45
SBI 413	Biology of Pests of Stored, Products and their Control	3	R	45	-
SBI 415	Storage Techniques	2	R	15	45
SMB 409	Food Microbiology	3	R	30	45
	Total	**21**			

Course Structure at 500 Level: Biology Techniques

Course Code	Course Title	Units	Status	LH	PH
GLT 501	Photography and Illustrations	2	R	15	45
SBI 502	Applied Storage Techniques	3	R	30	45
SBI 503	Research Project	6	C	-	270
SBI 506	Food and Storage Chemistry	3	R	30	45
SBI 507	Vectors and Pests Management	2	R	30	-
SBI 508	Applied Vectors and Pests Management	2	R	15	45
SBI 509	Applied Parasitology	3	E	45	-
SBI 510	Seminar	2	R		
SBI 511	Soil Ecology	3	E	30	45
SBI 512	Food Processing, Storage &Preservation	3	R	30	45
SBI 514	Systematic Biology	3	R	30	45
SBI 525	Advanced Taxonomy of Angiosperms	3	R	30	45
SBI 526	Biological Laboratory Techniques III	2	R	15	45
SBI 527	Plants & Environmental Pollution Monitoring	2	E	15	45
SBI 528	Economic Botany	2	E	15	45
		41			

3.19.10 **Course Synopses: Biology Techniques**

SBI 201: Genetics I **(2 Units: LH 30)**
Hereditable and non-hereditable characteristics, probability and tests of goodness of fit. Quantitative inheritance; variation in gene structure; Introduction to population genetics.

SBI 202 : Introductory Ecology **(2 Units: LH 15; PH 45)**
Concept and definitions of ecosystems in relation to animals and plants. Established relationships.

SBI 203: General Physiology I **(2 Units: LH 30)**
Physical and chemical processes in animal and plant physiology.

STB 204: Biological Laboratory Techniques I (2 Units: LH 15; PH 45)
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.

SBI 208: Cell Biology and Histology (3 Units: LH 30; PH 45)
Details of structure and function of muscles, mitochondrion, chloroplast, ribosomes, golgi complex and lysosomes. Nucleic acid, protein structure and synthesis. Enzymes, plant tissues types, animal tissue types, organs and organ systems. Techniques in histology.

SBI 209: Lower Invertebrates (2 Units: LH 15; PH 45)
Outline treatment of the protozoan and metazoan groups.

SBI 211: Seed Plants (2 Units: LH 15; PH 45)
Morphology and reproduction of seed plants.

SBI 213: Basic Principles of Botany (3 Units: LH 30; PH 45)
Basic principles of plant physiology, cytology, genetics and ecology.

SBI 301: Genetics II (3 Units: LH 30; PH 45)
Aspect of human genetics and plant breeding, pedigree analysis. Further consideration of various deviations from basic principles. Gene interaction.

SBI 302: Field Course I (1 Unit: PH 45)
Sampling techniques in local habitats. Applied plant anatomy in afforestation, horticulture and biotechnology. Assessment by report.

SBI 303: General Cytology (3 Units: LH 30; PH 45)
Light, phase-contrast, dark field and electron microscopy, auto-radiography, florescence, cell cycle, introductory cytogenetics.

SBI 304: General Ecology **(3 Units: LH 30; PH 45)**
The ecosystem approach to the study of ecology, energy flow and nutrients cycling. Dynamics of populations and communities ecosystem influence of man.

SBI 305: Molecular Biology **(3 Units: LH 30; PH 45)**
Biogenesis of microtubules, microfilaments, golgi mitochondria. Membrane – membrane interactions. Introduction to bioenergetics and thermodynamics.

SBI 306: General Physiology II **(3 Units: LH 30; PH 45)**
A general study of osmoregulation, excretion, transports, homeostatic and their co-ordination in animals. Plant water relation, growth and growth regulation. Physiological aspect of crop yield.

SBI 310: General Entomology **(3 Units: LH 30; PH 45)**
Evolution and systematic of insects. Insect structure and function with particular emphasis on insect integument, antennae, mouth parts and legs including functional modifications of these parts. Life history – moulting. Methods of locomotion in insects. Feeding, digestive, excretory and reproductive systems in insects. Insects of economic importance. The success of insects. Insects pests and control methods; insects collection methods. Identification and preservation techniques.

SBI 313: Biological Laboratory Techniques II **(2 Units: LH 15; PH 45)**
*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.

SBI 315: Seedless Plants **(3 Units: LH 30; PH 45)**
Morphology and reproduction of algae, bryophytes and pteridophytes including fossils.

SBI 401: Population Genetics: **(2 Units: LH 30)**
An introductory consideration of mathematical models for the analysis of gene frequencies and genetic variation in populations.

SBI 402: Industrial Attachment (24 Weeks) **(6 Units)**
Industrial attachment in Medical/Public Health of industrial establishments or storage firms corporations.

SBI 403: Cytogenetics of Plants **(3 Units: LH 30; PH 45)**
Aspects of cell and nuclear divisions. Morphology and behaviour of chromosomes. Chromosomal aberrations.

SBI 411: Principles of Storage Engineering (2 Units: LH 15; PH 45)
Power of storage machine. Different types of conveyors and their mechanisms. Grain processing and grinding equipment. Grain cleaning and grading equipment. General principles of crop and grain drying, storage and handling structures. Measuring instruments for crop drying processes. A guide to the major items of equipment used for the application pesticides. Field tests for equipment.

SBI 413: Biology of Pests of Stored Products and their Control (3 Units: LH 45)
Invertebrates pests of stored fish, wild life products, meat, tuber root crops, vegetables, fruits, cereals, legumes, leather, and timber, the detailed life cycles, identification of various stages, behavioural pattern and structural adaptations enabling them to act as efficient pests. The effect of environmental conditions on the abundance of invertebrate pest. Vertebrate pests of stored products and the damage they cause. Micro-organisms as pest factors which influence or inhibit their continued spread.

SBI 415: Storage Techniques (2 Units: LH 15; PH 45)
This course deals with various techniques (traditional and modern) used for the storage of diverse agricultural products with particular emphasis on dry and wet foods/food stuffs. Principles and methods of preservation of food, fish, wild life products and crops. Quality of products of storage e.g. degree of ripening, physical, biological and chemical characteristics of the major stored products. Methods of pest control. Pests of stored timber. Selected diseased tubers, root crops, cereals, legumes, vegetables and fruits and the microbiological deterioration of these stored products pre and post harvest under different ecological and climatic conditions. Residue analysis of the common insecticides and fungicides used for the protection of the stored products.

SBI 502: Applied Storage Techniques (3 Units: LH 15; PH 90)
This course shall involve a lot of practicals and field work on stored products protection and preservation including spraying, dusting fumigation and smoking. Formulation and application of insecticides and fungicides for controlling storage product pests and diseases. Prevention of storage losses and assessment of damage and crop losses; practical survey, design and construction of storage facilities for tubers and root products, grains, fungi and vegetables. Students shall assist farmers, visit food mills, bakeries canning factories and other food processing plants as well as cooperative facilities for transporting stored food products.

SBI 503: Project (6 Units: PH 270)
A research project involving an investigation on a selected biological problem. The project is to be written up in the form of a scientific report.

SBI 506: Food and Storage Chemistry (3 Units: LH 30; PH 45)
Proximate analysis of foods e.g. determination of moisture content, total ash, crude protein, amino acids, carbohydrates and lipids. Quality control tests in stored foods e.g. floatation, staining test objective and subjective tests. Organoleptic properties of foods. Food enzymes; classification, uses, action and factors affecting enzyme action. The chemistry of action of insecticides.

SBI 507: Vector and Pest Management **(2 Units: LH 30)**
Vectors and pests of economic importance e.g. insects, mites, molluscs, birds, rodents, etc. A study of some of the problems they pose in West African crops and vegetables, Cause of pest outbreak; the pest management concept. The use of pesticides and chemical in pest control; examples of insecticides and problem associated with their use. Mechanisms of action of pesticides and antimicrobial agents. Lethal dose factors (LD_{50}). Biological control of pests through the use of parasites and predators; microbial control of insect pathogens and conditions affecting their effectiveness against-insects. Use of pheromones, sterile male release techniques; insect plant interaction, selection mechanisms of host plant resistance. Cultural control methods in West Africa. Integrated control methods in West Africa.

SBI 508: Applied Vectors and Pests Management **(2 Units: LH 15; PH 45)**
This course shall particularly emphasize practical or field demonstrations and experiments on management of vectors and pests of economic importance in West Africa. Detailed study of the biology of vectors of animal diseases and their control e.g mosquitoes, tsetse-fly, blackfly, housefly, sandfly; practical demonstration of their control in their productive habitats where possible. Invertebrate vectors of plant diseases and their control e.g. aphids and scale insects. Vertebrate pests on farm crops e.g. birds, monkeys, rodents, bat and their control. Molluscs as agricultural pests; crop trees and their pests. Practical control of pests of farmland e.g. grasshoppers in waste land/abandoned farmland/college farm. Equipment used in vector and pest control and their practical methods of use in various research/storage institutions and agricultural development schemes for the control of pests.

SBI 509: Applied Parasitology **(3 Units: LH 45)**
Parasite nutrition, nature of interfaces between associating organisms. Gross and cytopathology of parasites. Vertebrate defensive responses to parasites to include principles of serology and immunology particularly in parasites of economic importance. Counter measure to vertebrate defences.

SBI 510: Seminar **(2 Units)**
The objective is to give students some experience in preparing, reading and presentation of original research papers and to be familiar with current researches in Biology. Also seminars on selected topics and projects shall be given by all students.

SBI 511: Soil Ecology **(3 Units: LH 30; PH 45)**
Physical and chemical nature of soil. Cycling of minerals and nutrient pools.

SBI 512: Food Processing, Storage and Preservation **(3 Units: LH 30; PH 45)**
Principles and practice of food processing. Techniques of processing and preservation of Nigerian foods with regards to their physical/chemical properties. Canning containers, outline of canning operation, principal spoilage organism in canned foods. Use of radiation in food preservation. Insect contaminants as spoilage organisms. Laboratory examination of canned foods. Methods of detecting contaminants in foods.

SBI 514: Systematic Biology **(3 units: LH 30; PH 45)**
A bio-systematic approach to the classification of organisms and nomenclature.

SBI 525: Advanced Taxonomy of Angiosperms **(3 Units: LH 30; PH 45)**
The origin of angiosperms, their classification and nomenclature, classical experimental and numerical taxonomy. Herbarium methods and organization.

SBI 526: Biological Laboratory Techniques III **(2 Units: LH 15; PH 45)**
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.
Practical
i) Handling and sexing of laboratory animals
ii) Determination of age and body weight
iii) Principles of spring, beam and torsion balances
iv) 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.

SBI 527: Plants and Environmental Pollution Monitoring **(2 Units: LH 15; PH 45)**
The use of algae, lichens, bryophytes and higher plants in monitoring environmental pollution. The use algae as indicators of aquatic pollution. The merits and demerits of using various taxonomic groups as indicators.

SBI 528: Economic Botany **(2 Units: LH 15; PH 45)**
Introduction to the plant kingdom, plant and the ancient man; basic plant taxonomy plants as sources of food, beverages, spices, essential oils, fibres, gums, drugs, resins and dyes. Medicinal plants and their uses; edible mushrooms and their cultivation; plants as ornaments.

3.19.11 Course Structure of Microbiology Techniques

Course Structure at 200 Level: Microbiology Techniques

Course Code	Course Title	Units	Status	LH	PH
CSC 101	Introduction to Computer Science	3	R	30	45
GLT 202	Hazards and Safety in the Lab.	2	C	15	45
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
STA 201	Statistics for Agriculture and Biological Sciences	4	R	60	-
SBI 201	Genetics I	2	C	30	-
SBC 201	General Biochemistry I	3	R	30	45
SCH 201	Inorganic Chemistry I	3	R	30	45
SCH 202	Analytical Chemistry I	2	R	15	45
SCH 203	Organic Chemistry I	3	R	30	45
SCH 205	Physical Chemistry I	3	R	30	45
SMB 201	General Microbiology I	3	C	30	45
SMB 202	General Microbiology II	3	C	30	45
SMB 203	Medical Microbiology	3	R	30	45
SMB 204	Microbiological Techniques	2	C	-	90
	Total	**44**			

Course Structure at 300 Level: Microbiology Techniques

Course Code	Course Title	Units	Status	LH	PH
CSC 201	Computer Programming I	3	E	30	45
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
SBC 301	Food Biochemistry	2	R	15	45
SBC 302	Chemistry & Metabolism of Carbohydrates	2	E	30	-
SCH 315	Instrumental method of Analysis	3	R	30	45
SMB 301	Bacteriology	3	R	30	45
SMB 302	General Virology	3	R	30	45
SMB 303	Microbial Genetics	3	R	30	45
SMB 304	Environmental Microbiology	2	R	15	45
SMB 305	Molecular Biology	3	R	30	45
SMB 306	Mycology	2	R	15	45
SMB 308	Microbial Physiology and Metabolism	3	R	30	45
SMB 310	Soil Microbiology	2	R	30	-
SMB 312	General Parasitology	2	E	30	-
	Total	**39**			

Course Structure at 400 Level: Microbiology Techniques

Course Code	Course Title	Units	Status	LH	PH
GLT 411	Laboratory Organisation & Management I	3	**C**	**30**	**45**
SBC 417	Biochemistry of Parasites	3	**E**	**30**	**45**
SMB 401	Industrial Microbiology	4	C	45	45
SMB 402	Industrial Attachment (24 weeks)	6	C		
SMB 403	Pharmaceutical Microbiology	2	R	30	-
SMB 405	Analytical Microbiology & Quality Control	3	R	30	45
SMB 407	Immunology & Immunochemistry	4	R	45	45
SMB 409	Food microbiology	3	R	30	45
	Total	**28**			

Course Structure at 500 Level: Microbiology Techniques

Course Code	Course Title	Units	Status	LH	PH
GLT 501	Photography and Illustration	2	R	15	45
GLT 508	Laboratory organization and Mgt II	3	R	30	45
SBI 502	Applied Storage Techniques	3	R	15	90
SBI 508	Applied Vectors and Pest Mg	2	R	15	45
SBC 512	Processing Biochemistry	3	R	45	-
SMB 502	Food Processing	3	R	30	45
SMB 503	Petroleum Microbiology	3	E	45	-
SMB 504	Principles of Epidemiology & Public Health	3	R	45	-
SMB 507	Plant Pathology	3	R	30	45
SMB 509	Fermentation Drinks	3	R	30	45
SMB 510	Seminar	2	C		
SMB 511	Research Project	6	C	-	270
		36			

3.19.12 Course Synopses of Microbiology Techniques

SMB 201: General Microbiology I **(3 Units: LH 30; PH 45)**

Historical aspects of microbiology with emphasis on the place of microorganisms in the world. Types of microorganisms – bacteria, viruses, fungi etc. Growth and reproduction of microorganisms. Sterilization and disinfection. Control of microorganisms by physical and chemical methods.

SMB 202: General Microbiology II **(3 Units: LH 30; PH 45)**

Systematic classification of bacteria, parasites, fungi, viruses, algae etc. Isolation, characterization and identification of microbes. Biological and biochemical reactions of microorganisms. Applied areas of microbiology.

SMB 203: Medical Microbiology **(3 Units: LH 30; PH 45)**
Pathogenic bacteria, fungi and viruses of both human and veterinary importance. Concept of pathogenicity and virulence with respect to development of diseases.
Clinical samples; pus, urine, CSF, blood aspirates, faeces-handling and laboratory processing methods.

SMB 204: Microbiological Techniques I **(2 Units: PH 90)**
Staining techniques, sterilization techniques, preparation and uses of buffers, cell suspension, centrifugation and diluting fluids. Microscope; preparation of microscope slides; photometer, colorimetry; chromatography, conductometry, centrifugation, experimental design and data interpretation; preparation of reports.

SMB 301: Bacteriology **(3 Units: LH 30; PH 45)**
Concepts and historical perspectives of bacteriology. Gross morphology of bacteria cells; structure of bacteria; relationship between size and metabolism of bacteria. Nutrition in bacteria; bacterial growth, bacterial classification; pathogenic bacteria and diseases. Virulence, spectrum and symptoms of infection; treatment and control of infections. Koch's postulate. Methods of isolation of bacterial pathogens.

SMB 302: General Virology **(3 Units: LH 30; PH 45)**
Historical background and development of virology. Structure and composition of viruses. Cultivation, isolation and identification of viruses. Antiviral agents such as interferon, bacteriophages; plant and animal viruses.

SMB 303: Microbial Genetics **(3 Units: LH 30; PH 45)**
Survey of the current status of microbial genetics (bacteria, fungi, viruses and protozoa) including discussion of methods and findings in the area of mutagenesis, inductions, isolation and biochemical characterization of mutants; adaptation, transformation, transduction, conversion and conjugation. General and specialized methods and techniques in microbial genetics. Experiments with virulent phases; temperate phases and lysogenic bacteria. Fungal and other lower eukaryotic genetics.

STM 304: Environmental Microbiology **(2 Units: LH 15; PH 45)**
Microorganisms and organisms important in aquatic systems and disposals. Ecology of microorganisms in fresh water; pollution and self-purification of water; purification of water; brief studies of marine microbiology. Disease transmission by water; microbiological examination of water; microbiology of waste disposal; biological oxygen demand and chemical oxygen demand; test for sewage in water.

SMB 305: Molecular Biology **(3 Units: LH 30; PH 45)**
Biogenesis of microtubules; microfilament, golgi bodies and mitochondria; membrane – membrane interaction, introduction to bioenergetics and thermodynamics.

SMB 306: Mycology (2 Units: LH 15; PH 45)
Structure, life cycle, physiology and classification of fungi; fungi of economic importance; laboratory methods of mycology; laboratory methods of mycology, pathology and immunology of superficial systems mycoses and actinomycoses.

SMB 308: Microbial Physiology and Metabolism (3 Units: LH 30; PH 45)
Aspects of microbial physiology; a revision of cell structure and function; growth and death of microorganism; nutrition, types of difference in relation to their energy metabolism and biosynthetic activity.

SMB 310: Soil Microbiology (2 Units: LH 30)
Characteristics of soil environment, microbial and fauna of soil; microbial activities in soil; nitrogen cycle, carbon cycle; mineral transformation by microorganisms. Ecological relationship among soil pathogens; effect of peptides on soil microorganisms; biodegradation and biofuel generation.

SMB 312: General Parasitology (2 Units: LH 30)
Nature of parasitism; host – parasite relationship; concept and evolution of the parasitic mode of life; advantages and disadvantages of parasitism; host specificity and susceptibility; epidemiology and control of common tropical parasitic infections; transmission of parasites from host to host and the role of vectors in the transmission of parasitic diseases.

SMB 401: Industrial Microbiology (4 Units: LH 45; PH 45)
Nature of industrial microbiology, microorganisms of industrial importance; aspects of the biology of moulds, yeasts, bacteria, actinomycetes and viruses of importance in various types of fermentation. Culture techniques and maintenance of selected cultures. Mutation, strain selection and development; hybridisation, media formulation, optimization of fermentation media at laboratory scale, perimeter design operation; antifoams; aspects of biochemical engineering; patents and patent law.

SMB 402: Industrial Attachment (24 Weeks) (6 Units)
This SIWES programme shall be undertaken in suitable laboratories in medical/public or industrial laboratories. Assessment will be based on written report, seminar presentation, and assessment by supervisors.

SMB 403: Pharmaceutical Microbiology (2 Units: LH 30)
Chemistry of synthetic chemotherapeutic agents; antibodies' production and synthesis of antibiotics and other anti-microbial agents. Quality control of pharmaceutical products. Concepts of growth and death in microorganisms' mode of action; assay of anti-microbial agents; concept of antibiotic sensitivity and resistance as related to microbial physiology.

SMB 405: Analytical Microbiology & Quality Control (3 Units: LH 30; PH 45)
Microorganisms as reagents in quantitative analysis, selection of test organisms for assays (antibiotics, amino acids, vitamins, etc); responses of microorganisms' use in assays; obtaining and measuring responses of microorganisms. Preparation of assay samples;

methods of assay; interpretations of results, aspects of quality control; plant and equipment sanitation; microbiological standards and specifications.

SMB 407: Immunology and Immunochemistry (4 Units: LH 45; PH 45)
Basic concept of immunology, structure of antigen; antigenic determinants; cellular response; genetics of response to antigenic stimulation; structure and classification of immunoglobules. Theories of antibody formulation. Antigen and antibody interactions; role of lymphoid tissues and thymus in immunoresponses; hypersensitivity; immuno-pathology, auto-immunity; immunophylaxis and immunotherapy. Practicals will be in modern techniques in immunology and immunochemistry.

SMB 409: Food Microbiology (3 Units: LH 30; PH 45)
The occurrence and interactions of microorganisms with food. Intrinsic and extrinsic parameters of foods that affect microbial growth. Methods of detecting the presence of microbes in foods. Effects of microbial growth of food-fermentation, spoilage and food-borne diseases; food sanitation and microbiological food quality control.

SMB 502: Food Processing (3 Units: LH 30; PH 45)
Principles and practice of food processing. Techniques of processing and preservation of Nigerian foods with regard to their physicochemical properties; canning containers; outline of canning operation; principal spoilage organisms in canned foods. Use of radiation in food preservation; insect contamination as spoilage organisms; laboratory examination of canned foods; method of detecting contaminants in foods.

SMB 503: Petroleum Microbiology (3 Units: LH 45)
Origin and chemical evolution of the atmosphere, hydrosphere and biosphere. Morphology and biostratigraphy of major groups of microfossils. Biological origin and accumulation of petroleum and sedimentary basins. Hydrobiology, petroleum pollution and its sources and biological control. Oil pillage, petroleum degrading microorganisms; hydrocarbonoclastic bacteria. Metallomenass bacteria that cause rusting of oil pipes.

SMB 504: Principles of Epidemiology & Public Health (3 Units: LH 45)
Nature of epidemiological investigation, spectrum of infections; herd immunity and latency of infections; multi-factorial systems in epidemics; zoonoses, antigenics drifts. Biological products for recommended immunization schedules, international control of infectious diseases; statistical application to epidemiology.

SMB 507: Plant Pathology (3 Units: LH 30; PH 45)
Principles and concepts in plant pathology. Some pathology of plants and animals, especially those prevalent in Nigeria. The geographical distribution of pathogens; their isolation, identification, morphology, life-cycles, sources of isolation, transmission and the effects on the host, aetiology, cultural characteristics and clinical manifestations of specific bacterial, viral and fungal pathogens of animals and plants. Control of plant diseases.

SMB 509: Fermentation Drinks **(3 units: LH 45)**
Basic concepts of fermentation, alcohol fermentation resulting in production of bread, bear, wine and vinegar. Fermentation leading to production of cheese, butter, yoghurt, etc, malolactic fermentation.

SMB 510: Seminar **(2 Units)**
Students should present seminars on topics of current interest in microbiology. The objective of this course is to give students some experience in preparing, reading and presenting original research papers and to be familiar with current researches in microbiology.

SMB 511: Research Project **(6 Units: PH 270)**
A research project involving an investigation on selected biological problems; the students should undertake research project in a current area of microbiology.

3.19.13 Course Structure of Chemistry Techniques

Course Structure at 200 Level: Chemistry Techniques

Course Code	Course Title	Units	Status	LH	PH
CSC 101	Introduction to Computer Science	3	R	30	45
GLT 101	Hazards and Safety in the Lab.	2	C	15	45
GLT 201	Instrument Maintenance I	2	R	15	45
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MTH 201	Mathematics Method I	3	E	45	-
SCH 201	Inorganic Chemistry I	3	C	30	45
SCH 202	Analytical Chemistry I	3	C	30	45
SCH 203	Organic Chemistry I	3	C	30	45
SCH 205	Physical Chemistry I	3	C	30	45
SPE 201	General Physics V(Elementary Modern Physics)	3	R	45	-
SPE 202	Electrics Circuits and Electronics	3	R	30	45
SPE 208	Experimental Physics II	1	R	-	45
STA 202	Statistics for Physical Sciences & Engineering	4	E	60	-
	Total	**41**			

Course Structure at 300 Level: Chemistry Techniques

Course Code	Course Title	Units	Status	LH	PH
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
MTH 301	Mathematics Method II	3	E	45	-
SCH 301	Inorganic Chemistry II	3	C	30	45
SCH 302	Atomic & Molecular Structure And Symmetry	2	R	30	-
SCH 303	Organic Chemistry II	3	C	30	45
SCH 304	Petroleum Chemistry	2	R	30	-
SCH 305	Physical Chemistry II	2	C	15	45
SCH 306	Natural Products Chemistry I	2	R	30	-
SCH 307	Organometallic Chemistry	2	R	30	-
SCH 308	Polymer Chemistry I	2	E	15	45
SCH 309	Industrial Raw Materials Resources Inventory	1	R	15	-
SCH 310	Colour Chemistry & Technology	3	R	30	45
SCH 311	Environmental Chemistry	2	R	30	-
SCH 312	Applied Spectroscopy	2	R	30	-
SCH 313	Introductory Industrial Chemistry	2	R	30	-
SCH 314	Industrial Chemical Process I	2	E	30	-
SCH 315	Instrumental Methods of Analysis	3	C	30	45
SCH 316	Industrial Chemical Technology I	2	E	30	-
SCH 318	Quality Control & Industrial Safety	1	C	15	-
SCH 320	Chemistry Laboratory Techniques and Practice	3	C	15	90
	Total	**48**			

Course Structure at 400 Level: Chemistry Techniques

Course Code	Course Title	Units	Status	LH	PH
GLT 401	Laboratory Organisation & Management I	3	C	30	45
SCH 401	Theory of Molecular Spectroscopy	2	E	30	-
SCH 402	Industrial Attachment (24 Weeks)	6	C		
SCH 403	Reaction kinetics	2	R	30	-
SCH 405	Radiation Chemistry & Nuclear Chemistry	2	R	30	-
SCH 407	Instrumentation & Analytical Chemistry II	3	C	30	45
SCH 409	Heterocyclic Chemistry	2	R	30	-
SCH 411	Coordination Chemistry	2	R	30	-
SCH 417	Natural products Chemistry II	1	R	15	-
SCH 419	Food Chemistry	2	R	30	-
SCH 421	Chemistry Lab. Techniques & Practice I	3	C	15	90
	Total	**28**			

PLEASE NOTE: Conclusive statement shall be made on the minimum CGPA of 1.5 for graduation after the forthcoming workshop on Grading System

Course Structure at 500 Level: Chemistry Techniques

Course Code	Course Title	Units	Status	LH	PH
GLT 501	Photography and Illustration	2	R	15	45
GLT 508	Laboratory organization and Mgt II	3	C	30	45
SCH 501	Research Project	6	C	-	270
SCH 502	Seminar	2	C		
SCH 503	Industrial Chemical processes II	2	E	30	-
SCH 504	Industrial Chemical Technology II	2	E	30	-
SCH 506	Food Analysis	2	R	15	45
SCH 508	Electrochemistry	2	E	30	-
SCH 509	Water and Waste Water Treatment	2	R	15	45
SCH 510	Analysis of Selected Materials and Drugs	2	R	15	45
SCH 511	Applied Surface & Colloid Chemistry	2	E	15	45
SCH 514	Dye and Textile Chemical Technology	2	R	15	45
SCH 515	Wood, Pulp and Paper Chemistry	2	R	15	45
SCH 516	Polymer Technology	2	R	30	-
SCH 517	Quantum Chemistry	2	E	30	-
SCH 520	Chemistry Laboratory Techniques & Practice II	3	C	15	90
	Total	**40**			

3.19.14 Course Synopses of Chemistry Techniques

SCH 201: Inorganic Chemistry I **(3 Units: LH 30; PH 45)**
Chemistry of First row transition metals. Introduction to coordination chemistry including basic treatment of crystal field theory. Comparative chemistry of the following elements: (a) Ga, In Tl, (b) Ge, Sn, Pb, (c) As, Sb, Bi (d) Se, Te, Po. Basic introduction to Organometallic Chemistry. Role of metals in Biochemical Systems.

SCH 202: Analytical Chemistry I **(3 Units: LH 30; PH 45)**
Theory of Errors, Statistical treatment of data: Theory of sampling. Chemical methods of analysis including volumetric, gravimetric and physiochemical methods; optical methods of analysis, separation methods.

SCH 203: Organic Chemistry I **(3 Units: LH 30; PH 45)**
Factors affecting structure and physical properties of organic compounds; Stereochemistry. Methane, energy of activation and free radical substitution reactions in alkanes. Functional group chemistry. Electrophilic and Nucleophilic substitution reactions. Aromaticity; Various organic reactions e.g. addition, free radical, elimination reactions etc.

SCH 205: Physical Chemistry I **(3 Units: LH 30; PH 45)**
Kinetic theory of gases; Behaviour of real gases; the law of thermodynamics; Entropy and free energy; Reactions and phase equilibria; Reaction rates; Rate laws; mechanism and theories of elementary processes; photochemical reactions, Basic electrochemistry.

SCH 301: Inorganic Chemistry II **(3 Units: LH 30; PH 45)**
The noble gases, hydrogen. Electronic structure and general properties and comparative study of group 11A elements. Chemistry of Boron; Carbon and Silicon. Nitrogen and phosphorus, Oxygen and sulphur. The halogens, Transition elements. Separation of metals. Co-ordination Chemistry. Ligand and Crystal field theories. Introduction to Radiochemistry, Radioactivity and the periodic table.

SCH 302: Atomic and Molecular Structure and Symmetry **(2 Units: LH 30)**
Schrodinger equation. Helium atom, ground and excited states. Sin and Pauli principle. Hydrogen molecule, Comparison of molecular orbital and valence bond theory, concept of resonance and configuration interaction. Coulson-Fisher function. Molecular orbitals for diatomic molecules; simple pi electron theory; Huckel theory. Walsh rules. Brief mention of other methods. Russell Saunders Coupling. Orbital and spin angular momentum. Use of symmetry in Chemistry.

SCH 303: Organic Chemistry II **(3 Units: LH 30; PH 45)**
Alcohols and their reactions. Ethers and epoxides. Aldehydes and ketones. Carboxylic acids and their derivatives. Carbanions and carbocations; β-unsaturated compounds; amines. Aromatic and alicyclic chemistry. Polyfunctional compounds. Heterocyclic chemistry.

SCH 304: Petroleum Chemistry **(2 Units: LH 30)**
Petroleum in the contemporary energy scene. Nature, classification and composition of crude petroleum and natural gas. Distribution of petroleum and natural gas resources (the global and Nigerian situations). Petroleum technology survey of refinery products and processes. Petrochemicals in industrial raw materials. Prospects for the petrochemical industry in Nigeria.

SCH 305: Physical Chemistry II **(2 Units: LH 15; PH 45)**
A review of Gibbs function. Chemical thermodynamics. Introduction to statistical thermodynamics. Ideal solutions. Non-ideal solutions. Properties of electrolytes.

SCH 306: Natural Products Chemistry I **(2 Units: LH 30)**
General methods of isolation, separation, purification and structural determination of natural products. Classification and biogenesis. Introduction to the chemistry of terpenoids, steroids, carotenoids and alkaloids.

SCH 307: Organometallic Chemistry **(2 Units: LH 30)**
Classification of Organometallic compounds. Preparation, structure and reactions including abnormal behaviours of organometallics. Generation and detection of free-radicals, free organometallic compounds.

SCH 308: Polymer Chemistry I **(2 Units: LH 15; PH 45)**
The nature of Polymer; Types of Polymers and Polymerisation processes; Addition, condensation polymerisations and their mechanisms. Physical properties of Polymers. Solubility and solution properties. Structure and properties of fibre forming polymers.

SCH 309: Industrial Raw Materials Resource Inventory (1 Unit: LH 15)
Survey of Nigeria's industries and their raw material requirements. Mineral chemistry. Fossils and their uses. Plant and animal products. Nuclear, solar and hydrodynamic sources of energy. Potentials and applications of locally available raw materials as industrial feedstock.

SCH 310: Colour Chemistry and Technology (3 Units: LH 30; PH 45)
Colour and constitution. Chemistry, properties of dyes and pigments. Classification of dyes and fibres. Dyeing mechanisms. Preparation and dyeing of natural and synthetic fibres. Colour fastness properties. Quality Control procedures and colouration industry.

SCH 311: Environmental Chemistry (2 Units: LH 30)
Concepts of elementary cycles. Characteristics of the atmosphere. Sources, types and effects of environmental pollution. Waste water treatment. Composition of domestic water. Water chemistry and analysis. Chemical and physical instrumentation in environmental sciences.

SCH 312: Applied Spectroscopy (2 Units: LH 30)
Principles and applications of UV, IR, NMR and Mass spectroscopy the elucidation of structures of organic compounds.

SCH 313: Introductory Industrial Chemistry (2 Units: LH 30)
Review of applications of chemistry in the chemical and allied industries. Sources of chemical raw materials and energy. Renewable and non-renewable resources. Resource depletion and recycling. Raw materials from coal, petroleum, wood, etc. Materials and energy balances. Pilot plants, models and scale-up principles. Process optimization.

SCH 314: Industrial Chemical Processes (2 Units: LH 30)
Production of primary intermediates and synthesis of industrial organic chemicals, polymer adhesives, dyes, explosives, insecticides, pesticides, herbicides, flavouring agents and pharmaceuticals. Fermentation process.

SCH 315: Instrumental Methods of Analysis (3 Units: LH 30; PH 45)
Spectroscopic techniques. Quantitative analysis. X-ray methods. Flourescence methods. Nuclear magnetic resonance, electron spin resonance. Refractometry and interferometry. Polarimetry, calorimetry.

SCH 316: Industrial Chemical Technology I (2 Units: LH 30)
Heat transfer and mass transfer processes. Unit operations chemical technology equipment.

SCH 318: Quality Control and Industrial Safety (1 Unit: LH 15)
Quality control as applied to selected products, preservation and control of industrial and laboratory hazards.

SCH 320: Chemistry Laboratory Techniques and Practice I (3 Units: LH 15; PH 90)
General direction for Volumetric Work: Types of Volumetric analysis, Volumetric apparatus – burettes, weighing bottles, pipettes. Volumetric measuring flasks. Properties, calibration of weights; installation and maintenance of balances, construction and operation; sensitivity of balances. Theory of weighing.
*Methods of Weighing***:** The direct method, Gauss's method of substitution, Board's method of substitution, weighing errors.
Methods of Expressing the Concentration of Solutions: Weight/Volume, Percentage methods, Dilution ratio, Molar and Normal concentrations, and Titre methods.
*Equivalent Weights***:** Equivalent weights for reaction in which there is no electron transfer: Neutralization, Precipitation, and Equivalent weights for oxidation-reduction reactions.
*Conversion from one Method to Another***:** Weight/volume to molar or normal, Molar to Normal and vice versa, Molar to Normal Titre, and Weight percent to molar or normal.
Note: Worked examples in this section should show how weights and volumes of substances are worked out when preparing various solutions and reagents used in the laboratory for both qualitative and quantitative analysis.

SCH 401: Theory of Molecular Spectroscopy (2 Units: LH 30)
Quantum theory of rotation and vibration. Theory of microwave, Raman, UV, Visible and NMR spectroscopy. General introduction to electron spin resonance. Massbauer effect, nuclear quadrupole resonance and other modern techniques.

SCH 403: Reaction Kinetics (2 Units: LH 30)
Review of first, second and third order rate equations. Rate constants and equilibrium constant. Collision theory, transition state theory, reaction coordinates. Unimolecular reaction theory; bimolecular reaction mechanisms, chain reaction mechanisms; catalysis and heterogenous reactions. Photochemical reaction mechanisms.

SCH 405: Radiochemistry and Nuclear Chemistry (2 Units: LH 30)
Natural radiations/radioactivity, fusion, fission decay processes, nature of radiation. Nuclear models, energetics of nuclear reaction. Principles and measurement of radioactivity. Applications of radioactivity.

SCH 407: Instrumentation/Analytical Chemistry II (3 Units: LH 30; PH 45)
Theory of error. Potentiometric and pH methods. Conductomeric methods. Electrolytic methods. Radiochemical methods. Chromatography.

SCH 409: Heterocyclic Chemistry (2 Units: LH 30)
The synthetic and mechanistic aspects of fused heterocyclic systems particularly Quinolines, Isoqinolines, Benzofurans, Benzothiophenes, Indoles, Benzopyrylium salts, Coumarins, Chromones. Application of heterocyclic systems in drug synthesis.

SCH 411: Coordination Chemistry (2 Units: LH 30)
Definition, Recognition and Applications of Coordination Chemistry. 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 John-Teller distortions. Stabilization 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.

SCH 417: Natural Products Chemistry II (1 Unit: LH 15)

Chemistry of terpenoids, steroids and alkaloids, antibiotics, flavonoids. Prostagladins and chlorophylls. Other natural products of Pharmaceutical importance. Discussion of chemistry of important members; Biogenesis.

SCH 419: Food Chemistry (2 Units: LH 30)

Occurrence, structure and functions of carbohydrates, proteins, fats and oil; physical and chemical properties. Starch behaviour during baking of bread. Glucose syrup-chemistry of enzymatic and non-enzymatic productions.

Ripening and maturing of fruits – Pectic substances and their uses. The chemistry of fermentation process in the food industry. Effect of enzymes in foods. Enzymatic and non-enzymatic browning.

SCH 421: Chemistry Laboratory Techniques and Practice I (3 Units: LH 15; PH 90)

Chemical Recovery of Substances: Solvents – (miscible and immiscible; acid contaminated) precipitates cleaning of Mercury – by filtration and by distillation.

Criteria of Purity of Organic Compounds: Explanation of the terms – melting and boiling points, Construction of melting and boiling point apparatus, and typical determination.

Soxhlet Extractor- Used for the continuous extraction of solids in a hot solvent.

Gravimetric Techniques– Simple treatments only: The principle of Gravimetric analysis, Steps in Gravimetric analysis, Preparation of the solution, Precipitation, Digestion, Filtration, Washing, Drying or igniting, Weighing, and Calculation

Centrifugation: Type of centrifuges, relative centrifugal force and separating factor. Use, care and maintenance: Oxidation – Reduction (Redox) Titrimetry, Primary standard substances used in Redox titrimetry; solution used in Redox Titrations, oxidations and reductions equivalents.

Permanganate Process

General uses of permanganate

Techniques of preparing and standardizing Potassium Permanganate solution

Storage of permanganate

Dichromate Process

Preparations and standardization of potassium

Dichromate solution

Iodimetry/Iodometry Methods

General applications of iodimetry/iodometry; preparation and standardization of iodine solution.

Storage and preservation of thiosulphate solution

Types of indicators and their preparation for redox titrimetry.

Precipitation Titrimetry

Primary standard substances used in precipitation titrimetry preparation.

Standardization, and storage of nitrate solution.

pH Measurement

Methods of measuring pH.

Colorimetric method (measurement by indicators)

Electrometric method (Measurement by electronic meter)

Discussion should include the types, construction, use and maintenance of the equipment as well as indicator/reference electrodes.

SCH 501: Research Project (6 Units: PH 270)

CHE 501 is a six-unit project carried out over 2 semesters constituting the final year of the undergraduate program. It is aimed at exposing the graduating students to the technique of designing and executing a research project of relevance to current national needs and those of various industries that utilize research findings of chemical and allied institutes. These projects are carried out under the supervision of members of the academic staff of Departments.

SCH 502: Seminar (2 Units)

This is a 2-unit course of critical review of current topics of chemical interest. Students are required to write a treatise on selected topics and to present class seminars on them.

SCH 503: Industrial Chemical Processes II (2 Units: LH 30)

Chemical processing of minerals, metallurgy and hydrometallurgical processes. Industrial electrochemistry. Manufacture of some heavy inorganic chemicals. Cement and binding materials. Inorganic fertilizers.

SCH 504: Industrial Chemical Technology II (2 Units: LH 30)

Hydrogen and carbon monoxide synthesis, gas, exo-process, water gas, source of hydrogen and its applications. Industrial organic materials, raw materials. Technical and economic principles of processes and product routes. Flow diagrams. Selected oils and fats, soaps and detergents, sugar, varnishes, plastics, wood-pulp and paper. Environmental pollution.

SCH 506: Food Analysis (2 Units: LH 15; PH 45)

Sampling and treatment for analysis. Proximate analysis of sugar and fruit products; Milk and dairy products; Fresh food; Fermented products (beer, wine, vinegar); Flour and confectionary. Oil rancidity.

SCH 508: Electrochemistry (2 Units: LH 30)

Electrical double layer, potential at zero charge, polarisable and non-polarisable interface, mass transport, concentration polarisation, Fick's Laws; Levic equation.

SCH 509: Water and Waste Water Treatment (2 Units; LH 15; PH 45)

Background, sample water analysis, flow, dispersion, degradation, amounts and composition of wastes, biological aspects, particles, transport in soil and ground water sinks; sinks for water treatment, conventional processes in handling sewage, water treatment, plant wastes, advanced waste treatment. Effects of water pollution.

SCH 510: Analysis of Selected Materials & Drugs (2 Units: LH 15; PH 45)
Various techniques in use for the analysis of crude materials. Analysis of environmental samples, e.g. pesticide residue, hydrocarbons and air. Analysis for heavy metal contaminants. Organic functional groups and drug analysis. Soil geochemical analysis.

SCH 511: Applied Surface and Colloid Chemistry (2 Units: LH 30)
Some general principles relating to surfaces. Electrical potentials. Attractive forces, solid gas interface. Definition of colloid and history of colloid development. Types of colloids. Polymers. Proteins, Gels, Association colloids, Detergency.

SCH 514: Dye and Textile Chemical Technology (2 Units: LH 15; PH 45)
Principles of yarn manufacture both natural and man-made. Basic machine processes, bleaching, dyeing theory and printing. Surface activity. Colour fastness and factors affecting it. Colouring matters. Management problems in textile industries.

SCH 515: Wood, Pulp and Paper Chemistry (2 Units: LH 15; PH 45)
Forests – conservation, exploitation and aforestation. Species, anatomy, physical properties and classification of wood. Preparation of wood for pulping. Physical and chemical methods of pulping. Bleaching reagents and pulp bleaching. Pulp-properties and uses.

SCH 516: Polymer Technology (2 Units: LH 30)
Large scale industrial polymerization processes. Polymer Technology. Polymer processing, injection, extrusion, compression and transfer moulding of thermoplastics. Polymer additives. Polymer surface coating and adhesive.

SCH 517: Quantum Chemistry (2 Units: LH 30)
Postulates of Quantum mechanics; operators; angular momentum, solution of the hydrogen atom problem. Theory of atomic spectra. Self-consistent Field theory. Computational aspects. Perturbation and variation methods.

SCH 520: Chemistry Laboratory Techniques and Practice II
(3 Units: LH 15; PH 90)
Buffer Solution: Definition, types and uses, Preparation of buffer solution (acidic and alkaline) of known pH and known molar concentration.
Colorimetric and Photoelectric Colorimetric: Introduction to the nature of radiant energy, the electromagnetic spectrum. The law of absorbance, The Lambert law, The Beer's law, Combination of Lambart and Beer's Law, Deviation from Beer's Lambart Law, Visual colorimetric techniques (use of comparators); the duplication method; the dilution method; the method of balance or variable depth; the standard series method.
Photoelectric Filter Photometer: The construction of a single beam filter photometer e.g. EEL. Colorimeter should be described including the principles of operation; operational precautions and limitations; trouble shooting and how to correct them. Examples of the faults often associated with filter photometers are: no meter deflection; instrument cannot set zero with blank sample; instrument sometimes gives accurate readings. Maintenance of the instrument

Spectrophotometry: Principles of photoelectric spectrophotometry, Treatment of different types of cells and their applications, Types of spectrophotometers – UV; IR and visible (examples should include the single beam and double beam spectrophotometers).
Refractometry: Theory: Specific and molar refraction, working principles of a refractometer –e.g. Abbey refractometer; applications of refractometric method of analysis. Care of the instrument.
Polarimetry: Theory of equipment. Practice.
Purification of Organic Compounds: The principal methods used to purify organic compounds.
Crystallization: Explanation of the process in its simplest form, choice of solvent, experimental details for recrystallization, use of de-colourizing carbon for the removal of traces of matter and resinous products.
Distillation: Brief theory of distillation, methods of distillation.
Distillation at Atmospheric Pressure: Typical assemblies and techniques used, distillation under diminished pressure (vacuum distillation), typical assemblies and techniques used.
Fractional distillation: Fractionating columns, azeotropes, types, techniques, fractional distillation under diminished pressure.
Chromatographic Methods: Principles, classification of chromatographic techniques; adsorption, partition. Techniques of column chromatography, paper chromatography, thin-layer chromatography, ion exchange chromatography, and gas chromatography

3.19.15 Course Structure of Biochemistry Technique

Course Structure at 200 Level: Biochemistry Techniques.

Course Code	Course Title	Units	Status	LH	PH
GLT 201	Instrument Maintenance I	2	**C**	15	45
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MTH 201	Mathematics Method I	3	E	45	-
SBC 201	General Biochemistry I	3	C	45	-
SBC 202	General Biochemistry II	3	C	45	-
SBI 201	Genetics I	2	R	30	-
SBI 204	Biological Laboratory Techniques I	2	R	15	45
SMB 201	General Microbiology I	3	R	30	45
SCH 201	Inorganic Chemistry I	3	R	30	45
SCH 202	Analytical Chemistry I	3	R	30	45
SCH 203	Organic Chemistry I	3	R	30	45
SCH 205	Physical Chemistry I	3	R	30	45
STA 201	Statistics for Agriculture & Biological Sciences	4	E	60	-
	Total	**42**			

Course Structure at 300 Level: Biochemistry Techniques

Course Code	Course Title	Units	Status	LH	PH
CSC 201	Computer Programming I	3	E	30	45
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
SMB 303	Microbial Genetics	3	R	30	45
SBC 301	Food Biochemistry	2	R	30	-
SBC 302	Chemistry & Metabolism of Carbohydrates	2	R	30	-
SBC 303	Membrane Biochemistry	1	E	15	-
SBC 304	Protein Biosynthesis	2	R	30	-
SBC 305	Nutritional Biochemistry	2	R	30	-
SBC 308	Metabolism of Nucleic Acids	2	R	30	-
SBC 310	Chemistry & Metabolism of Lipids	2	R	30	-
SBC 312	Enzymology	2	R	30	-
SBC 314	Bioenergetics	1	E	15	-
SBC 316	General Biochemical Methods (Practical)	2	C	-	90
SCH 303	Organic Chemistry II	3	R	30	45
SCH 305	Physical Chemistry II	2	R	15	45
SCH 315	Instrumental Method of Analysis	3	R	30	45
SCH 320	Chemistry Laboratory Techniques & Practice I	3	R	15	90
	Total	**41**			

Course Structure at 400 Level: Biochemistry Techniques

Course Code	Course Title	Units	Status	LH	PH
GLT 401	Laboratory Organisation and Management I	3	C	30	45
SBC 401	Advanced Enzymology	2	R	30	-
SBC 402	Industrial Attachment (24 Weeks)	6	C		
SBC 403	Biochemical Toxicology I	3	R	45	-
SBC 405	Plant Biochemistry	2	R	30	-
SBC 407	Biosynthesis of Macromolecules	1	R	15	-
SBC 409	Advanced Biochemical Methods (Practical)	2	C	-	90
SBC 411	Bioinorganic Chemistry	1	R	15	-
SBC 413	Genetic Engineering	2	R	30	-
SBC 415	Biochemical Reasoning	1	R	15	-
SBC 417	Biochemistry of Parasites	2	R	30	-
	Total	**25**			

Course Structure at 500 Level: Biochemistry Techniques

Course Code	Course Title	Units	Status	LH	PH
GLT 501	Photography and Illustration	2	C	15	45
GLT 508	Laboratory Organisation & Management II	3	C	30	45
SBC 501	Metabolic Regulation	2	R	30	-
SBC 502	Biochemical Toxicology II	3	R	30	45
SBC 503	Pharmacological Biochemistry	2	R	30	-
SBC 504	Advanced Biotechnology	3	R	30	45
SBC 505	Enzyme Biotechnology	3	R	30	45
SBC 506	Biomass Utilization	2	E	15	45
SBC 507	Industrial Biochemistry	3	R	45	-
SBC 508	Seminar	2	C		
SBC 509	Biophysics	2	E	30	-
SBC 510	Tissue Biochemistry	1	R	15	-
SBC 511	Research Project	6	C	-	270
SBC 512	Process Biochemistry	3	E	45	-
SCH 520	Chemistry Laboratory Techniques & Practice II	3	R	15	90
	Total	**40**			

3.19.16 Course Synopses of Biochemistry Techniques

SBC 201: General Biochemistry I **(3 Units: LH 45)**
Chemistry of amino acids and their derivatives, methods of isolation and identification, acidity and alkalinity, pH and pK values and their effects on cellular activities; Buffers. Chemistry/Structures of carbohydrate, lipids, proteins and nucleic acids; primary, secondary, tertiary and quaternary structures of proteins.

SBC 202: General Biochemistry II **(3 Units: LH 45)**
Nomenclature of nucleosides, and nucleotides; Effects of acid and alkali on hydrolysis of nucleic acids. Structures and functions of major cell components; prokaryotic versus eukaryotic organisms

SBC 301: Food and Nutrition Biochemistry **(2 Units: LH 30)**
An introduction to the theory and application of physical and chemical methods of determining the constituents of food. Food processing preservations and storage of traditional foods: roots and stem tubers, fruits and fruit drinks, seeds and grains, green vegetables. Food poisoning and intoxication: prevention and cure.

SBC 302: Chemistry and Metabolism of Carbohydrates **(2 Units: LH 30)**
Degradation and digestion of carbohydrates-sugars, storage polysaccharides and cell walls. Reactions of sugars, Glycolysis, the tricarboxylic acid cycle the phosphogluconate pathway the glyoxylate pathway, the pentose phosphate pathway and the cori cycle, the calvin pathway. Gluconeogenesis and glyconeogenesis. Disorders of carbohydrate metabolism.

SBC 303: Membrane Biochemistry **(1 Unit: LH 15)**
Structure, composition and functions of biological membranes. Isolation, characterization and classification of membranes; chemistry and biosynthesis of membranes. Molecular organization of membrane components. Natural and artificial membrane bilayers – the unit membrane hypothesis. Membrane transport system; active versus passive transport systems. Transport of sugars and amino acids; ionopheres.

SBC 304: Protein Biosynthesis **(2 Units: LH 30)**
General organizational biosynthesis of proteins; Genome organization

SBC 305: Nutritional Biochemistry **(2 Units: LH 30)**
Food nutrients, Energy values of foods and energy expenditure by mammalians.
Nutritive values of foods: carbohydrates, fats, proteins, vitamins, mineral elements and water. Nutritional disorders, prevention and therapy. Nutritional status and nutrient requirements. Recommended dietary allowances. Assessment of nutritional status. Nutrient requirements, in relation to physical activity and ageing, diet and disease; obesity and under nutrition.

SBC 308: Metabolism of Nucleic Acids **(2 Units: LH 30)**
Metabolism of purines and pyrimidines, nucleosides and nucleotides; abnormalities in nuclei acid metabolism-xeroderma pigmentation and skin cancer.

SBC 310: Chemistry and Metabolism of Lipids **(2 Units: LH 30)**
Classification of lipids – fatty acids, triglycerides, glycosylglyerols; phospholipids, waxes, prostagladins. Lipids micelles, monolayer and bilayer lipoprotein; covalent backbone of proteins. Amino acid sequence of protein. Protein isolation, fractionation, purification and characterization. Biological functions of proteins. Oxidative degradation of amino acids and metabolism of one carbon unit. Biosynthesis of amino acids and some derivatives; the urea cycle; metabolism of inorganic hydrogen. Disorders of amino acid metabolism.

SBC 312: Enzymology **(2 Units: LH 30)**
Vitamins and co-enzymes. Fat and water soluble vitamins, structures and functions of vitamins and co-enzymes. Classification and nomenclature of enzymes. Genetics of enzymes and inhibition. Mechanisms of enzyme-catalysed reactions. Effects of temperature, pH, ions and inhibitors on enzyme catalysed reactions. Michaelis-Menten equation. Allosteric/Regulatory enzymes. Active sites of enzymes. Estimation of kinetic parameters, enzyme activities km, Vmax, Ki etc. Zymogen activation, digestive enzymes etc. Production, isolation, purification and characterization of enzymes. Recent advances in enzymology.

SBC 314: Bioenergetics **(1 Unit: LH 15)**
High-energy compounds; chemicals potentials, electrochemical potentials, Electron transport system and oxidative phosphorylation; Regulation of ATP production. Chemical thermodynamics, Oxidations reductions.

SBC 316: General Biochemical Methods (Practical) (2 Units: PH 90)
Practical laboratory exercises in areas of interest to cut across a wide spectrum of general biochemistry.

SBC 401: Advanced Enzymology (2 units: LH 30)
Steady state enzymes kinetics. Transient kinetic methods. Chemistry of enzymes catalysis. Regulatory enzymes. Molecular models for allosterism. Multi-enzyme complexes. Enzyme assays. Criteria for determining purity of enzymes. Enzyme reconstitution. Regulation of enzyme activity and synthesis.

SBC 402: Industrial Attachment (24 Weeks) (6 Units)
Students should be attached to some industrial organizations for 24 Weeks, preferably the first semester of the fourth year.

SBC 403: Biochemical Toxicology I (3 Units: LH 45)
Biochemical toxicology, definition and scope, absorption and distribution; toxicokinetics, metabolism of toxicants; comparative toxicology; physiological factors affecting metabolism of zenobiotics elimination of toxicants and their metabolites, toxicant-receptor interactions, genetic poisons, chemical carcinogenesis; trace element toxicity, hepatotoxicity.

SBC 405: Plant Biochemistry (2 Units: LH 30)
Organization of plant cells, photosynthesis, alkaloids and flavonoids, plant hormones, Biosynthesis of carotenoid pigments, Biochemistry of Plants Development. The plant cell wall structure, formation and growth, Lignin formation. Free amino acids, pyrimidines, purines and nucleosides in plants. Metabolism of auxins, gibberellins and cytokinins. Synthetic growth regulators and herbicides. Structure function relationship of plant hormones.

SBC 407: Biosynthesis of Macromolecules (1 Unit: LH 15)
Structure and functions of macromolecules. Storage and structural polysaccharides, mucopolysaccharides, glycoproteins, bacterial cell wall synthesis of complex lipids, lipoproteins and nucleic acids.

SBC 409: Advanced Biochemical Methods (Practical) (2 Units: PH 90)
The purpose of this course is to familiarize students with operations of latest biochemical equipment and with methods of assimilation and dissemination of information. Students will therefore go round lecturers and laboratories housing specialized equipment with the aim of exposing them to such equipment under the supervision of lecturers. Part of the course will also cover the effective use of the library, preparation of dissertations or thesis, papers for journal publications and journal reviews. Special assignments and essays will be given to students.

SBC 411: Bioinorganic Chemistry **(1 Unit: LH 15)**
Relationship between the physiochemical properties and biological functions of inorganic ions. Ligand complexes and their biochemical significance. Electrolyte metabolism. Nitrogen fixation and sulphur cycle.

SBC 413: Genetic Engineering **(2 Units: LH 30)**
Replication, transcription and translation, a brief review. The genetic code and its relationship to cellular functions. DNA replication in a cell-free system. Genetic transformation, transduction and conjugation. Gene mutation, mutagenic agents and their applications to gene transfer. Gene mapping. Structure of eukaryotic genome. Recombinant DNA and its application. Hybridomas.

SBC 415: Biochemical Reasoning **(1 Unit: LH 15)**
Evaluation and design of experimental biochemistry from available information and data. Analysis, interpretation and inference drawing from biochemical research data.

SBC 417: Biochemistry of Parasites **(2 Units: LH 30)**
Survey of different types of parasites. Host-parasites relation. Metabolism in selected parasites. Parasitism versus Symbiosis. Genetics of parasites. *In vitro* cultivation of selected parasites. Immunology of parasites, chemotherapeutical control of parasites.

SBC 501: Metabolic Regulations **(2 Units: LH 30)**
The relationship of Krebs Cycle to protein, carbohydrate, lipid and nucleic acid metabolism. Integration of metabolic pathways. Turnover rates and metabolic pools. Regulation of enzymes of metabolic pathways; feed-back inhibition versus enzyme synthesis; catabolite repression; end product repression; the lactose operon and arabinose operon. Identification of different regulatory mechanisms in metabolic pathways.

SBC 502: Biochemical Toxicology II **(3 Units: LH 30; PH 45)**
Resistance and tolerance of toxicants; natural toxins, chronic testing in animals; short term tests for mutagenicity in the toxicological evaluation of chemicals; drug metabolite isolation and structural identification; biochemical modes of action of pesticides; enzymatic basis of detoxification.

SBC 503: Pharmacological Biochemistry **(2 Units: LH 30)**
Cellular metabolism in infected cells. Biochemical aspects of host-parasite relationships. Metabolic factors affecting chemotherapeutic agents. Theories of the mechanism of drug action. Drug resistance and other factors affecting drug efficacy. The physiological and biochemical action of some selected drugs. Nigerian traditional medicinal plants in the management and therapy of common ailments in Nigeria – malaria, sickle cell anaemia, common cold, hepatitis etc.

SBC 504: Advanced Biotechnology **(3 Units: LH 30; PH 45)**
Coordination of microbial metabolism, biosynthesis of metabolites, media and air sterilization; power requirement in fermentation vessels, instrumentation and control of fermentation processes, computers in fermentation processes; theory, application and

technique of continuous culture. Chemicals and fuel via fermentation, oxygen transfer and scale-up; production of antibiotics; cellulose, and starch hydrolysis (mechanisms and applications.

SBC 505: Enzyme Biotechnology: (3 Units: LH 30; PH 45)
Principles of industrial large-scale production of enzymes (techniques in fermentations). Large-scale extraction and purification. Principles and Designs of immobilized-enzyme reactors. Characteristics of free versus immobilized enzymes. Immobilized coenzymes and white cells. Enzyme utilization in industrial processes.

SBC 506: Biomass Utilization: (2 Units: LH 15; PH 45)
The concept of biomass for energy and fuels now and in the future. Food, chemical, feedstocks. Raw materials and preparation – forest inventories, agricultural perspectives, aquatic source, municipal solid waste production of micro-algae, hydrogen from water, structure and chemical composition of biomass anatomy, ultra-structure and chemical composition of wood cellulose. Structural characteristics of acid hydrolysis of lignin. Conversion methods of biomass-biological and thermochemical. Cellulose and their applications.

SBC 507: Industrial Biochemistry (3 Units: LH 45)
A short review on microbial physiology and genetics. A review on general metabolic pathway control and application in industrial processes. Continuous culture methods, principles and applications. The chemostat and its application in industrial fermentations. Fermentations-alcoholic, amino acids, antibiotics and its other secondary metabolites. Primary and secondary metabolism. Process evaluation and development. Over production of metabolites – amino acids, taste enhancers, organisms of industrial importance. Induction of mutation in microorganisms and plants for the purpose of over production. Strain selection/development and enhancement. Gene dosage and its application in industrial processes.

SBC 508: Seminar (2 Units)
Students should present seminars on current topics of interest in Biochemistry.

SBC 509: Biophysics (2 Units: LH 30)
Some instrumental methods of biophysics, chemical energy, structures and behaviours of macromolecules in solution. Reaction kinetics. Mechanisms in biophysics, sensory function of the nervous system.

SBC 510: Tissue Biochemistry (1Unit: LH 15)
Biochemistry of muscles, kidney, liver and adipose tissues. General metabolism of the brain and neuronal biochemistry. Biochemistry of reproductive tissues. Detoxification and excretion in tissues.

SBC 511: Research Project (6 Units: PH 270)
Independent research findings into selected areas/topics of interest to the academic staff. Students will be required to carry out literature survey on the topics, perform experiments

and produce short reports (preferably at the end of the second semester). Students will be subjected to both seminar and oral examination on the projects undertaken.

SBC 512: Process Biochemistry **(3 Units: LH 45)**
Basic concepts of anaerobic metabolism, isolation, cultivation and identification of anaerobes – Thermophilic anaerobes and their unique features. Survey of useful products manufactured by microorganisms, culture of yeasts, mould bacteria actinomycetes mammalian cells, genetic programming of industrial microorganism. Microbial production of beer, wine, bread, and cheese. Microbiological production of pharmaceutics (hormones and interferon) and industrial chemicals. Methanogenesis (mechanisms and application for waste treatment) production methods in industrial microbiology, agricultural microbiology, and strain improvement strategies for industrial organism.

3.19.17 **Course Structure of Physics/Electronics Techniques**

Course Structure at 200 Level: Physics/Electronics Techniques

Course Code	Course Title	Units	Status	LH	PH
CSC 201	Computer Programming I	3	E	30	45
GLT 201	Instrument Maintenance I	2	C	15	45
GST 122	Communication in English II	2	R	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MTH 201	Mathematics Method I	3	R	45	-
MTH 202	Elementary Differential Equations	3	R	45	-
SPE 201	Basic Modern Physics	3	R	45	-
SPE 202	Electrical Circuits	3	R	30	45
SPE 204	Waves and Optics	3	R	45	-
SPE 205	Thermal Physics	3	R	45	-
SPE 207	Physics Practical III	1	R	-	45
SPE 208	Physics Practical IV	1	R	-	45
SPE 210	Basic Electronics	3	R	30	45
STA 202	Statistics for Physical Sciences & Engineering	4	E	60	-
	Total	**40**			

Course Structure at 300 Level: Physics/Electronics Techniques

Course Code	Course Title	Units	Status	LH	PH
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
MTH 303	Vector and Tensor Analysis	3	E	45	-
MTH 304	Complex Analysis I	3	E	45	-
SPE 301	Analytical Mechanics I	3	R	45	-
SPE 302	Analytical Mechanics II	3	R	45	-
SPE 303	Electricity and Magnetism	3	R	45	-
SPE 304	Electro-magnetic Waves & Optics	3	R	45	-

SPE 305	Quantum Physics	3	R	45	-
SPE 306	Statistical and Thermal Physics	3	R	45	-
SPE 307	Practical Physics IV	1	R	-	45
SPE 308	Practical Physics V	1	R	-	45
SPE 309	Energy and Environment	1	R	15	-
SPE 311	Physics Lab. Techniques & Practice I	2	R	-	90
SPE 313	Electrical Circuit Theory	3	R	45	-
SPE 314	Solid State Physics I	3	R	45	-
SPE 315	Introduction to Solid State Electronics	3	R	30	45
SPE 316	Electronics I	3	R	30	45
	Total	47			

Course Structure at 400 Level: Physics/Electronics Techniques.

Course Code	Course Title	Units	Status	LH	PH
GLT 401	Laboratory Organisation and Management I	3	C	30	45
SPE 401	Quantum Mechanics I	3	R	45	-
SPE 402	Industrial Training (24 Weeks)	6	C		
SPE 405	Mathematics Methods in Physics I	3	R	45	
SPE 407	Computational Physics	2	R	30	-
SPE 409	Electrical Measurements & Instrument	3	R	30	45
SPE 415	Digital Electronics	3	R	30	45
SPE 419	Introduction to Telecommunication Sys.	2	R	15	45
SPE 424	Atomic & Molecular Spectroscopy	3	R	45	-
	Total	**28**			

Course Structure at 500 Level: Physics/Electronics Techniques.

Course Code	Course Title	Units	Status	LH	PH
GLT 501	Photography and Illustration	2	C	15	45
GLT 508	Laboratory Organisation & Management II	3	C	30	45
SPE 501	Quantum Mechanics II	3	R	45	-
SPE 503	Semiconductor Technology	3	R	30	45
SPE 504	Vacuum Physics and Thin Film Technology	2	R	30	-
SPE 505	Mathematical Methods in Physics II	3	R	45	-
SPE 507	Physics Lab. Techniques & Practical II	2	R	-	90
SPE 512	Fundamentals of Energy Process	3	R	45	-
SPE 517	Electronics Devices: Designs and Fabrication	2	R	-	90
SPE 520	Research Project	6	C	-	270
SPE 522	Seminar	2	C		
SPE 531	Nuclear and Particle Physics I	2	R	30	-
SPE 532	Nuclear and particle Physics II	2	R	30	-
	Total	**35**			

3.19.18 **Course Synopses of Physics/Electronic Techniques**

SPE 201: Basic Modern Physics (3 Units: LH 45)
Special relativity. Defects in Newtonian Mechanics; the speed of light; the Lorentz transformation of velocities; Experimental basis of quantum theory; Black body radiation; electrons and quanta; Bohr's theory of atomic structure; De Broglie hypothesis, the uncertainly principle; Schrodinger's equation and simple applications.

SPE 202: Electrical Circuits (3 Units: LH 30; PH 45)
D. C. Circuits, Kirchoff's law, source of e.m.f and current, Network analysis and circuit theorems. A. C. circuits. Inductance, capacitance, the transformer, sinusoidal wave-forms, rms and peak values, power, impendence and admittance, series RLC circuit, Q factor, resonance, network analysis and circuit theorems, filters. Electronics; semiconductors, the pin-junction, field effect transistors, bipolar transistors, characteristics and equivalent circuits, amplifier, feedback.

SPE 204: Waves and Optics (3 Units: LH 45)
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, holography; dispersion and scattering. Geometrical optics; waves and rays, reflection at a spherical surface, thin lens. Optical lenses, mirrors and prisms.

SPE 205: Thermal Physics (3 Units: LH 45)
The foundation of classical thermodynamics. The first law, work heat and internal energy, Carnot cycles and second law. Entropy and irreversibility, thermodynamics potentials and the Maxwell relations. Applications; qualitative discussion of phase transition; third law of thermodynamics, ideal and real gases, Elementary kinetic theory of gases including Boltzman counting. Maxwell-Boltzman law of distribution of velocities. Simple applications of the distribution law.

SPE 207: Physics Practical III (1 Unit: PH 45)
The laboratory course consists of a group of experiments drawn from diverse areas of physics (Optics, Electromagnetism, Mechanics, Modern Physics etc) designed to enhance students' understanding of the theoretical aspects of these areas of Physics.

SPE 208: Physics Practical IV (1 Unit: PH 45)
Continuation of SPE 207.

SPE 210: Basic Electronics (3 Units: LH 30; PH 45)
Thermionic emission, vacuum thermionic devices e.g. valves and C.R.T. junction and zener diodes and their applications. Bipolar transistor, characteristics and blasing of bipolar transistors, small signal amplifier, waveform generators. Logic elements and circuits, amplifiers, noise, feedback, simple resistive capacitive network, power tunnel, shot key and multifunction diodes and their applications.

SPE 301: Analytical Mechanics I (3 Units: LH 45)
Newtonian mechanics, motion of a particle in one, two and three dimensions, systems of particles and collision theory; Newtonian gravitation; conservative forces and potentials, oscillations, central force problems; accelerated frames of reference; rigid body dynamics generalized motion; mechanics of continuous media.

SPE 303: Electricity and Magnetism (3 Units: LH 45)
Maxwell's equations and electromagnetic potentials. The wave equation, Propagation of plane waves. Reflection and Refraction. Transmission lines, waves guides and resonant cavities; radiation, Geometrical optics, interference of waves. Diffraction.

SPE 305: Quantum Physics (3 Units: LH 45)
Wave – particle duality and the uncertainty principles, basic principles of quantum theory; energy levels in potential well; reflection and transmission of potential barriers; atomic and molecular structure and spectra, nuclear structure and reactions; fission and fusion; magnetic resonance; elementary particles.

SPE 306: Statistical and Thermal Physics (3 Units: LH 45)
Basic concepts of statistical mechanics; microscopic basics of thermodynamics and applications of macroscopic systems, condensed states, phase transformation; quantum distributions; elementary kinetic theory of transport processes, fluctuation phenomena. Applications.

SPE 307: Practical Physics IV (1 Unit: PH 45)
A series of important experimental techniques. Topics covered include electronics, optics, electricity, atomic, molecular nuclear and low temperature physics, statistics and data handling and scientific writing.

SPE 308: Practical Physics V (1 Unit: PH 45)
Continuation of Course SPE 307

SPE 309: Energy and the Environment (1 Unit: LH 15)
Energy and power, principles, demands and outlook, transformation of energy and its cost; thermal pollution; electrical energy from fossil fuels; hydroelectric generation; principles and problems. Costs, capacity, storage, reserves, efficiency, new environmental effects. Electrical energy from nuclear reactors, energy in the future, breeder reactors; fusion power, geothermal power, tidal power, etc. Promise and problems. Lectures (1/5) Excursions.

SPE 311: Physics Laboratory Techniques and Practice I (2 Units: PH 90)
Mechanics:
Construction and graduation of meter rules. Scales. Practical use of timers
Productions of standard weights of mass 50g, 100g, etc to 500g.
Coiling of helical springs as practical means of measurements of oscillations and motion-straight line graphs elongation – introduction of Young's modulus of elasticity.

Construction of pulleys and force diagrams boards and using the pulley, boards and masses of resolve forces
Construction of simple lever systems
Construction of knife edges with wood and metal
Construction of toy track and its application to the experimental verification of uniform acceleration.
Use of burnt fluorescent tube for experimental determination of Stoke's law – Also comparison of viscosities of liquids.
Inertia and Motion – application to Newton's first law of motion.
Unit of force-Momentum – Conservation of
Action and Reaction – Practical examples – the hammer and the nail
The spring balance – construction, force resolution.
Thermometers – Capillarity.
Sound: Production of resonant tubes from dead fluorescent tubes – local materials, Construction of sonometer boxes and the calibration of the boxes,
Using either of the above in conjunction with turning forks to determine experiment in sound and wave motion.
Light (Optics): Construction of simple plane mirrors
Care and maintenance of optical instruments commonly used in the laboratories e.g. the cathetometer, the microscope
Use and maintenance of interferometers. Use of the Newton's ring, the gratings and their use in the determination of Optical Laws.
The laser. Use and care of the laser. Different types of lasers available should be introduced and their characteristics studied. Application of lasers in optical experiments
Construction of reflectors. Devices, p-junctions, bipolar and field effect transistor; Solar cells.

SPE 313: Electric Circuit Theory **(3 Units: LH 45)**
General outline of linear circuit analysis, linear transformations, one port and two port networks, single-phase sinusoidal alternating, current circuits, lock diagrams, poly-phase circuits, network topology.
The methods of symmetrical components; some properties of three phase systems, examples of networks of unbalanced impedances. Distribution parameter networks, periodic non-sinusoidal currents in linear circuit, Fourier series, harmonics in three phase systems. Conventional filter design and operation. Operational methods of transient analysis of distributed parameter networks, non-linear a.c. circuits, frequency response of electrical networks, Bode plots. Poles and zeroes and time delay, root-locus concepts.

SPE 314: Solid State Physics **(3 Units: LH 45)**
Crystal structure and crystal binding. Elastic properties, lattice-vibrations. Superconductivity. Dielectric properties. Magnetism: paramagnetism and diamagnetism; ferromagnetism and antiferromagnetism; Magnetic resonance. Imperfections in solids.

SPE 315: Introduction to Solid State Electronics **(3 Units: LH 30; PH 45)**
Electrical condition in metals and semiconductor, energy barrier, motion of electrons in electric and magnetic fields, Hall effect, Thermoelectric effects. Photoelectric and

secondary Electronic Emission Phenomena. Photoconduction, Devices based on Photoelectric effects, photoconductive and secondary emission effects. Photomultipliers. Photodiodes intrinsic and extrinsic semiconductor, fabrication of simple devices, p-n junction, bipolar and field effect transistor. Solar cells.

SPE 316: Electronics I **(3 Units: LH 30; PH 45)**
Frequency response analysis of electronic amplifiers, oscillators. Power feedback instrumentation amplifiers. Introduction to operational amplifier. Field effect transistor circuits stabilized power supplied and voltage regulation circuits. Transducers, Noise and interference in systems. Introduction to multistage amplifiers. Differential amplifier circuits.

SPE 401: Quantum Mechanics1 **(3 Units: LH 45)**
The formulation of quantum mechanics in term of state vectors and linear operations. Three dimensional spherically symmetric potentials. The theory of angular momentum and spin. Identical particles and the exclusion principle. Method of approximation. Multi-electron atoms.

SPE 402: Industrial Attachment (24 Weeks) **(6 Units)**
Students should be attached to relevant industries for 24 weeks for appropriate industrial training. Assessment to be based on each student's report, seminar presentation and supervisors' assessments.

SPE 405: Mathematical Methods in Physics I **(3 Units: LH 45)**
Linear algebra and functional analysis; Transformation in linear vector space and matrix theory. Hilbert space and complete sets of orthogonal functions. Special function of mathematical physics. The gamma function; hypergeometric function; Legendre function; Bassel function. Hermite and Languerre function. The Dirac Delta function. Integral Transforms and 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.

SPE 407: Computational Physics **(2 Units: LH 30)**
Use of numerical methods in Physics; various methods of numerical integration, differentiation, numerical solutions of some differential equations in Physics, Statistical analysis of experimental data.

SPE 409: Electrical Measurements and Instrumentation **(3 Units: LH 30; PH 45)**
The transistor as a switch, power dissipation base over drive storage drive and switching speed, logic gates: Nano or with close logic, the TTL and gate, Truth table, noise margins, television pole, open collector and tristate, TTL, CMOS, NMOS, ECL combinational systems. Boolean algebra, identities, De-Morgan's Law, Karnaugh maps, Quine McCluskey minimization by computer aided techniques. The half and full adder. Fli-flop; R.S., J-K and D types edge and level trigger, maser slave types, the shift register. Circuit techniques. Oscillation sine wave amplitude control, sequencing frequencing stability. Waveform discrimination. Practical ramp generators. Conversion techniques, frequency to

voltage staircase generators analogue to digital D to A. Termination of pulsed lines, Bergeron diagram. Low noise amplifier design. Use to discrete components for minimum noise.

SPE 415: Digital Electronics (3 Units: LH 30; PH 45)

The transistor as a switch, power dissipation base over drive storage drive and switching speed, logic gates; NAND OR with close logic, the TTL AND gate, Truth table, noise margins, Television pole, open collector and triastate, TTL, CMOS, NMOS, ECL combinational systems, Bolean algebra, identities, De-Morgan's law, Karmaugh maps. Quin McChusky minimization by computer aided techniques. The half and full adder. Fli-flop: R-S, J-K and D types' edge and level trigger, master slave types, the shift register, circuit techniques, Oscillation sine wave amplitude control, sequencing frequency stability, waveform discrimination. Practical ramp generators. Conversion techniques, frequency to voltage staircase generators analogue to digital D to A, Termination of pulsed lines, Beargon diagram, Low noise amplifier design, use to discrete components for minimum noise.

SPE 419: Introduction to Telecommunication Systems (2 Units: LH 15; PH 45)

Modulation, Radio and T.V. systems, Telephone instruments, lines loses, noise, T. & T. networks, radar and navigational aids data transmission.

SPE 424: Atomic and Molecular Spectroscopy (3 Units: LH 45)

The hydrogen atom. Relativistic effects and spin. Identical particles and symmetry. Many electron atoms. Coupling schemes and vectors model. Zeeman effects, Hyperfine structure. The diatomic molecule, the Frank Condon principle. X-ray diffraction. Microwave methods. Resonance phenomena; ES, MMR and optical pumping and Mossbauer scattering.

SPE 501: Quantum Mechanics II (3 Units: LH 45)

Time-independent and time-dependent perturbation theory. Scattering theory, theory elastic potential scattering, Green's function and partial wave methods. Selected phenomena from each of atomic physics, molecular physics, Solid state Physics and Nuclear physics are described and then interpreted using quantum mechanics models.

SPE 503: Semiconductor Technology (3 Units: LH 30; PH 45)

The chemical physics of semiconductors, preparation, purification, growth of simple crystals, evaluation of chemical structural properties, dropping, effects mechanical and metallurgical properties. Thermodynamic and kinetic consideration in crystal growth from met and by chemical vapour transport techniques. Si, Ge, Ga, As and measurements of electrical properties. Processing of semiconductor materials for device fabrication. Formation of p-n junction luminescence and luminescent materials, photo emissive and photoconductive materials. Materials for IC's and their fabrication.

SPE 504: Vacuum Physical and Thin Film Technology (2 Units: LH 30)

Design and characteristics of vacuum systems. Different types of vacuum pumps and their uses, measurement of low pressure, different types of pressure gauges, use of valves and other vacuum materials, industrial uses of vacuum systems, vacuum heating, furnaces, induction heating, electron bombardment heating. Vacuum evaporation by various means, evaporation sources and techniques, substrate and surfaces preparation for thin firm deposition in vacuum. Heat treatment for thin film, compatibility of film and substrates, sputtering techniques, deposition of thin insulating films by r.f. sputtering, preparation and use of masks for thin film deposition. Characterization and application of thin films.

SPE 505: Mathematical Methods in Physical II (3 Units: LH 45)
Partial differential equations; solution of boundary value problem of partial differential equations by various methods which include separation of variables, the method of integral transforms, Sturm-Liouvelle theory, integral and summation of series. Applications to various physical situations which may include electromagnetic theory, quantum theory, diffusion phenomena.

SPE 507: Physics Laboratory Techniques and Practical II (2 units: PH 90)
Electricity
Collection and Classification of Conductors/Insulators:
Making of Dry cells boxes
Connection of Dry cells in series and parallel
Practical use of d.c. ammeters and voltmeters
Construction modification of d.c. and a.c. meters. Use of shunts and multipliers
Simple a.c/d.c tests with meters – condenser testing techniques
Making of small resistance with standard wire gauges
Testing of small resistances constructed with meters
Comparison of resistances.
Construction of resistance boxes
Introduction of post office box
Construction of the meter bridge
Construction of the potentiometer bridge
Application of bridges to experiments
Voltmeters and Ammeters
Wiring techniques – lamps and switching arrangements in wiring
Other electrical indication instruments – the galvanometer
Application to wheat stone bridge
Different galvanometers in common use in the laboratories.
Construction and use of jockeys
Fuses – connections
Fault finding techniques e.g. trouble shooting techniques
Colour coding of resistors and condensers.
Connection of resistances – series/parallel resistivity tests
Comparison of e.m.f. of cells.
Experimental determination of Ohm’s Kirchhoff’s Law
Simple construction of parallel plate condensers.

Magnetism

Magnetic materials – collection and classification of magnetic and non-magnetic substances

Use of magnetic needles in the determination of the earth's magnetic poles

The electroscope

The electromagnet – construction of electric bells and relays

Making of the solenoids

Transformers, construction and maintenance

Making of inductance – various winding techniques

Simple experiments involving inductance

Simple experiments involving electromagnetic inductances

The induction coil applications of simple demonstrations – a.c. and d.c. generations

Connection of cables to a.c. sources (American, Britain and European Cable Colour Codes).

SPE 512: Fundamentals of Energy Processes (3 units: LH 45)

Theory of modern energy conversion, transmission and storage methods; windmills, Heat engines, Classical engines, Ocean thermal energy converters, thermoelectric, thermionic, fuel cells, production of hydrogen, electrolytic, chemical thermolytic, photolytic, hydrogen storage. Photoelectron converters, photo thermovoltaic converters, Biomass, Photosynthesis, production methanol and ethanol from vegetable matter.

SPE 517: Electronic Device/Design and Fabrication (2 Units: PH 90)

Relevant items/devices of commercial interest to be handled by individual students.

SPE 531: Nuclear and Particle Physics I (2 Units: LH 30)

Nuclear structure, Nuclear masses, nuclear forces, nuclear-nucleon scattering, nuclear models. Radio-active decay. Alpha, beta, gamma decays. Nuclear reactions.

SPE 532: Nuclear and Particle Physics II (2 Units: LH 30)

Nuclear instrumentations and radiation detection techniques, detectors, nuclear spectroscopy. Neutron physics; production, detection of neutrons. Fission and fusion. Nuclear reactor and nuclear energy. Elementary particles; Conservation laws, partial classification. Strong electromagnetic and weak interactions.

3.19.19 Course Structure of Geology Techniques

Course Structure at 200 Level: Geology Techniques

Course Code	Course Title	Units	Status	LH	PH
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment & Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
SCH 201	Inorganic Chemistry I	3	R	30	45
SCH 202	Analytical Chemistry I	3	R	30	45
SCH 205	Physical Chemistry I	3	E	30	45
SGE 200	Earth History	3	R	30	45
SGE 201	Physical Geology	2	R	15	45
SGE 202	Optical & Determinative Mineralogy	2	R	15	45
SGE 203	Crystallography and Mineralogy	3	R	30	45
SGE 204	Igneous and Metamorphic Petrology	3	R	30	45
SGE 206	Field Geology and Map Interpretation	3	C	15	90
SGE 207	Basic Geology Surveying	3	R	15	90
SGE 208	Mineral Resources & Environmental Geology	2	R	15	45
SGE 210	Engineering Geology	3	R	30	45
STA 202	Statistics for Physical Sciences & Engineering	4	E	60	-
	Total	**45**			

Course Structure at 300 Level: Geology Techniques

Course Code	Course Title	Units	Status	LH	PH
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
SGE 301	Sedimentology	3	R	30	45
SGE 302	Introductory Geochemistry	3	R	30	45
SGE 303	Systematic Palaeontology	3	R	30	45
SGE 304	Stratigraphy and Geochronology	2	R	30	-
SGE 305	Igneous Petrology	2	R	15	45
SGE 306	Metamorphic Petrology	2	R	15	45
SGE 307	Photogeology and Remote Sensing	2	R	15	45
SGE 308	Hydrogeology I	2	R	15	45
SGE 309	Geological Techniques	2	C	15	45
SGE 311	Micropalaeontology	2	E	15	45
SGE 312	Structural Geology	3	R	30	45
SGE 313	Principles of Geophysics	2	R	30	-
SGE 314	Exploration and Mining Geology	3	R	30	45
SGE 316	Palaeontology	2	E	15	45
SGE 320	Independent Field Mapping	3	C	-	135
	Total	**42**			

Course Structure at 400 Level: Geology Techniques

Course Code	Course Title	Units	Status	LH	PH
GLT 401	Laboratory Organisation and Mgt I	3	C	30	45
SGE 401	Engineering Geology I	3	R	30	45
SGE 403	Petroleum Geology	3	R	45	-
SGE 405	Economic Geology	3	R	45	-
SGE 406	Industrial Attachment (24 Weeks)	6	C		
SGE 407	Hydrogeology II	3	R	45	-
SGE 409	Applied Geophysics	3	R	30	45
SGE 411	Geological Techniques II	2	C	15	45
SGE 413	Palynology	3	E	45	-
	Total	**29**			

Course Structure at 500 Level: Geology Techniques

Course Code	Course Title	Units	Status	LH	PH
GLT 501	Photography and Illustration	2	C	15	45
GLT 508	Laboratory Organisation & Management II	3	C	30	45
SGE 501	Research Project	6	C	-	270
SGE 503	Exploration Geochemistry	3	R	30	45
SGE 504	Energy Resources	2	R	30	-
SGE 505	Geology of Nigeria	2	R	15	45
SGE 506	Remote Sensing	2	R	30	-
SGE 507	Regional, Structural Geology & Global Tectonics	2	R	30	-
SGE 508	Engineering Geology II	2	R	30	-
SGE 509	Gemstone Technology	3	R	30	45
SGE 510	Seminar	2	R		
SGE 514	Marine Geology	2	E	30	-
SGE 516	Regional Geology of Africa	2	R	30	-
	Total	**33**			

3.19.20 **Course Synopses: Geology Techniques**

SGE 200: Earth History **(3 Units: LH 30; PH 45)**
The geologic time-scale and its methods of measurement. Origin and chemical evolution of the atmosphere, hydrosphere and biosphere – the history of life from bacteria to man. Concepts of palaeoclimate, palaeoceanography, palaeomagnetism. Basic principles of stratigraphy. Practical identification of common fossils. Sedimentation – Principles and processes. Internal processes on earth. Igneous and metamorphic.

SGE 201: Physical Geology **(2 Units: LH 15; PH 45)**
Planet Earth. Its composition from core to crust. Minerals, rocks and weathering. Surface processes and landforms; major earth structures. Practical identification of common rock forming minerals and rocks; interpretation of topography and simple geologic maps. Deformation processes – joints, faults and folds. Metamorphism and metamorphic rocks. Minerals and rocks – origin, distribution, identification and classification.

SGE 202: Optical and Determinative Mineralogy **(2 Units: LH 15; PH 45)**
Characteristic properties and propagation of light. The polarising microscope. Principles of optical crystallography. Identification of rock-forming minerals in parallel and convergent light under the polarizing microscope. Introduction to X-ray crystallography.

SGE 203: Crystallography and Mineralogy **(3 Units: LH 30; PH 45)**
Formation of a crystal; principles of crystal chemistry, crystal state; crystal structure; crystallographic notations; crystal lattice and unit cell; elements of symmetry, crystal, twinning; systematic mineralogy, silicate structures. Systematic description, occurrence and uses of common rock forming minerals; association of minerals and rocks; physical and optical properties and identification of common rock forming minerals.

SGE 204: Igneous and Metamorphic Petrology: **(3 Units: LH 30; PH 45)**
Origin, occurrence, geologic setting and systematic description of igneous rocks. Metamorphism and description of metamorphic rocks; metamorphic minerals and textures of metamorphic rocks.

SGE 206: Field Geology and Map Interpretation **(3 Units: LH 15; PH 90)**
A field course involving the fundamentals of structural geology; descriptions of deformational structures; field mapping techniques and the detailed interpretation of topographic and geologic maps. Determination of geometric forms of colours; interpretation of surface data.

SGE 207: Basic Geology Surveying **(3 Units: LH 15; PH 90)**
Surveying instruments and their uses e.g. chair, steel measuring tape, ranging poles, land chain, arrows, dumpy levels, the odolite, planimeters etc. Linear surveying, levelling, area measurements, volume of earthwork, curve ranging and tachometry, barometric heightening

SGE 208: Mineral Resources and Environmental Geology (2 Units: LH 15; PH 45)
Metallic and non-metallic mineral resources – their composition, distribution and utilization. Fossil fuels; surface and underground water hydrology. Pollution and its source, hazards and control. Prediction and control of geologic hazards.

SGE 210: Engineering Geology (3 Units: LH 30; PH 45)
Introductory soil and rock mechanics. Engineering properties of soils and rocks. Principal geologic factors affecting certain engineering projects – stability of slopes and cuttings; reservoirs and dam site foundation – types of problems in dams, dykes, bridges, building, and pavements. Behaviour of water in rocks and soils. Stoppage and erosion in reservoirs. Geological exploration of an engineering site – general consideration, preliminary investigation, applied geophysical surveys, drilling, boring, wrenching and pitting.

SGE 301: Sedimentology (3 Units: LH 30; PH 45)
Origin of sediments and sedimentary rocks, sedimentary processes, quantitative and statistical study of texture; structure and composition of sedimentary rocks, description of sedimentary rocks, study records. Petrography, study of sedimentary rocks under the polarizing microscope.

SGE 302: Introductory Geochemistry (3 Units: LH 30; PH 45)
Abundance, classification and distribution of elements in the cosmic system, lithosphere; hydrosphere and atmosphere, geochemistry of different rock types and mineral deposits; weathering and soil formation; principles and methods of exploration geochemical analysis.

SGE 303: Systematic Palaeontology (3 Units: LH 30; PH 45)
Morphology, evolution and identification of major animal phyla, their stratigraphic and palaeoecological distributions; vertebrates and plant fossils; trace fossils.

SGE 304: Stratigraphy & Geochronology (2 Units: LH 30)
Concepts of chronology, litho-biostratigraphy classification, terminology and correlation. Facies analysis, origin and evolution of sedimentary basins; geohistory analysis. Principles of geochronology, Rb/Sr, K/Ar and U/Pb dating methods. Stable isotopes; Pre-Cambrian geochronology; Pre-Cambrian geochronology of Nigeria.

SGE 305: Igneous Petrology (2 Units: LH 15; PH 45)
Extrusive and intrusive igneous processes, associations of igneous rocks in space and time; phases equilibrium and the genesis of selected igneous rocks. Granitic rocks – classification and petrogenesis. Older and younger granites of Nigeria. Charnockites, kimberlites, serpentinites, and carbonatites.

SGE 306: Metamorphic Petrology (2 Units: LH 15; PH 45)
Physicochemical processes in metamorphism; agents and controls of metamorphic processes; metamorphic differentiation. Classification of metamorphic rocks, metamorphic textures. Metamorphic facies and facies series. Facies of contact and regional metamorphism. Retrograde metamorphism, polymetamorphism and orogeny. The

carbonatite problem; eclogites. Evolution of gneisses and migmatites. Anatexis, metasomatism and granitisation.

SGE 307: Photogeology and Remote Sensing (2 Units: LH 15; PH 45)
Concepts and foundation of Remote Sensing; types of sensors; elements of photographic systems. Aerial photography-types; principles of stereoscopic vision. Measuring and plotting instruments in photogeology. Principle of aerial photo interpretation; mapping. Introduction to non-photographic remote sensing systems. The use of remote sensing in reconnaissance mapping, economic mineral prospecting and hydrogeology.

SGE 308: Hydrogeology I (2 Units: LH 30)
Hydrogeology and hydrology – definition and scope. Hydrological cycle; hydrological properties of rocks. Occurrence and movement of groundwater; groundwater and well hydraulics; fundamental hydrodynamic laws. Hydrometeorology – rainfall, overland flow, through flow interception etc hydrographs; unit hydrograph, theory and the application. Explanation of the basic hydrological equation.

SGE 309: Geological Techniques (2 Units: LH 15; PH 45)
DTA (Differential Thermal Analysis): Equipment and analysis of sample. Use of flame photometer and spectrophotometer in determining various elements. Microscopy - (Transmitted and reflected light and electron microscopes). Hardness measurement of ore-minerals and other related minerals and the equipment used for measurement.

SGE 311: Micropalaeontology (2 Units: LH 15; PH 45)
Morphologic and biostratigraphic study of major groups of micro-fossils.

SGE 312: Structural Geology (3 Units: LH 30; PH 45)
Stresses and strain analysis; and the ellipsoid stress component and trajectories; experimental deformation behaviour of rock materials; rheology in the earth's crust; fold mechanics, brittle fracture and failure, use of Mohr's circle; brittle and ductile shear zones, small scale geological structures. Salt domes and diapirism. Elements of physical metallurgy – crystal defects and dislocations, work hardened annealing, recovery, recrystallization, deformation mechanisms and development of textures and preferred orientations by plastic flow and recrystallization. Solution of structural problems by stereographic projection; structural mapping practice; study and interpretation of geological maps.

SGE 313: Principles of Geophysics (2 Units: LH 30)
Gravity and magnetic methods and data interpretation, spontaneous potential and electrical resistivity methods, concepts of electrical potential, current density and conductivity of rocks, potential distribution in a homogenous earth and apparent resistivity. ER field equipment, its use and data interpretation.

SGE 314: Exploration and Mining Geology (3 Units: LH 30; PH 45)
Definition and scope of mineral exploration. Mode of occurrence and factors controlling ore disposition. Concepts of ore search. Reconnaissance and detailed exploration

techniques – geological, geochemical and geophysical. Types of drilling and machinery. Roles of geologist in drilling. Ore reserve estimation and classification. Mining and mining methods. Factors controlling the choice of mining methods. Geological mapping and surveying of open-pit and underground mines. Roles of geologist in mining. Introduction to mineral economics. Mineral rights and mining law.

SGE 316: Palaeontology (2 Units: LH 15; PH 45)
Paleontological sampling, palaeoecologic principles and palaeobiologic models; macro and micro – evolution; statistical data analysis of paleontological data.

SGE 320: Independent Field Mapping (3 Units: PH 135)
Field mapping training class during the long vacation at the end of the 300 level courses. This involves an independent mapping exercise lasting 4-6 weeks in selected parts of Nigeria. A report on the exercise should be written and submitted at the beginning of the fourth year.

SGE 401: Engineering Geology I (3 Units: LH 30; PH 45)
Engineering properties of rocks, concrete aggregate and quarrying techniques; elements of soil mechanics; geological site investigations, foundations; dams, influence of groundwater on engineering project slopes, roads, railroads, dams and reservoirs. Method of ground improvement – grouting, compaction, anchoring, drainage.

SGE 403: Petroleum Geology (3 Units: LH 45)
The origin, migration and accumulation of petroleum. Source rock characteristics, maturation and destruction of petroleum. Properties of petroleum reservoirs. Subsurface and production geology. Hydrocarbon traps; abnormal pressure. Exploration methods, evaluation of petroleum potential and reserves. Reserves and basic classification. Drilling, completing and producing oil and natural gas wells. Examples of major oil deposits. Oil deposits in Nigeria. Oil and geopolitics.

SGE 405: Economic Geology (3 Units: LH 45)
The role of structure in mineral exploration. Definition of economic minerals and economic mineral deposits. Processes of formation of mineral deposits; classification of ore deposit. Mineral deposits in Nigeria.

SGE 406: Industrial Attachment (24 Weeks) (6 Units)
Students should be attached to geological and allied organizations for a period of 6 months for appropriate practical/field experience. Assessment should be based on written report, seminar presentation and supervisors' assessments.

SGE 407: Hydrogeology II (3 Units: LH 45)
Aquifers and types, ground water exploration and exploitation techniques; hydrochemistry. Case histories of basement complete hydrogeology. Applications of geophysical methods in shallow groundwater development (including springs); water quality: physical, chemical and biological parameters. Effect of groundwater on rocks and soils as construction materials and sites.

SGE 409: Applied Geophysics **(3 Units: LH 30; PH 45)**
Induced polarization and electromagnetic methods, seismic exploration – data acquisition, processing and interpretation.

SGE 411: Geological Techniques II **(2 Units: LH 15; PH 45)**
The mechanical stability of the raw materials measured by crushing; polishing, breaking, abrasion, AIV, ACV, PSV (Published Stone Value).

SGE 413: Palynology **(3 Units: LH 45)**
The Geological Time Scale: The archean; tectonism; metallogeny and crustal evolution. The early to mid-late proterozic; basic ultrabasic intrusions, geosynclines, mineralization, Mid-late proterozic, basinal development, crustal evolution and metallogeny. The palaeozoic petrotectonic evolution of continents form Cambrian to Permian; mineralization associated with the tectonism. The break-up of ranges.

SGE 501: Research Project **(6 Units: PH 270)**
Geological investigation and independent research involving field, laboratory and library studies.

SGE 503: Exploration Geochemistry **(3 Units: LH 30; PH 45)**
Principles of major and trace elements analysis, preparation and analytical procedures, geochemical surveys, field operations – sample collection and processing; surveying techniques, map preparation and interpretation of data. Geochemical methods in mineral prospecting and exploration. Case histories of geochemical surveys and integrated exploration programmes. The future of geochemistry in mineral exploration.

SGE 504: Energy Resources **(2 Units: LH 30)**
Introduction to energy resources. Primary resources; external sources, the earth's internal heat. Secondary resources. Photosynthesis and fossil fuel, the fossil fuels bank. Global perspective of energy resources, the growth of energy demand, global requirement and distribution.
Fossil Energy: Coal, its geology – origins, stages of formation, properties and ages, world coal resources, petroleum, nature, origin and generation. World resources of petroleum. Side effects of fossil fuel conversion.
Nuclear Energy: Nuclear reactions and reactors, fuel requirement for reactors, uranium – geology and geochemistry. Uranium production and economics; its reverses and resources. Side effects of nuclear industry; radioactive waste disposal.
Geothermal Energy: Hyper-thermal resources; zones with low conductive shallow strata, hot rocks
Surface Energy Resources: Solar energy – its thermal collection, photovoltaic conversion, biomass conversion via photosynthesis. Wind energy, hydro-electric power – its contribution to global power supplies. Tidal power, wave energy. Energy supply and demand in Nigeria – present and future scenes.

SGE 505: Geology of Nigeria **(2 Units: LH 15; PH 45)**
Major geomorphic and structural elements in Nigeria. The basement complex; origin, structure and evolution of early – middle proterozoic rocks. A working excursion to major geological features and type localities within the basement complex and sedimentary parts of Nigeria.

SGE 506: Remote Sensing **(2 Units: LH 30)**
Review of basic concepts in remote sensing. Acquisition of remotely collected data. Applications to mineral resources and environmental evaluation.

SGE 507: Regional Structural Geology and Global Tectonics **(2 Units: LH 30)**
Study of large-scale regional structures of the Earth; continental drift, plate tectonics and patterns of crustal evolution in specific regions.

SGE 508: Engineering Geology II **(2 Units: LH 30)**
Geotechnics and applications in Engineering Geology; terrain classification. Application of geology to engineering problems in construction of roads, bridges, dams etc.

SGE 509: Gemstone Technology **(3 Units: LH 30; PH 45)**
CASE HISTORIES: Applied geology methods exploration, systematic study of economic mineral deposits; ferrous metals and their alloys (iron, manganese, columbite, tantalite, tungsten, molybdenum, nickel, cobalt, Chromium, titanium); non-ferrous metals (Copper, lead, zinc, aluminium, tin); precious metals (gold, silver, platinum); radioactive elements (uranium, thorium).
Mineral deposits in Nigeria – metallic, non-metallic, radioactive, industrial rocks and minerals in Nigeria (Talc, clay, limestone, marble, asbestos, serpentine, e.t.c), their possible uses in industry. Basement complex metallogeny – spatial distribution; prospects of future. Methods of acquisition and exploitation on mineral deposits in Nigeria.

SGE 510: Seminar **(2 Units)**
Literature search, write-up and seminar presentation on a topic in Geology.

SGE 514: Marine Geology **(2 Units: LH 30)**
Elements of physical, chemical and biological oceanography methods of ocean floor sampling and probing; structure and physiography of ocean basins; distribution of marine sediments and mineral resources; beach erosion and coastal management.

SGE 516: Regional Geology of Africa **(2 Units: LH 30)**
Geology, structure, and evolution of African Precambrian domains and their radiometric ages; development of phanerozoic interior and coastal basins in Africa with emphasis on Nigeria.

3.19.21 Course Structure of Chemical/Petroleum Technology Techniques

Course Structure at 200 Level: Chemical/Petroleum Technology

Course Code	Course Title	Units	Status	LH	PH
CSC 201	Computer Programming I	3	E	30	45
GLT 201	Instrument Maintenance	2	C	15	45
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MTH 201	Mathematical Methods I	3	R	45	-
SCH 201	Inorganic Chemistry I	3	R	30	45
SCH 203	Organic Chemistry I	3	R	30	45
SCH 205	Physical Chemistry I	3	R	30	45
SCP 200	Industrial Process Calculations	3	R	45	-
SCP 201	Thermodynamics	3	R	45	-
SCP 203	Applied Mechanics	2	R	30	-
STA 202	Statistics for Physical Sciences & Engineering	4	E	60	-
	Total	**37**			

Course Structure at 300 Level: Chemical/Petroleum Technology

Course Code	Course Title	Units	Status	LH	PH
CSC 202	Computer Programming II	3	E	30	45
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
SCP 301	Chemical Thermodynamics	3	R	45	-
SCP 302	Introduction to Transfer Processes	3	R	45	-
SCP 303	Technology of Materials	2	R	15	45
SCP 304	Chemical Reaction Technology	3	R	30	45
SCP 305	Petroleum Chemistry	3	R	45	-
SCP 306	Mass Transfer	3	R	30	45
SCP 307	Applied Fluid Mechanics	2	R	30	-
SCP 308	Heat Transfer	3	R	45	-
SCP 309	Metallurgy	3	R	30	45
SCP 310	Chemical Technology of Petroleum	3	R	45	-
SCP 314	Strength of Materials	3	R	30	45
	Total	**40**			

Course Structure at 400 Level: Chemical/Petroleum Technology

Course Code	Course Title	Units	Status	LH	PH
GLT 401	Laboratory Organisation and Management	3	C	30	45
SCH 407	Instrumentation & Analytical Chemistry II	3	R	30	45
SCP 401	Particulate Mechanics	2	R	30	-
SCP 402	Industrial Attachment (24 Weeks)	6	C		
SCP 405	Polymer Science & Technology	3	R	45	-
SCP 407	Petroleum Production Technology	3	R	30	45
SCP 409	Technology of Fossil Fuel Processing	3	R	45	-
SCP 410	Chemical Technology Practical I	2	C	-	90
	Total	**25**			

Course Structure at 500 Level: Chemical/Petroleum Technology

Course Code	Course Title	Units	Status	LH	PH
GLT 501	Photography and Illustration	2	C	15	45
GLT 508	Laboratory Organisation & Management II	3	C	30	45
SCP 501	Environmental Technology	3	R	45	-
SCP 502	Process Design	2	R	30	-
SCP 503	Process Control	3	R	30	45
SCP 504	Biochemical Engineering	3	R	30	45
SCP 505	Process Optimization Engineering	2	R	30	-
SCP 506	Chemical Technology Practical II	2	C	-	90
SCP 509	Pulp and Paper Technology	2	C	30	-
SCP 510	Seminar	2	C	C	
SCP 511	Project	6	C	-	270
	Total	**30**	C		

3.19.22 Course Synopses: Chemical/Petroleum Technology Techniques

SCP 200: Industrial Process Calculations (3 Units: LH 45)
Units and dimensions. Stoichiometry; Vaporization Processes. Material balance involving chemical reactions. Heat balance; simultaneous heat and mass balances. Unsteady state heat & mass balances. Introductory Process Economics.

SCP 201: Thermodynamics (3 Units: LH 45)
Definition of terms and general concepts of system, surrounding, process, temperature heat, work & energy. First Law of Thermodynamics; application to open systems. Second Law of Thermodynamics; application to heat engines. Entropy. First and second laws combined. Perfect gases. Joule Thompson coefficient. Equilibrium processes. Maxwell's relations; two phase system thermodynamic functions of solution P-V-T relationship; work from heat energy

SCP 203: Applied Mechanics (2 Units: LH 30)
Vectors, operations with forces, resultants of coplanar force systems. Resultant of spatial force systems. Equilibrium and coplanar force systems. Centre of gravity, centre of mass.

Newton's laws of motion and their applications; impulse and momentum. Kinematics of a point, composition and resolution of velocities and accelerations; relative velocity and acceleration, representation by vectors. Plane kinematics of rigid body; angular velocity diagrams applied to simple mechanisms; instantaneous centre of rotation. Equations of motion, linear momentum and moment of momentum. Kinetic energy, moment of inertia. Free vibrations of systems with one and two degrees of freedom including damping-tensional vibration.

SCP 301: Chemical Thermodynamics (3 Units: LH 45)

Generalised P-V-T relations. The P-V-T behaviour of pure substances. Equation of state for gases. The principle of corresponding state. Compressibility relations, reduced pressure, reduced volume, temperature, pseudo-critical constants. P-V-T approximations for gaseous mixture-ideal gas mixtures. Dalton's law of additive pressure; Amagat law of additive volumes. Pseudo-critical point method. Kay's rule. Gilliland's method Behaviour of liquids.

Heat Effects: Heat capacities as a function of temperature. Heat effects accompanying phase change-Clausius-Clapeyron equation. Standard heats of reaction, formation and combustion. Effect of temperature on heat of reaction. Heats of mixing and solution. Enthalpy concentration diagrams for H_2SO_4/H_2O, etc. Partial enthalpies: single and multiple effect evaporators with regards to heat effects.

Industrial Stoichiometry. Gas analysis – Orsat methods, determination of components in fuels. Calculations based on fuel reaction for nitrogen and oxygen in the fuel: correction for sulphur; calculation based on fuel-gas analysis. Net hydrogen-carbon ratio in the fuel and percent excess air. Air/fuel and fuel-gas/air ratios. Interrelations of fuel and fuel-gas analysis. High nitrogen fuels. Mixed fuels.

Thermodynamics of Flow Processes: Fundamental equations: continuity equation, equation of motion, energy equation. Bernoulli's equation. Flow in pipes, laminar and turbulent flows, Reynolds numbers, friction factor-fanning equation. Flow meters. Nozzles. Compressors, single and multistage, effect of clearance.

Phase Equilibria: Criteria of equilibrium. Fugacity of a pure component. General fugacity relations for gases. Fugacities of gas mixture. Effects of temperature and pressure on fugacity. Pressure temperature composition relationship. Phase behaviour at low and elevated pressure. Raoult's Law, Henry's Law. Equilibrium constant; Activity coefficient, Gibbs-Duhem equation; Margules and Van Laar equations.

Chemical Reaction Equilibrium: Standard free energy change and equilibrium constant. Evaluation of equilibrium constants. Effects of temperature and pressure on equilibrium constants. Calculation of conversion. Gas-Phase reactions, percent conversion. Liquid-phase reactions, heterogeneous reactions.

SCP 302: Introduction to Transfer Processes (3 Units: LH 45)

Basic laws of mass momentum and energy transfer processes and their relationship. Simple problems involving dimensionless groups such as Re, Sc, Pr, Measurement, calculation & prediction of transport coefficient.

SCP 303: Technology of Materials (2 Units: LH 15; PH 45)
Structure of matter. Crystal imperfection. Simple phase diagrams of alloys. Physical properties of materials (i.e. wood, cement, plastics, and alloys). Mechanical properties of engineering materials. Engineering and true stress-strain curve. Ultimate strength, ductile, impact strength, hardness, torsion, creep and fatigue failure. Electrical properties – conductivity, semi-conductivity and super conductivity. Optical properties.

SCP 304: Chemical Reaction Technology (3 Units: LH 30; PH 45)
Review of fundamentals of chemical thermodynamics and of chemical kinetics, as would be relevant to reactor design. Homogenous reactions: analysis of constant-volume batch reactor and variable-volume batch reactor. Design of single homogenous ideal batch, ideal flow and ideal back-mix flow reactors. Temperature effects on yield and selectivity timer distribution.

SCP 305: Petroleum Chemistry (3 Units: LH 45)
Origin of petroleum. Exploitation technique. Parameters for evaluation (grading). Constituents; fractionation and methods of identification. Chemistry of refining processes. Characteristics and uses of refinery products. Economic aspects of crude petroleum oil pollution and its control.

SCP 306: Mass Transfer (3 Units: LH 30; PH 45)
Review of theories for prediction of mass coefficients. Application of distillation; extractive and azeotropic distillation.
Multi-component distillation, gas absorption, liquid/liquid extraction, drying, leaching and humidification.

SCP 307: Applied Fluid Mechanics (2 Units: LH 30)
Fluid statics; Newtonian and non-Newtonian fluids. Forces on submerged surfaces, Equations of fluid motion. Flow measurements, forces exerted by flowing fluids, laminar and turbulent flow. Reynolds number, flow in pipes and channels, dimensional analysis, one, two or three-dimensional steady flows of a comprehensible fluid, critical flow, small amplitude waves, shock waves; fluid machinery.

SCP 308: Heat Transfer (3 Units: LH 45)
Nature of processes of conduction, convection and radiation. Definition of thermal conductivity and heat-transfer coefficients. Conducting through materials with constant and varying heat-transfer areas. Unsteady-state conduction: Solution of equations for simple cases.
Schmidt's methods: Dimensional analysis and heat transfer by convection, forced convection inside and outside tubes and tube bundles. Thermal boundary layer. Reynolds analogy and its developments. Heat exchangers – log mean temperature difference in single and multiple gas exchangers; calculation of heat transfer coefficient. Optimum design. Calculation of net heat exchange between bodies – multiple reflection and net radiation methods. Radiation from gases.

Heat transfer during condensation of vapours. Derivation of Nussle equation. Drop – wise and film-wise condensation. Effect of non-condensable gases. Heat transfer to boiling liquids.

SCP 309: Metallurgy (3 Units: LH 30; PH 45)
Introduction to Metallurgy, Hardening of metals. Deformation and Annealing of metals. Corrosion annealing of metals. Corrosion and oxidation phenomena. Alloy steels stainless, creep of metal joining. The measurement of temperature. Electrical and magnetic alloys. Copper and its alloys. Polymers. Aluminium, magnesium and light alloys. Titanium and other flow metals.

SCP 310: Chemical Technology of Petroleum (3 Units: LH 45)
Desalination processes. Atmospheric and vacuum distillation of petroleum and petroleum fractions. Gasoline stabilization and sweetening. Properties of fuels, octane number, etc. Hydrocarbon gas purification and separation. LPG Production. Gas Processing – alkylation and polymerization. Thermal processes – cooking, thermal cracking and pyrolysis. Catalytic reforming and isomerisation.

SCP 314: Strength of Materials (3 Units: LH 30; PH 45)
Force equilibrium free body diagrams. Elasticity – concept of stress, strain tensile test. Young's modulus and other strength factors. Axially loaded bars, composite bars, temperature stress and simple indeterminate problems. Hoop stresses in cylinders and rings, bending moment, shear force and axial force diagrams for simple cases. Simple torsion and application. Advance topics on bending moments and shear force in beams. Theory of bending of beams. Deflection of beams. Unsymmetrical bending and shear centre. Application strain energy. Biaxial and triaxial state of stress. Transformation of stresses. Mohr's circle. Failure theories, springs, creep, fatigue, fracture and stress concentration.

SCP 401: Particulate Mechanics (2 Units: LH 30)
Particle-Fluid Mechanics: Motion of single particles and drops in a fluid. Terminal falling velocities. Flow past sphere assemblies. Effect of particle concentration on soning rate. Thickener calculations. Centrifuging-characteristics of a rotating fluid. Principles of separation by sedimentation and centrifuging. Types of centrifuges.

SCP 402: Industrial Attachment (24 Weeks) (6 Units)
Students should be attached to appropriate industries for a continuous period of 24 Weeks for relevant industrial experience. Assessment should be based on written report, seminar presentation and supervisors' reports.

SCP 405: Polymer Science and Technology (3 Units: LH 45)
Introduction to polymers and their characteristics, Sources of polymers. Structure and physical properties of polymers, theology, solution and molecular weights. Plasticity and elasticity. Polymerisation reactions and manufacturing methods. Zeigler Natta catalysis. Processing and technology of polymers.

SCP 407: Petroleum Production Technology (3 Units: LH 30; PH 45)
Origin of Oil, conditions necessary for the accumulation of oil. Drilling fluids, hole control. Basic petroleum physics, measurement of resistivity, porosity and other petrophysical properties. Reserves, measurement and production. Models of oil reservoirs. Material balances for gas drive, solution drive and water drive fields. Elementary oil production engineering.

SCP 409: Technology of Fossil Fuel Processing (3 Units: LH 45)
Source, availability and characterization of fossil fuel (petroleum, natural gas, tar sands, coal). Modern processing technology; choice of product lines and products, alternative product lines and product specifications should be emphasised.

SCP 410: Chemical Technology Practical I (2 Units: PH 90)
Series of experiments designed to emphasise the practical aspects of most of the courses taught at the 400 Level.

SCP 501: Environmental Technology (3 Units: LH 45)
Pollution and the Environment-definitions and inter-relationships, natural and man-made pollution the economics of pollution. Air pollution-gaseous and particulate pollutants and their sources. Effects on weather, vegetation materials and human health. Legislation relating to air pollution. Methods of control of gaseous emission and destruction, cyclones inertial, separators, electrostatic precipitators, bag filters, wet washers etc. dispersal form chimneys and method of calculating chimney height. Flare stacks.
Water pollution-river pollution by industrial effluents legislation and standards for effluent discharge. Impurities in natural and their effects. Brief survey of river ecology and the effects of effluents on the ecosystems Treatment processes including precipitation flocculation coagulation sedimentation, clarification and colour removal. Principles of biological treatment processes. Cost of treatment. Treatment for water re-use, on exchange. Cooling water treatment. Land Pollution – Disposal of solid wastes by incinerator and dumping. Possible future trends including conversion of solid wastes into useful materials or energy. Treatment of other types of pollutions-noise. Thermal and Nuclear pollutions.

SCP 502: Process Design (2 Units: LH 30)
Presentation and discussion of real process design problems. Block diagrams, process and engineering flow diagrams, process outline charts incorporating method study, and critical examination. Specification of vessels, examples include distillation towers and ancillaries, heat exchangers, vaporiser and knock-out vessel. Emphasis on conception and invention of processes as well as analysis and economic balance to specify optimum design and operating conditions Discussion of a variety of cases throughout the course.

SCP 503: Process Control (3 Units: LH 30; PH 45)
Classical control theory. Transfer function. Time and frequency response, stability theory. Root locus method. Control system designs. Instrumentation modern control theory. Observability and controllability. State – space analysis. Introductory sample data analysis. Control of distillation columns, reactors and heat exchangers.

SCP 504: Biochemical Engineering **(3 Units: LH 30; PH 45)**
Aspects of living processes. Microbiology and control of microorganisms. Microbial kinetics. The Biochemistry and physicochemical properties of biological compounds. Biochemical pathways and metabolism of simple substrates. Fermentations. Enzyme kinetics. Biochemical reactors. Design of microbial culture processes in the manufacture of pharmaceuticals, commercial enzymes and alcoholic beverages. Batch and continuous culture. Biological waste disposal

SCP 505: Process Optimisation Engineering **(2 Units: LH 30)**
Stationary Optimisation: Differential approach, numerical approach, linear and non linear programming. Trajectory optimisation including dynamic programming and calculus of variation. Numerical computational techniques including first & second order methods.

SCP 506: Chemical Technology Practical II **(2 Units: PH 90)**
Series of laboratory experiments designed to emphasise the practical aspects of many of the 500 Level courses.

SCP 509: Pulp and Paper Technology **(2 Units: LH 30)**
Cellulose and hemi-cellulose structures and characteristics. Lignin. Pulp-types and properties. Types of pulping processes – sulphite, alkaline, mechanical, semi-chemical etc. Bleaching, fibre preparation, nature of fibre bonding. Sheet formation. Water usage and disposal in pulp and paper industries. Colouring properties of paper, pigment, coating printing and laminating.

SCP 510: Seminar **(2 Units)**
Seminar presentation on current topics in chemical and petrochemical technology.

SCP 511: Research Project **(6 Units: PH 270)**
A research project involving an investigation on a selected chemical/petrochemical petrochemical problem.

3.19.23 Course Structure of Physiology/Pharmacology Techniques

Course Structure at 200 Level: Physiology/Pharmacology Techniques

Course Code	Course Title	Units	Status	LH	PH
GLT 201	Instrument Maintenance I	2	C	15	45
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
SCH 201	Inorganic Chemistry I	3	E	30	45
SCH 202	Analytical Chemistry I	3	R	30	45
SCH 203	Organic Chemistry I	3	R	30	45
SCH 205	Physical Chemistry I	3	E	30	45
SPP 201	Introduction to Physiology	2	R	30	-

SPP 202	Introductory Pharmacology	3	C	45	-
SPP 203	Blood and Body fluids	2	R	30	-
SPP 204	Autonomic Nervous System	3	R	45	-
SPP 205	Cardiovascular System	2	R	30	-
SPP 206	Central Nervous System	3	R	30	45
SPP 207	Renal System	2	R	15	45
SPP 209	Respiratory System	2	R	30	-
SPP 211	Alimentary System	2	R	30	-
SPP 213	Practical Physiology	2	R	-	90
	Total	**45**			

Course Structure at 300 Level: Physiology/Pharmacology Techniques

Course Code	Course Title	Units	Status	LH	PH
GST 222	Peace Studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
SCH 303	Organic Chemistry II	3	R	30	45
SCH 305	Physical Chemistry II	2	R	15	45
SPP 301	Principles of Drug Action	3	C	30	45
SPP 302	Hypertension	3	R	30	45
SPP 303	Parasympathetic/Sympathetic	3	R	30	45
SPP 304	Sex Organs and Sex Hormones	3	R	30	45
SPP 305	Toxicology	3	R	30	45
SPP 306	Practical Pharmacology	2	C	-	90
SPP 307	Instrumentation	3	C	15	90
SPP 308	Animal Management	3	C	15	90
STA 201	Statistics for Agriculture & Biological Sciences	4	E	60	-
	Total	**38**			

Corse Structure at 400 Level: Physiology/Pharmacology Techniques

Course Code	Course Title	Units	Status	LH	PH
GLT 401	Laboratory Organization and Management I	3	C	30	45
SPP 401	Central Nervous System Pharmacology	3	C	45	-
SPP 402	Industrial Attachment (24 Weeks)	6	C		
SPP 403	Pharmacology of pain	3	R	30	45
SPP 405	Psychopharmacology	2	R	30	-
SPP 407	Antidepressant drugs	3	R	45	-
SPP 409	Antiepileptic drugs	3	R	45	-
SPP 411	Convulsant agents	3	R	45	-
	Total	**26**			

Course Structure at 500 Level: Physiology/Pharmacology Techniques

Course Code	Course Title	Units	Status	LH	PH
GLT 501	Photography and illustration	2	C	15	45
GLT 508	Laboratory Organization and Management II	3	**C**	30	45
SPP 501	Principles of Chemotherapy	3	R	30	45
SPP 502	Ethnopharmacology	3	R	30	45
SPP 503	Antiparasitic Drugs	3	R	45	-
SPP 504	Seminar	2	C		
SPP 505	Practical Physiology	3	C	15	90
SPP 506	Practical Pharmacology	3	C	15	90
SPP 507	Research Project	6	C	-	270
SPP 508	Breeding and Care of Laboratory Animals.	2	R	15	45
SPP 509	Gastrointestinal Physiology	3	R	30	45
SPP 513	Alcoholism and Drug Therapy	2	E	30	-
	Total	**35**			

3.19.24 **Course Synopses: Physiology/Pharmacology Techniques**

SPP 201: Introduction to Physiology **(2 Units: LH 30)**
Introduction and history of Physiology. Structure and functions of cell membranes. Transport process. Biophysical principles. Homeostasis and control systems including temperature regulation. Blood – functions of erythrocytes, leukocytes and thrombocytes. Blood groups.

SPP 202: Introductory Pharmacology **(3 Units: LH 45)**
Definition of pharmacology. History of pharmacology and the relationship of pharmacology to physiology and clinical subjects. Sources and types of drugs. Classification, sites and mechanisms of drug action. Drug receptors and interaction of agonists and antagonist. Methods of drug administration. Principles of drug absorption. Drug biotransformation. Drug excretion.

SPP 203: Blood and Body Fluids **(2 Units: LH 30)**
Blood and Body fluids. Composition of blood and lymph. Chemistry of blood plasma and serum proteins. Red blood cell functions, white blood cell functions. Defence mechanisms, antibody-antigen interactions. Mechanism of blood coagulation. Blood disorders and treatment.

SPP 204: Autonomic Nervous System **(3 Units: LH 45)**
Anatomical and functional organization of the Autonomic Nervous System (ANS). Sympathetic and parasympathetic systems. Sympathetic transmission – synthesis, storage, release and distribution of noradrenalin. Evidence for noradrenalin as a neurotransmitter. Parasympathetic – synthesis storage, release and distribution of acetylcholine. Neuromuscular transmission .

SPP 205: Cardiovascular System **(2 Units: LH 30)**
Anatomy and physiology of the heart. The electrocardiogram. Principles of blood circulation (systemic, pulmonary and coronary). Cardiac output; arterial, venous and capillary pressures. Control of blood pressure. Auto-nervous and normal regulations. Cardiac failure and hypertension.

SPP 206: Central Nervous System **(3 Units: LH 30; PH 45)**
Spinal cord and pathways. Control of muscle movement. Cortical and cerebellar control of motor functions basal ganglia and control of movement. Transmission and processing of information. The reticular activating system .Wakefulness, sleep and attention – EEG waves. The limbic system and emotions.

SPP 207: Renal System **(2 Units: LH 15; PH 45)**
Anatomy and functions of the kidney; formation of urine, micturition. Regulation of extracellular fluids – diuretics. Regulation of acid-base balance. Therapeutic alterations of urinary pH. Renal disease and treatment. Control of body pH. Some selected practicals on the above.

SPP 209: Respiratory System **(2 Units: LH 30)**
Physiology of the respiratory system. Pulmonary ventilation. Mechanism of breathing. Volumes, pressure and composition of respiratory gases. Mechanism of and factors affecting gaseous exchange. Diffusion of oxygen and carbon dioxide through the respiratory membrane. Transport of oxygen and carbon dioxide in the blood and body fluids. Nervous and chemical control of respiration. Respiratory insufficiency. Extraneous influences affecting respiration. Drugs affecting respiration and respiratory disorders.

SPP 211: Alimentary System **(2 Units: LH 30)**
Physiology of the alimentary tract. Movement of food through the alimentary canal. Secretary functions of the alimentary tract digestive juice. The liver and biliary system. Absorption and storage of metabolites of carbohydrates, proteins and fat metabolism. Water absorption in the large intestine. Defecation and cathartics. Diseases of the alimentary system.

SPP 213: Practical Physiology **(2 Units: PH 90)**
Practical involving the anatomical and functional organizations of autonomic (parasympathetic and sympathetic) and central nervous systems and reproductive systems. Introductory practical knowledge on effects of drugs on selected tissues.

SPP 301: Principles of Drug Action. **(3 Units: LH 45)**
Therapeutic index. Principles, design and types of bioassay. Routes of drug administration, factors determining absorption, distribution and excretion of drugs. Drug dosage regimen. Introduction to drug metabolism enzyme induction and drug interaction. Introduction to pharmacokinetics.

SPP 302: Hypertension (3 Units: LH 45)
Types of antihypertensive drugs and mechanisms of action. Diuretics, vasodilators and antianginal drugs – cardiac glycosides, quinidine and quinidine-like drugs; antiarrhythmic drugs. Calcium channel blockers, histamines, 5-hydroxypahmine, prostaglandins and their antagonists. Leukotrienes and their roles.

SPP 303: Parasympathetic/Sympathetic (3 Units: LH 45)
Pharmacology of drug affecting cholinergic nerve transmission. Site of action – Cholinergic receptors and classification. Cholinesterases and anticholinesterases. Pharmacology of drugs affecting adrenergic nerve transmission, storage uptake and release of catecholamine, structure-activity relationships in sympathomimetic amines.

SPP 304: Sex Organs and Sex Hormones (3 Units: LH 45)
Types and functions of sex hormones. Pregnancy and lactation; contraceptive steroids and fertility regulation. Reproductive System – Anatomy and physiology of sex organs.

SPP 305: Toxicology (3 Units: LH 30; PH 45)
Origin and scope of toxicology. Toxicological evaluation. Purpose and value of ED_{50} and LD_{50} determination, acute and chronic poisoning in rabbits. Metabolism of some toxic substances. Systemic toxicology. Management of drug poisoning. Forensic toxicology. Cosmetics and food additives testing. Procedures for analysis of toxicological agents by use of TLC, UV, IR, NMR, HPLC for qualitative and quantitative assay.

SPP 306: Practical Pharmacology (2 Units: PH 90)
Relevant experiments designed to enhance students' grasp of theoretical aspects of pharmacology.

SPP 307: Instrumentation (3 Units: LH 15; PH 90)
Introduction to the apparatus and instruments used for experimental physiology

SPP 308: Animal Management (3 Units: LH 15; PH 90)
Design of animal house for various colonies of laboratory animals; Breeding and handling methods; diseases and control of infections; collection of blood and humane killing methods e.g. physical and chemical means; routes of drug administration; laws governing the use of laboratory animals.

SPP 401: Central Nervous System Pharmacology (3 Units: LH 45)
Central neurotransmitters. Local and general anaesthetics; differentiation of action.

SPP 402: Industrial Attachment (24 Weeks) (6 Units)
Students should be attached to good laboratories in pharmaceutical establishments or top class hospitals/related units for a period of 6 months for appropriate practical experience. Assessment should be based on written report, seminar presentation and supervisors' assessments.

SPP 403: Pharmacology of Pain (3 Units: LH 30; PH 45)

Definition, types, characteristics and patho-physiology of pain, inflammation and anaphylaxis. Experimental models and screening techniques for analgesics and anti-inflammation agents. Evaluation of analgesic activity, hot plate method. Aspirin, morphine, mechanism of antipyretic and inflammatory analgesics; opiates and receptors. Tolerance and dependence. Anxiety-reducing drugs, sedatives and hypnotics, antipsychotic drugs.

SPP 405: Psychopharmacology (2 Units: LH 30)

History of Psychopharmacology. Blood-Brain barrier and other membrane phenomenon in psychopharmacology. Behavioural pharmacology of CNS stimulants. Drug abuse and drug addiction. Clinical uses of psychotherapeutic agents. Toxicology of psychotherapeutic agents.

SPP 407: Antidepressant Drugs (3 Units: LH 45)

Types of antidepressant drugs – tricyclics – typical and atypical modes of action and side effects

SPP 409: Antiepileptic Drugs (3 Units: LH 45)

Epilepsy – types of seizures and drugs used in each case

SPP 411: Convulsant Agents (3 Units: LH 45)

Strychnine, bicuculine picrotoxin, tetanus toxin. Psychotominetic drugs. Physico- and neuropharmacology practicals on the aetiology of cancer, bacterial infections, and common tropical diseases, and the various pathophysiological states associated with these diseases. The mechanisms of actions of the various chemotherapeutic drugs and their toxic agents. The chemistry and the structural activity relationship of these therapeutic agents. The mechanisms of drug resistance, role of immunity in chemotherapy and the rationale for combination therapy.

SPP 501: Principles of Chemotherapy (3 Units: LH 30, PH 45)

The chemistry and mechanisms of action of anti-parasitic, antimicrobial and anti-neoplastic agents, anti-malarials, and antiviral agents. Drugs used in treatment of tuberculosis and leprosy. Anti-retroviral drugs. Vaccines and sera.

SPP 502: Ethnopharmacology (3 Units: LH 30; PH 45)

Definitions, historical and religious basis of ethnomedicine. Traditional medicine in folklore. Race and cultural influence of traditional medicine. Important plants and animal sources of modern medicine; from *Cinchona* bark to *Artemesia*. Scientific methods of evaluation of herbal preparations.

SPP 503: Anti-parasitic Drugs (3 Units: LH 45)

Trypanocides – schistomicides and amoebicides Resistance to chemotherapeutic agents antimalarias and antibiotics

SPP 504: Seminar (2 Units)

Literature review and seminar presentations on topics of current interest in pharmacology or physiology

SPP 505: Practical Physiology (3 Units LH 15; PH 90)

General principles of toxicity testing. Organotoxicity – oculartoxicity, nephrotoxicity and hepatotoxity. Adverse drug interactions and generic components in clinical practice. Agricultural, environmental and industrial toxicology. Principles of antidotal treatment, Cancinogenesis and teratogenesis. Toxicological evaluation of a new drug. Post-marketing surveillance of drugs.

SPP 506: Practical Pharmacology (3 Units: LH 15; PH 90)

General principles of drug quality control and assurance systems. Structural organization and functions of a Quality Control Department. Sources of impurities in pharmaceutical substances, quality variation of pharmaceutical products. Application of chemical and physicochemical analytical techniques in purity determination, identification and quantification of drugs in pharmaceutical and radiopharmaceutical preparations, including multi-component formulations from a regulatory and quality control standpoint.

Evaluation of crude drugs. Microbiological evaluation of sterile and non-sterile pharmaceutical products. Practical work should involve comprehensive analysis of some selected raw materials and finished drug products. It should be supplemented by visits to local manufacturing units where students may examine the practice of quality control.

SPP 507: Research Project (6 Units: PH 270)

Research project on a topic of interest in pharmacology or physiology. The project should involve literature review, experimental work and written report.

SPP 508: Breeding & Care of Laboratory Animals (2 Units: LH 15; PH 45)

Care of laboratory animals. Breeding of different laboratory animals.

SPP 509: Gastrointestinal Physiology (3 Units: LH 30; PH 45)

Digestive secretions – their composition, function and control mechanism of the alimentary canal. Gastric acid and histamine and gastrin metabolism. Gastrointestinal motility. Basic experimental techniques on gastrointestinal physiology.

SPP 513: Alcoholism and Drug Therapy (2 Units: LH 30)

Definition and classification of alcohols. Sources and uses of alcohols. Pharmacology of ethanol, pharmacokinetics, pharmacological action on body systems, metabolism and excretion, effects of ethanol and drug metabolizing systems. Therapeutic uses of ethanol. Classification and alcohol contents of alcoholic beverages, intoxication definition.

3.20 STATISTICS (BSc)

3.20.1 Philosophy, Aims and Objectives of the Degree Programme

The aims and the objectives of the Bachelor Honours Degree programme in Statistics should be:

a. To instil 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.

b. To provide students a broad and balanced foundation in Statistics knowledge and practical skills in Statistics.

c. To develop in students the ability to apply their Statistics knowledge and skills to the solution of theoretical and practical problems in Statistics.

d. To develop in students, through an education in Statistics, a range of transferable skills of values in Statistics related and non-Statistics related employment.

e. To 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.

f. To generate in students an appreciation of the importance of Statistics in industrial planning, economic planning, environmental and social planning.

3.20.2 Admission and Graduation Requirement

UTME

The entry requirements shall be at least credit level passes in five subjects including English Language, Mathematics and Physics to form the core subjects and any other two relevant science subjects at the Senior Secondary School Certificate 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.

3.20.3 Learning Outcomes

a) *Regime of Subject Knowledge*

All bachelors honours level, Statistics graduates are expected to develop cognitive abilities and skills relating to statistics.

b) *Competencies and Skills*

They should be able to demonstrate practical skills relating to the solution of statistical problems and its applications.

c) *Behavioural Attitudes*

They should be able to demonstrate general skills relating to non-subject specific competencies, ICT capability, communication skills, interpersonal skills and organization skills.

3.20.4 Attainment Levels

Graduates of Statistics are expected to have the ability to apply knowledge and skills to solving theoretical and practical problems in Statistics and other related areas in relation to national and societal needs.

3.20.5 Resource Requirement for Teaching and Learning

a) Academic and Non-Academic Staff (See Section 1.6)
b) Academic and Non-Academic Spaces (See Section 1.6)
c) Academic and Administrative Equipment (See section 4)
d) Library and Information Resources (See section 1.6)

3.20.6 Course Structure

Course Structure at 100 Level Statistics

Course Code	Course Title	Units	Status	LH	PH
CSC 101	Introduction to Computer Science	3	R	30	45
CSC 102	Introduction to Problem Solving	3	R	30	45
GST 111	Communication in English I	2	C	30	-
GST 112	Logic, Philosophy & Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	E	30	-
GST 121	Use of Library, Study Skills & ICT	2	C	30	-
MTH 101	Elementary Mathematics I	3	R	45	-
MTH 102	Elementary Mathematics II	3	R	45	-
PHY 101	General Physics I	3	E	45	-
PHY 102	General Physics II	3	E	45	-
PHY 107	General Practical Physics I	1	E	-	45
PHY 108	General Practical Physics II	1	E	-	45
STA 111	Descriptive Statistics	4	C	60	-
STA 112	Probability I	4	C	60	-
STA 121	Statistical Inference I	4	C	60	-
STA 131	Statistical Computing I	3	C	15	90
	Total	**43**			

PLEASE NOTE: Conclusive statement shall be made on the minimum CGPA of 1.5 for graduation after the forthcoming workshop on Grading System

Course Structure at 200 Level Statistics

Course Code	Course Title	Units	Status	LH	PH
CSC 201	Computer Programming I	3	R	30	45
CSC 204	Fundamentals of Data Structures	3	R	30	45
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MTH 202	Elementary Differential Equations	3	R	45	-
MTH 204	Linear Algebra I	2	R	30	-
MTH 209	Introduction to Numerical Analysis	3	R	45	-
STA 201	Statistics for Agriculture & Biological Sciences	4	-	60	-
STA 202	Statistics for Physical Sciences & Engineering	4	-	60	-
STA 211	Probability II	4	C	60	-
STA 212	Introduction to Social & Economic Statistics	3	C	45	-
STA 221	Statistical Inference I	4	C	60	-
STA 231	Statistical Computing II	2	C	-	90
STA 299	Industrial Attachment I (12 Weeks)	3	C		
	Total	**46**			

Course Structure at 300 Level Statistics

Course Code	Course Title	Units	Status	LH	PH
GST 222	Peace studies and Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
MTH 201	Mathematical Methods I	3	R	45	-
STA 311	Probability III	4	C	60	-
STA 312	Distribution theory I	4	C	60	-
STA 321	Statistical Inference III	4	C	60	-
STA 322	Regression and Analysis of Variance I	2	C	30	-
STA 323	Design and Analysis of Experiments I	3	R	45	-
STA 324	Survey methods and sampling theory	3	R	45	-
STA 331	Statistical Computing III	2	R	-	90
STA 332	Laboratory /Field-work for Experimental design	2	R	-	90
STA 333	Laboratory/field-work for survey methods and sampling theory	2	R	-	90
STA 399	Industrial Attachment II (12 Weeks)	3	C		
	Total	**38**			

Electives

Course Code	Course Title	Units	Status	LH	PH
CSC 321	Systems Analysis and Design	3	E	30	45
MTH 310	Mathematical Methods II	3	E	45	-
STA 341	Statistical Quality Control	3	E	45	-
STA 342	Demography I	3	E	45	-
STA 343	Operation Research I	3	E	45	-
STA 351	Biometric Methods	3	E	45	-
STA 399	Industrial Attachment II (12 Weeks)	3	C		

Course Structure at 400 Level Statistics

Course Code	Course Title	Units	Status	LH	PH
STA 411	Probability IV	3	E	45	-
STA 412	Distribution Theory II	4	C	60	-
STA 413	Statistical Inference IV	4	C	60	-
STA 414	Stochastic Processes	3	E	45	-
STA 415	Regression and Analysis of Variance II	4	C	60	-
STA 421	Time series Analysis	3	E	45	-
STA 422	Logical Background of Statistics & Decision Theory	4	C	60	-
STA 423	Design and Analysis of Experiments II	3	E	45	-
STA 424	Sampling Techniques	3	R	45	-
STA 431	Research Project	6	C		
	Total	**37**			

Other Electives

Course Code	Course Title	Units	Status	LH	PH
STA 441	Multivariate Data Analysis	3	E	30	45
STA 442	NonParametric Statistics	3	E	45	-
STA 443	Operations Research II	3	E	45	-
STA 444	Econometric Methods	3	E	45	-
STA 451	Biometric Methods II	3	E	45	-
STA 452	Psychometric Methods	3	E	45	-
STA 453	Bayesian Inference and Decision Theory	3	E	45	-
STA 454	Environmental Statistics	3	E	45	-
STA 455	Educational Statistics	3	E	45	-
STA 456	Health Statistics	3	E	45	-
STA 457	Medical Statistics	3	E	45	-
STA 458	Energy Statistics	3	E	45	-
STA 459	Demography II	3	E	45	-
STA 461	Actuarial Statistics	3	E	45	-

3.20.7 Course Synopses

STA 111: Descriptive Statistics: (4 Units: LH 60)

Statistical data: types, sources and methods of collection. Presentation of data: tables chart and graphs. Errors and Approximations. Frequency and cumulative distributions, Measures of location, partition, dispersion, skewness and Kurtosis. Rates, ratios and index numbers. Basic probability concepts; binomial, normal, Student's t and chi-square distributions. Hypothesis testing and confidence intervals for one and two means and proportions**.** Regression.

STA 112: Probability 1 (4 Units: LH 60)

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 (4 Units: LH 60)

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 131: Statistical Computing I (3 Units: LH 15; PH 90)

Introduction to computer: structure, involving, type, uses and applications. Computations (using computers and calculators), involving topics in STA111 and 121. Organizations of computations to access, transform, explore, analyse data and produce results. Concepts and vocabulary of statistical computing.

STA 201: Statistics for Agriculture and Biological Sciences (4 Units: LH 60)

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 (4 Units: LH 60)

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 (4 Units: LH 60)

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: LH 45)
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 I (4 Units: LH 60)
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: PH 90)
Uses of computers in statistical computing. Introduction to various statistical packages. Use of statistical packages in solving problems in statistics.

STA 299: Industrial Attachment I (12 Weeks) (3 Units)
Students should be attached to some relevant organizations for 12 Weeks at the 200 Level preferably during the long vacation for industrial experience. Students to be assessed based on seminar presentation, their reports and assessment by supervisors

STA 311: Probability III (4 Units: LH 60)
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 (4 Units: LH 60)
Distribution and frequency functions. Documents, cumulants and their generating functions. Some special univariate distribution. Laws of large numbers. Central limit theorem. Distribution: Stochastic independence. Bivariate moment generating functions of random variable. Bivariate distribution: Stochastic independence. Bivariate moment generating functions. Bivariate normal distributions. Distribution associated with the normal, X^2, t and F distribution

STA 321: Statistical Inference III **(4 Units: LH 60)**
Criteria of estimation consistency unbiasedness, efficiency, minimum variance and sufficiency, Methods of estimation; maximun 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: LH 30)**
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 323: Design and Analysis of Experiments I **(3 Units: LH 45)**
Basic principles of experimentation, Randomisation, replication and blocking. Local control. Basic designs: completely randomised, randomised blocks, Latin squares, Balanced incomplete blocks, split plot. Missing values. Relative efficiency. Estimation and tests of variance components. Multiple comparisons. Departures from underlying assumptions. Applications to agriculture, biology and industry.

STA 324: Survey Methods and Sampling Theory **(3 Units: LH 45)**
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 PH 90)**
Use of advanced statistical computing packages. Analysis of statistical and numerical algorithms. Introduction to Monte Carlo Methods.

STA 332: Laboratory/Field work on Experimental Design I **(2 Units: PH 90)**
Computations based on field and laboratory appraisal of some of the techniques and problems on experimental design.

STA 333: Laboratory/Field Work for Survey Methods & Sampling Theory **(2 Units: PH 90)**
Computations based on field and laboratory appraisal of techniques of survey methods and sampling theory.

STA 341: Statistical Quality Control **(3 Units: LH 45)**
Basic concepts; Standardization and specifications. Sources and detection of process variation. Control charts for attributes and variables and their properties: d, p, x and charts. Process capacity studies. Cumulative sum charts and their properties. Sampling inspection

for attributes and variables and their properties: single, double, multiple and sequential plans. Continuous sampling plans.

STA 342: Demography I **(3 Units: LH 45)**
Types and sources of demographic data. Methods of collection of Population censuses, sample surveys and vital registration. Evaluation of the quality of demographic data. Measures of fertility, mortality, nuptiality and migration. Standardization and Decomposition. Life tables: construction and application. Framework for developing demographic information systems.

STA 343: Operations Research I **(3 Units: LH 45)**
Nature and scope of operations research. Linear programming and graphical, simplex (including big M and two-phase) methods. Sensitivity analysis. Duality theory. Transportation and assignment problems. Network analysis: CPM and PERT. Inventory theory and applications. Sequencing and scheduling.

STA 351: Biometric Methods I **(3 Units: LH 45)**
Introduction to population genetics. Statistical methods in Biology. Sampling and estimating biological populations. Design and analysis of biological experiments. Design and analysis of clinical trials Bioassays: types and nature. Direct and indirect assays: Parallel line assays, slope ratio assays.

STA 399: Industrial Attachment II (12 Weeks) **(3 Units)**
Students should be attached to some relevant 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

STA 411: Probability IV **(3 Units: LH 45)**
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 **(4 Units: LH 60)**
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 **(4 Units: LH 60)**
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 414: Stochastic Processes (3 Unit: LH 45)
Generating functions: tail probabilities and convolutions. Recurrent events. Random walk (unrestricted and restricted). Gamblers ruin problem. Markov processes in discrete and continuous time. Poisson, branching, birth and death processes. Queuing processes: M/M/I, M/M/s, M/a/I queues and their waiting time distributions.

STA 415: Regression and Analysis of Variance II (4 Units: LH 60)
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 421: Time Series Analysis (3 Units: LH 45)
Estimation and isolation of components of time series. Time series relationships, cyclical behaviour, periodicity, spectral analysis, coherence, filtering, regression. Non-stationary and stationary processes: theoretical moments, auto – correlation and partial auto-correlation; Sample moments: auto-correlations; partial auto-correlations; univariate Time Series model: identification and estimation - Auto-regressive (AR), Moving Average (MA) and Auto regressive Moving (ARMA). Diagnostic checking of models, linear prediction and forecasting analysis.

STA 422: Logical Background of Statistics and Decision Theory (4 Units: LH 60)
Empirical sources of knowledge-hypothesis, observation and experiment. Deductive sources of knowledge and scientific attitude. The concept of causation. Probability, a brief historical treatment to show conflicting definitions. Bayesian statistics and the notion in inverse probability. The place of statistical methods in science. Principles of decision making. Utility functions and their properties. Role of uncertainty. Bayes Strategies. Problems of prior and posterior distributions: value of prior information Minimax strategies. Statistical inference. Theory of games.

STA 423: Design and Analysis of Experiments II (3 Units: LH 45)
Further split plot design and nested designs, unbalanced designs, incomplete block designs, 2’’ factorial designs, Yates – Algorithm confounding and fractional replication. Diallel cross Analysis. Introduction to response surface methodology.

STA 424 : Sampling Techniques (3 Units : LH 45)
Ratio, regression and difference estimation procedures. Double sampling. Interpreting scheme. Multiphase and multistage sampling, cluster sampling with unequal sizes; problem of optimal allocation with more than one item. Further stratified sampling.

STA 431: Research Project: (6 Units: PH 270)
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.

STA 441: Multivariate Data Analysis (3 Units: LH 30; PH 45)
Multivariate normal and related distributions. Inference about mean vectors. Mahalanobis distance, sampling distributions of the mean vector and covariance matrix; Hotelling's T^2; simultaneous inference Multivariate analysis of variance. Tests of independence and homogeneity. Discrimination and classification. Principal components and factor analysis. Canonical correlation analysis. Cluster analysis.

STA 442: Non-Parametric Methods (3 Units: LH 45)
Order statistics and their distributions. Tests based on runs. Tests of Goodness of Fit. One sample and two sample linear ranks tests for location and scale. Tests for independent samples. Measure of association for bivariate samples and multiple classifications.

STA 443: Operations Research II (3 Units: LH 45)
Integer programme problem: formulations and solution methods. Non – linear programming: search methods Newton-Raphson method, Frit-John optimality conditions and Lagrangian multipliers. Network analysis. Path methods including Bellman's equations, cyclic and network with positive paths. Dynamic programming: routine of problems, resource allocation and equipment replacement.

STA 444: Econometric Methods (3 Units: LH 45)
Nature of econometric. Econometric models: nature, types and characteristics. Econometric problems related to single equation models. Construction estimation and tests. Models involving lagged variables. Simultaneous equation systems; structural form, reduced form, identification, estimation and test. Application of econometric models: demand analysis, production functions, consumption and investment function.

STA 451: Biometric Theory II (3 Units: LH 45)
Stability models, simultaneous selections models. Path analysis. Discriminant analysis. Parallel line and slope ratio assays in completely randomized block and incomplete block designs. Logistic curve and logic transformations in relation to bio-assays.

STA 452: Psychometric Methods (3 Units: LH 45)
The foundations of mental measurement theory: Measurement in psychology and education. The construction of true and error scores. The classical test theory model: fixed length, variables length: Some estimates of parameters of the classical model. Other weak type – score models: parallel measurements. Types of reliability co-efficient and their estimation. Some test theory for equivalent measurements. Item, sampling in test theory and in research design.

STA 453: Bayesian Inference and Decision Theory (3 Units: LH 45)
Subjective probability, Bayes Theorem, conjugate priors, non-informative priors, estimation, testing, prediction, empirical Bayes methods, properties of Bayesian procedures, comparisons with classical procedures, approximation techniques, Gibbs sampling, hierarchical Bayesian analysis. Principles of decision-making. Roles of uncertainty, utility functions and their properties. Theory of games.

PLEASE NOTE: Conclusive statement shall be made on the minimum CGPA of 1.5 for graduation after the forthcoming workshop on Grading System

STA 454: Environmental Statistics **(3 Units: LH 45)**
Scope, nature and sources of environmental statistics. Assessment of environmental quality and measurement of air and water pollution. Sampling methods in natural and applied sciences. Environmental Impact Assessment. Requirement for environmental reporting system. Characteristics and uses of the United Nations frame work for the development of environmental statistics. Capacity development for environmental reporting system.

STA 455: Educational Statistics **(3 Units: LH 45)**
Scope, nature and uses of educational statistics. Sources and methods of collection of educational statistics. Educational indicators, Design of education information systems, Education flow models and performance evaluation, Multivariate methods in educational analysis, operations research in educational management.

STA 456: Health Statistics: **(3 Units: LH 45)**
Scope and types of health statistics. Classification of disease; injuries and causes of death. Sources and methods of collecting health statistics; census, sample surveys, vital registration and administrative statistics. Health indicators: types, uses and problems. Health systems. Health planning and financing. Health information systems. Operations research in the health services.

STA 457: Medical Statistics **(3 Units: LH 45)**
Scope and nature of medical statistics. Epidemiology methods: relative risks and odds ratios, adjustment of data with and without use of multivariate models, cohort studies (life tables). Competing risks, survival analysis. Sequential methods in clinical trials. Stochastic models epidemiology.

STA 458: Energy Statistics **(3 Units: LH 45)**
Energy sources: renewable and non-renewable, Nature, scope and uses of energy statistics. Concepts, definitions, and units of measurements in use in energy statistics. Energy production and consumption surveys. Data requirements and the procedure for developing an energy database. Constructing an energy balance sheet with Nigeria as a case study. Modelling energy supply and demand.

STA 459: Demography II **(3 Units: LH 45)**
Estimating fertility, mortality and nuptiality from limited and defective data. Stationary, stable and quasi-stable population models: theory and applications. Multiple decrement life tables. Population projections: mathematical models, component methods and matrix analysis. Path analysis and multiple classification analysis.

STA 461: Actuarial Statistics **(3 Units: LH 45)**
The time value of money; compound interest and discounting; present values and accumulated values of streams of payments. Decremental rates and other indices; Annuities and sinking funds; solving equations of value; Investment and Appraisal Techniques; Analysis of experiments data and derivation of exposed to risk formulae. Graduation methods (and their applications to curve fitting). Construction of mortality, sickness, multiple decrements and similar tables with applications to life insurance. National social security and pension schemes.

3.21 ZOOLOGY (BSc)

3.21.1 Philosophy, Aims and Objectives of the Degree Programmes.

The programme has been designed to provide a sound understanding of the concepts and methodologies of Zoology in key areas that meet the needs of society. The main objectives of the programme are to broadly educate students for positions in the conservation and bio-diversity sectors, and to prepare them for graduate and professional studies in the animal sciences.

3.21.2 Admission Requirements.

UTME

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 School Certificate Examination 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 two A level passes (graded A-E) at GCE Advanced Level or its equivalent in relevant subjects (Biology, Zoology, Botany, Chemistry, Mathematics and Physics) may be admitted into 200-Level.

3.21.3 Learning Outcomes

All Bachelors honours degree student in Zoology are expected to develop the following abilities and skills:

a. *Regime of Subject Knowledge*
Cognitive abilities and skills relating to solution of problems in Zoology

b. *Competencies and Skills*
Practical skills relating to the conduct of Laboratory and Field work in Zoology

c. *Behavioural Attitudes*
General skills relating to non-subject specific competencies, communication, interpersonal, organization skills.

3.21.4 Attainment Levels

Graduates of Zoology are expected to have the ability to apply knowledge and skills to solving theoretical and practical problems in Zoology in relation to national and societal needs.

3.21.5 Career Opportunities

The programme prepares students for careers in teaching, biological and biotechnological research employment with various government agencies or private companies, environmental consulting etc.

3.21.6 Resource Requirement for Teaching and Learning

a) Academic and non-academic staff. (See section 1.6)
b) Academic and Non-Academic Spaces (See section 1.6)
c) Academic and Administrative Equipment (See section 4)
d) Library and Information Resources (See section 1.6)

3.21.7 Course Structure

Course Structure at 100 Level Zoology

Course Code	Course Title	Units	Status	LH	PH
BIO 101	General Biology I	3	C	45	-
BIO 102	General Biology II	3	C	45	-
BIO 107	General Biology Practical I	1	C	-	45
BIO 108	General Biology Practical II	1	C	-	45
CHM 101	General Chemistry I	3	R	45	-
CHM 102	General Chemistry II	3	R	45	-
CHM 107	General Chemistry Practical I	1	R	-	45
CHM 108	General Chemistry Practical II	1	R	-	45
CSC 101	Introduction to Computer Science	3	R		
GST 111	Communication in English	2	C	30	-
GST 112	Logic, Philosophy & Human Existence	2	E	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills & ICT	2	R	30	-
MTH 101	Elementary Mathematics I	3	R	45	-
MTH 102	Elementary Mathematics II	3	R	45	-
PHY 101	General Physics I	3	R	45	-
PHY 102	General Physics II	3	R	45	-
PHY 107	General Physics Practical I	1	R	-	45
PHY 108	General Physics Practical II	1	R	-	45
	Total	**41**			

Electives : To be selected from either Botany and Biological Science Courses.

Course Structure at 200 Level Zoology

Course Code	Course Title	Units	Status	LH	PH
BIO 201	Genetics I	2	C	30	-
BIO 202	Introductory Ecology	2	C	15	45
BIO 203	General Physiology I	2	C	30	-
BIO 204	Biological Techniques	2	C	15	45
BIO 205	Introductory Developmental Cell Biology	3	E	30	45
BOT 202	Seedless Plants	2	E	30	-
BOT 203	Seed Plants	2	E	30	-
CHM 211	Organic Chemistry I	3	R	30	45
GST 122	Communication in English II	2	C	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GST 211	Environment and Sustainable Development	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
MCB 221	General Microbiology	3	E	30	45

MCB 231	Basic Techniques in Microbiology	2	E	-	90
STA 201	Statistics for Agriculture & Biological Sciences	4	R	60	-
ZOO 211	Invertebrate Zoology	3	C	30	45
ZOO 212	Chordate Zoology	3	C	30	45
ZOO 299	Industrial Attachment I (12 Weeks)	3	C		
	Total	**44**			

Course Structure at 300 Level Zoology

Course Code	Course Title	Units	Status	LH	PH
BIO 301	Genetic II	3	C	30	45
BIO 302	Field Course I	3	R		
BIO 304	General Ecology	3	C	30	45
BIO 305	Molecular Biology I	3	R	45	-
GST 222	Peace Studies & Conflict Resolution	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GST 311	Entrepreneurship	2	R	30	-
ZOO 311	Comparative Animal Physiology	3	C	30	45
ZOO 312	The Biology of Tropical Parasites	3	R	30	45
ZOO 313	Arthropod Diversity	3	R	30	45
ZOO 314	Vertebrate Zoology	4	R	30	90
ZOO 315	Principles of Development	3	R	30	45
ZOO 316	Histology	3	R	15	90
ZOO 399	Industrial Attachment II (12 Weeks)	3	C		
	Total	**40**			

Course Structure at 400 Level Zoology

Course Code	Course Title	Units	Status	LH	PH
BIO 413	Field Course II	3	R		
BIO 414	Molecular Biology II	3	R	45	-
ZOO 411	Entomology	4	R	45	45
ZOO 412	Principles of Parasitology	4	R	45	45
ZOO 413	Hydrobiology and Fisheries	4	R	45	45
ZOO 414	Special Topics in Physiology	3	E	30	45
ZOO 415	Wildlife Ecology and Conservation	3	E	30	45
ZOO 416	Animal Behaviour	3	E	30	45
ZOO 417	Local Fauna	3	E	30	45
ZOO 418	Essay topics in Zoology	2	C		
ZOO 419	Project	6	C	-	270
ZOO 420	Biostatistics & Experimental Design	2	R	30	-
	Total	**40**			

Electives: To be selected from other Biological Sciences Courses.

3.21.8 Course Synopses

ZOO 211: Invertebrate Zoology **(3 Units: LH 30; PH 45)**
The systematics, inter-relationship and basic organization of the invertebrates.

ZOO 212: Chordate Zoology **(3 Units: LH 30; PH 45)**
The systematic inter-relations and basic organization of the vertebrates.

ZOO 299: Industrial Attachment I (12 Weeks) **(3 Units)**
Students should be attached to some industrial 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

ZOO 311: Comparative Animal Physiology **(3 Units: LH 30; PH 45)**
Nutrition and Digestion, Respiration. Blood and circulation. Excretion and homeostasis. The physiology of movement. Hormones. Nervous communication and the sense organs.

ZOO 312: The Biology of Tropical Parasites **(3 Units: LH 30; PH 45)**
Classification, adaptation, morphology, anatomy, life cycle and other features of interest of the protozoans, platyhelminthes, 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 **(3 Units: LH 30; PH 45)**
Adaptive radiation within the phylum arthropoda with particular reference to the structure and functions of the body appendages. General biology of selected arthropod groups. Biological success of the arthropods

ZOO 314: Vertebrate Zoology **(4 Units: LH 30; PH 90)**
Vertebrate systematics, evolution and functional anatomy; geographical distribution of recent vertebrates; the Nigeria vertebrate fauna.

ZOO 315: Principles of Development **(3 units: LH 30; PH 45)**
Problems and processes of development. Gene-activity in oogenesis. Cytoplasmic localization in the nature egg. Gastrulations and cell interactions. Cellular and molecular basis of embryogenesis. Tissue interactions in development. The significance of the placenta and the development of immunity

ZOO 316: Histology **(3 Units: LH 15; PH 90)**
The cellular basis of tissue formation. Cell communication. Stability of the differentiated state. The formation, distribution, structure and function of vertebrate tissues. The organization of the tissues into organ systems.

ZOO 399: Industrial Attachment II (12 Weeks) (3 Units)
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 are to be assessed based on seminar presentation, their reports and assessment by supervisors

ZOO 411: Entomology (4 Units: LH 45; PH 45)
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. Insect physiology.

ZOO 412: Principles of Parasitology (4 Units: LH 45; PH 45)
Evolution of parasitic mode of life. Nature of parasitism in relation to other forms of animal associations. Host-parasitic relationships. Epidemiological studies and control measures of importance. Tropical parasitic diseases and the role of vector in the transmission of these diseases.

ZOO 413: Hydrobiology and Fisheries (4 Units: LH 45; PH 45)
A comparative study of the hydrobiology and cycle of life in marine, brackish and fresh water. Fisheries biology including the food and feeding habits of fish populations. Fecundity and reproduction, age and growth. Aquaculture with particular reference to Nigeria. The Fish fauna of Nigeria. Fishing gear and fishing techniques.

ZOO 414: Special Topics in Physiology (3 Units: LH 30; PH 45)
Specialized aspect of animal physiology, for example; muscle contraction and cytoskeletal elements, intracellular microenvironment and metabolic compartmentalisation: membrane organization, receptors and endocytosis, cell communication.

ZOO 415: Wildlife Ecology and Conservation (3 Units: LH 30; PH 45)
Dynamics of wildlife population. Techniques of wildlife investigation. Principles of wildlife management. The wildlife resources of Nigeria; conservation policies, problems and prospects. World wildlife resources: differences in values, management philosophies and traditions.

ZOO 416: Animal Behaviour (3units: LH 30; PH 45)
The basis of behaviour orientation mechanism in animals, instinct and intelligence, feeding behaviour, social life, courtship and meeting, migration and navigation. Biological clocks and rhythms.

ZOO 417: Local Fauna (3 Units: LH 30; PH 45)
General survey of local molluscs, anthropods and vertebrates.

ZOO 418: Essay Topics in Zoology (2 Units)
An essay based on a review of the literature on a Zoological topic. Student should be assessed based on quality of a submitted report and seminar presentation.

ZOO 419: Project (6 Units: PH 270)

A research project involving an investigation in Zoology and a written presentation and discussion of results.

ZOO 420: Biostatistics and Experimental Design (2 Units: LH 30)

Experimental Design (Hypothesis, use of replicates; randomization of treatment). Analysis and presentation of data (graphing data, types of graphs, tables and principles of table construction). Samples and sampling methods. Descriptive Statistics – measuring location (mean, median and mode); measuring dispersion (range, variance and standard deviation); Test of significance (T-Test, F-Test , 2-Test); Regression and Correlation.

SECTION FOUR:

EQUIPMENT AND SPACE REQUIREMENTS FOR SCIENCE PROGRAMMES

Preamble

Science Programmes involve a lot of practical work and therefore require the utilisation different types of equipment for teaching and research. Some similar items of very expensive equipment are usually required in many programmes of science discipline as well as other science-based disciplines. It is therefore desirable for each university to establish a central research laboratory to house major multi-disciplinary items of equipment. This is to ensure a cost-effective and optimal utilisation of these expensive types of major equipment.

Apart from the central equipment laboratory, most departments in science discipline also require workshops for the repair and fabrication of some materials and equipment which are used for teaching and research. These include glass-blowing workshop, mechanical workshop and carpentry workshop. The most common types of equipment required for the central equipment laboratory, the workshops as well as the items of equipment to be located in each department are listed below.

4.1 List of Equipment for Central Equipment Laboratory

Name

Mass Spectrometer
Gas Chromatograph
HPLC
FT-IR Spectrometer
Atomic Absorption Spectrometer
UV-Visible Spectrophotometer
Liquid Nitrogen Equipment
CHN Analyser
Freeze Dryer
Electron Microscope
High Speed Refrigerated Centrifuge
Bomb Calorimeter
Colorimeter

4.2 List of Equipment Required for Glass Blowing Workshop

Name

Glassblowing lathe machine
Glass cutting machine
Annealing oven
Vacuum pump
Hand torch burner

Glass grinding machine
Cork boring machine
Didymium goggles
Oxygen gas cylinder
Butane gas cylinder
Flaring tools
Carbon paddle
Lighter
Corks
Strain viewer
Tool box
Glass rods and tubes (various sizes)

4.3 List of Equipment Required for Mechanical Workshop

Name
Lathe machine
Milling machine
Pillar drilling machine
Micro-drilling machine
Grinding machine
Vices
Work benches
Tool boxes with complete set of mechanical tools
Metal rods and tubes (various sizes)

4.4 List of Equipment Required for Carpentry Workshop

Name
Mortising machine
Planner
Narrow band saw
Circular machine
Sanding machine
Drilling machine
Spraying machine
Grinding machine
Vice
Electric hand drill
Work table
Tool boxes with complete set of carpentry tools.

4.5 List of Important Equipment Required for Biochemistry Programme

Name

Water Bath (Thermostatic)
Drying Oven (Thermostatic)
Spectrophotometers and Colorimeters
pH Meters
Electrophoretic Units
Centrifuges
Incubators
Hot Plates and Heaters
Test-Tube Mixers
Gas Cylinders and Valves and Tubings
Distillers (All Glass)
Deionizers
Fraction Collector
Micro-Kedhjal Apparatus
Column Chromatography Equipment
Thin Layer Chromatography Equipment
Rotary Evaporator
Glass wares

4.6 List of Important Equipment Required for Biology, Botany & Zoology Programmes

Name

Skeletal System
Muscular System
Brain and Nervous System
Circulatory System
Digestive System
Eye and Vision
Skin and Excretory Organs
GB 28 Concealing and Warning Adaptations
Ice Cube Maker
Incubator/Sterilizer
Embedding Bath
Water Baths
Autoclaves
Balances
Hot Plates
Incubators
Binocular microscopes
Stereo Microscopes
Refrigerators
Shakers
pH Meters
Sahli's Heamoglobinometer
Distillers (All Glass)

R. Humidity with Thermometer
Embedding Oven
Ovens
Thermostatic Incubator
Microtome
Automatic Tissue Processor
Tissue Embedding Centre
Air Pumps (Diaphragm)
Vacuum Pumps
Tissue Grinder Glass
Photometer and Atometer
Shadon Unit Kit No. 1
Barothermograph
Kymograph Muscle
Spirometer
Colorimeter
Insect Light Traps
Insect Box
Slide Projector
Over-head Projector
Bench Centrifuges
Micro Refrigerated Centrifuges
Steel Frame Aquaria
Auxanometer
Oxygen Meter
Glass wares

4.7 List of Minimum Basic Equipment for Biotechnology Programme

Name
Sterile work station
Ice chip maker
Agarose gel electrophoresis units
Polyacrilamide gel electrophoresis units
U.V.Gel-viewing unit
Gel documentation system
Electroporator
Vortex mixer
-80^{o}C freezer
PCR machine and tubes
Microcentrifuge
Incubator
Hibridisation oven
Shaker water bath
Autoclave
Regular ovens
Microwave oven

Water distilling unit
UV – Visible spectrophotometer
Glass wares.

4.8 List of Important Equipment Required for Chemistry Programme

Name
Infra-red Spectrophotometer
UV-Visible Spectrophotometer
Atomic Absorption Spectrophotometer
Gas Chromatograph
HPLC
Ovens
Furnace
Water Baths
Heating Mantles
Bunsen Burners
Hot Plates
Magnetic Stirrer/Hot Plates
Magnetic Stirrers
Mechanical Stirrers
Vacuum Pumps
Rotary Evaporators
Water Circulating Pumps
Colorimeter
Column Chromatography Apparatus
TLC Apparatus
PCR Machine
Vacuum Desiccators
Water Distillers
Water Deionisers
Balances
Ice Making Machine
Glass wares
Thermometers

4.9 List of Important Equipment Required for Computer Science Programme

Name
HARDWARE
PC with 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
External Hard Disk, 500GB (minimum of two)
Bread Boards (at least four)
Air Blowers
Cable Crimpers
LAN Testers
Cable Strippers

Unshielded Twisted Pair Cable (Cat 6)
Cisco Switches (at least two)
SOFTWARE
JAVA
PHP/HTML, XML
MYSQL
FORTRAN 2000
PYTHON
C/C++
Visual Studio.net
LINUX/ Windows 7
Microsoft Professional Suite
MathLab
CASE Software
RAISE Language

4.10 List of Equipment Required for Environmental Management and Toxicology Programme

Name
Water Distiller
Water Deioniser
Water Baths
Hot plates
Orbital Shakers
Overhead Stirrer
Balances
Top loading Balance
Deep Freezer
Ovens
Heating Mantle
Autoclave
Muffle Furnace
Centrifuge
Vacuum Pumps
TLC Kit
pH meters
Conductivity meter
UV – Visible Spectrophotometer
Atomic Absorption spectrophotometer
Flame Photometer
Gas Chromatograph

4.11 List of Equipment Required for Geology Programme

Name
Atomic Absorption Spectrophotometer
Ultra-violet/Visible Spectrophotometer

Rock Cutting and Grinding Machine
Hydraulic Press
Rock Cutler-Cutrock
Lathe Machine
Jaw Crusher
Colorimeter
Sieve Shaker
pH Meter
Brunton Compasses
Field Hammers (Geological)
Rock/Mineral Polishing Machine
Electron Microprobe Analyser
Titration Potentiometer
Lloyd Gas Analyser
Petrographic polarizing Microscopes
Binocular Microscopes
Hotspot Furnace (Muffle)

4.12 List of Equipment Required for Mathematics Programme

Name

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
Computer Software Packages like Matlab, Mathcard and Mapie

4.13 List of Equipment Required for Microbiology Programme

Name

Incubators
Refrigerators
Deep Freezer
Microscopes
Autoclaves
Water Baths
Ovens
Bacteriological Hood with UV Lamp
Safety Cabinet
Laminar Flow Unit
Centrifuges
Spectrophotometer
Electrophoresis System
pH Meter
Vacuum Pump
Colony Counter
Bacterial Counter
Stomacher Blender
Waring Blender

Balances
Membrane Filtering Apparatus
Vacuum Desiccators
Anaerobic Jar
Seitz Filter
Hot Plate/Magnetic Stirrer
Slide Projector/Screen
Overhead Project
Glass wares
Shaker Incubators
Dialysis Tubes
Ultrasonic Dismembrator
Electric Stirrer
Colorimeter
Rotary Evaporators
Test-Tube Shaker
Bunsen Burners

4.14 List of Important Equipment (minimum) for Petroleum Chemistry Programme

S/No.	Description	Quantity required
1.	Aniline Point Tester	2
2.	Atomic absorption Spectrophotometer	1
3.	Automatic Asphalt Furnace	1
4.	Automatic Viscometer	1
5.	Bitumen Extractor	1
6.	Breakdown Voltage Tester	1
7.	Brookfield Viscometer	1
8.	CHN Rapid Analyzer	1
9.	Cold Bath up to -40°C	2
10.	Cold Filter Plugging Point	2
11.	Colorimeter	2
12.	Congealing Point Tester	2
13.	Copper Strip Corrosion	2
14.	Differential Scanning Colorimeter	1
15.	Differential Thermal Analyzer	1
16.	Distillation of Tar	1
17.	Distillation Unit of Liquid Fuels	1
18.	Drop Point Tester	1
19.	Ductility Meter	1
20.	Electron Microscope	1
21.	Elemental Analyzer	1
22.	FIA Hydrocarbon Analyzer	1
23.	Flash Point tester	1

24.	Four Ball Tester	1
25.	Gas Chromatograph	1
26.	Gas Chromatograph-Mass Spectrometer	1
27.	Gel Permeation Chromatograph	1
28.	Hard groove Grindibility	1
29.	Ice Making Machines	1
30.	Infra-red Spectrophotometer (FTIR)	1
31.	Interfacial Tensiometer	1
32.	Jet Evaporation Loss	1
33.	Karl Fischer Titrator	1
34.	Light Fastness Testing Machine	1
35.	Light Scattering Photometer	1
36.	Magnetic Susceptibility Balance	2
37.	Membrane Osmometer	1
38.	Microanalytical Balance	5
39.	NMR Spectrometer (Multiprobe)	1
40.	Penetrometer	1
41.	Rams Bottom Furnace	2
42.	Rust Preventive Characteristic	1
43.	Saybolt Viscometer	3
44.	Selective Ion Meter	2
45.	Smoke Point Tester	2
46.	TAN Delta Resistivity Bridge	2
47.	Tar Viscometer	2
48.	Ultraviolet-Visible Spectrophotometer	2
49.	Vapour Phase Osmometer	1
50.	Xray Diffraction Machine	1

4.15 **List of Equipment Required for Physics Programme (i) General Physics**

Name
Venier Callipers
Metre Rules
Screw Gauge
Glass wares
Balances
Spring Balance (various)
Travelling Microscopes
Stop Watch
Slotted Weights
Spiral Spring
Knife Edge
Inclined Plane
Prisms (various)
Optical Pins (boxes)
Drawing Board

Optical Benches
Converging lens (Various)
Ray box
Diverging lens (various)
Ammeters (various types and ranges)
Voltmeters (various types and ranges)
Rheostats (various ranges)
Resistors (various ranges)
Resistance box (various ranges)
Circuit Keys
Potentiometer
Metre bridge
Galvanometers (various types and ranges)
Daniel Cell
Leclanche Cell
Calorimeter
Thermometers (various types and ranges)
Lee's conductivity apparatus
Connecting wires (various Lengths)
Boyle's Law apparatus
Linear expansion apparatus
Equation of State of Ideal gas apparatus
Maxwellian velocity distribution apparatus
Tuning fork (various)
Resonance tube
Ripple tank
Air Track
Specific gravity bottles
Young's Modulus apparatus
Rectangular glass block
Moment of inertia and angular momentum apparatus
Free fall apparatus
Phite Screen
Lens Holder
Sonometer box
Concave mirror (various radii)
Convex Mirror (various radii)
Bunsen Burners
Mercury Lamps
Sodium Lamps
Water Distillation apparatus
Refrigerator
Centre-zero Galvanometer
Thermal Conductivity apparatus
Vapour Pressure apparatus
Oscilloscope (various types)

(ii) 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.

Name

Signal generators (various types)
Low voltage power supply
H.T. Power Supply
Transformers (various grades)
Avometers
Refractometers
Polarimeter
Laser spectral unit with power supplies
Michelson interferometer
Digital Meters
Plotters
Capacitance meter
Recorder
Video Monitor
Pulse generators
Microscope
Amplifier
Multi-vibrator
Transistors (various types)
Radioactive Source
Ionization Chamber
Rate Meter
Digital Counter
Diffraction grating
X-ray tube
Cathode ray tube
Helmholtz Coils
Electric oven
Thermocouple
Filter Circuits
Electromagnet
Atomizer
Frank Hertz Tube
Cadmium Lamp and accessories
Lummer-Gehrcke Plate
Coils
Inductors
Capacitors
Thermistor
Photocell

Diodes
Digital Multimeter
Function generator (various ranges)
Biprisms
Simpson meter
Noise generator
Flux Meter
Microphones
Electrostatic voltmeter
Van de Graaff Generator
Luminescence tube
Immersion heater
Computers with appropriate software

4.16 **List of Equipment Required for Statistics Programme**

Name

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, Eview.

4.17 **List of Equipment Required for Science Laboratory Technology Programme**

Name

pH Meters
Distillers
Deionisers
Spectrophotometers (UV/VIS/IR)
Atomic Absorption Spectrophotometer with accessories
Ice making Machine
Incubator
Rotary Evaporator
Bunsen Burners
Colorimeter
Light Scattering Photometer
Micro-analytical Balance

4.17.1 **Geology/Mining Technique**

Name

Rock cutting and Grinding Machine
Hydraulic Press
Lathe Machine
Sieve Shaker
X-ray Fluorescence
Brunton Compasses

Field Hammers (Geological)
Binocular Microscopes
Hotspot Furnace

4.17.2 **Microbiology Technique**

Name
Refrigerator
Deep Freezer
70^o Freezer (Ultra Low)
Microscopes
Autoclaves
Water Baths
Ovens
Bacteriological Hood with UV Lamp
Metter Balances

4.17.3 **Physics/Electronics Technique**

Name
Meter Rule
½ Meter Rule
Vernier Calipers
Screw Gauge
Glass Bearers (Various Sizes)
Travelling Microscope
Spring Balance
Stop Watch
Retort Stand
Slotted Weights
Spiral Spring
Knife Edge
Inclined Plane
Prisms (Various)
Optical Pins (boxes)
Drawing Board
Optical Benches
Converging Lens (various focal lengths)
Ray Box
Diverging Lens (various focal Lengths)
Ammeters (various types and ranges)
Voltmeters (various types and ranges)
Rheostats (various ranges)
Resistors (various ranges)
Resistance boxes (various ranges)
Circuit Keys
Potentiometer
Metre Bridge

Galvanometer
Calorimeter
Thermometer (various types and ranges)
Boyle's Law Apparatus
Linear Expansion Apparatus
Turning Fork
Resonance Tube
Specific Gravity Bottles
Glass Capillary Tubes
Young's Modulus Apparatus
Rectangular Glass Block
Lens Holders
Sonometer Box
Concave Mirrors (various radii)
Convex Mirrors (various radii)
Mercury Lamps
Sodium Lamps
Oscilloscope (various types)
Daniel Cell
Leclanche Cell

4.18 List of Laboratory and Equipment Requirements for Marine Science Programme

S/No.	Description	Qty. Reqd
	Academic and Administrative Equipment	
1.	Flame Photometer	(1)
2.	Visible Spectrophotometer (Colorimeter)	(1)
3.	Water Distiller	(1)
4.	Hot Place With Magnetic Stirrer	(1)
5.	Water Bath	(1)
6.	Shaker Water Bath	(1)
7.	Fume Cupboard	(I)
8.	P^h/Tds Meter (Including E^c And Temperature)	(3)
9.	E^h Meter	(1)
10.	Muffle Furnace	(1)
11.	Oven	(1)

List Of Equipment In Chemical Oceanography Laboratory

1.	Hanna Multiparameter	(1)
2.	Camcorder	(1)
3.	Disccolved Oxygen Meter	(1)

4.	Ph Meter	(1)
5.	Hot Air Drying Oven	(1)
6.	Colorimeter	(1)
7.	Spectrophotometer	(1)
8.	Flame Photometer	(1)
9.	Dissecting Set	(1)
10.	Sensitive Balance	(1)
11.	Top Loading Balance	(1)
12.	Autoclave	(1)
13.	Water Bath	(1)
14.	Dissecting Microscope	(1)
15.	Olympus Microscope	(1)
16.	Microtom	(1)
17.	Nitrogen/Protein Determinotor	(1)
18.	Muffle Furnace	(1)
19.	Soxhlet Extraction Unit	(1)
20.	Dessicator	(1)
21.	Kjeldahl Distillation Unit	(1)

General Meteorological Observatory

1.	Pyscrometer	(1)
2.	Evaporimeter	(1)
3.	Barometer	(1)
4.	Air Temperature	(1)
5.	Pollution	(I)
6.	Net Pyranometer	(1)
7.	Tipping Bucket	(1)
8.	Soil Temperature Measurement	(1)
9.	Global Radation	(1)
10.	Weather Harwk (Aws)	(1)
11.	Ultraviolent Measurement (Aws)	(1)
12.	Wind Vane (Wind Speed)	(1)
13.	Anemometer (Wind Speed)	(1)
14.	Sunshine Recorder	(1)

Marine Resources/Limnology Laboratory

1.	Masterchef Blender	(1)
2.	Kenwood Blender	(1)
3.	Wpa Cm 35 Conductivity Meter	(2)
4.	Theodolite	(1)
5.	Aurcinoresssor	(1)
6.	Ice Flake Machine	(1)
7.	Grinding Machine	(2)
8.	Deep Freezer	(1)

9. Kjeldahl Digestion (1)
10. Microscopes (4)

Operational Equipments

1. Hyperbaric Equipments
2. Marine Safety Equipments
3. Swimming Kits
4. Diving Aparatus
5. Softwares (Marine Science)
6. Tv Screen
7. Under Water Cameras

4.19 Minimum Space Requirements for Office Accommodation, Classrooms, Laboratories, Seminar and Conference Rooms

Description	**Size**
Professor	$18.5m^2$
Academic Staff	$13.5m^2$
Faculty Officer	$18.5m^2$
Other Senior Staff	$13.5m^2$
Classroom Accommodation	$0.7m^2$/Student
Departmental Office and storage space	$0.7m^2$/Student
Seminar Room	$0.2m^2$/Student
Laboratories	$7.5m^2$/Student
Conference Room	$37.0m^2$