National Universities Commission

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

Computing

2022

Ten Unique Features

1. The rapidly evolving computing discipline has led to the introduction of new programmes with unique features.
2. Introduction of cyber threat intelligence and cyber conflict, deep and dark web security, cyber-threat hunting, monitors and controllers, artificial intelligence cyber defense application, and surveillance in cyber defense operations.
3. It addresses deficiencies in the old curriculum.
4. It features an inclusion and emphasis on additional hands-on practical and relevant skills in both the old and new programs.
5. Courses establish minimum requirements, while the standards establish minimum learning requirements;
6. The learning standards describe knowledge and skill expectations either within or outside of a course;
7. Increase in core courses requirements to improve student learning, ensure skills acquisition as well as give graduates more educational and career options assuring that they are well prepared for the future after graduation;
8. Production of digital technology specialists in web technologies application, multimedia, document processing, mobile and pervasive computing, internet communications, network servers and infrastructures, web application development, data analytics, machine learning, artificial intelligence, and deep learning;
9. Managerial and business skills for effective management of organisation, infrastructure, software projects, and technologies to create business value in an enterprise organization
10. Nurtures a progressive transition from knowledge-based learning to competency-based learning across all levels of study, in recognition of the changing dynamics of computing in the age of digitalization.

Executive Secretary: Abubakar Adamu Rasheed

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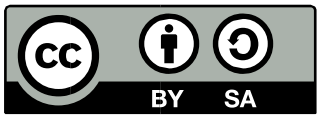

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Foreword

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

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

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

Malam Adamu Adamu
Honourable Minister of Education

Preface

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

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

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

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

The new CCMAS is a product of sustained stakeholder interactions over two years. The composition of each panel took into consideration, the triple helix model, as a unique feature. This involved a blend of academic experts, academies, government (represented by NUC), professional bodies and of course, the private sector represented by the Nigerian Economic Summit Group (NESG). In order to enrich the draft documents, copies of each discipline were forwarded to all critical stakeholders including the relevant academic units in Nigerian Universities, the private sector, professional bodies and the academies for their comments and input. These inputs along with the curriculum of programmes obtained from some foreign

and renowned universities served as major working materials for the various panels constituted for that purpose.

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

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

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

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

1. Administration and Management
2. Agriculture
3. Allied Health Sciences
4. Architecture
5. Arts
6. Basic Medical Sciences
7. Computing
8. Communication and Media Studies
9. Education
10. Engineering and Technology
11. Environmental Sciences
12. Law
13. Medicine and Dentistry
14. Pharmaceutical Science
15. Sciences
16. Social Sciences
17. Veterinary Medicine

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

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

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

List of Reviewers

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Professor	SORIYAN	Abimbola	Obafemi Awolowo University, Ile Ife	**Chairman**
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Professor	AWODELE	Oludele	Babcock University, Ilisan Remo	Data Science
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Contents

Introduction

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

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

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

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

The Current Review of the BMAS

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

i. Academic staff of Nigerian universities;
ii. Representatives of the Academies;
iii. Representatives of Professional bodies/associations
iv. Representatives of the private sector

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

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

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

1. Change of nomenclature from **Benchmarks Minimum Academic Standards (BMAS)** to **Core Curriculum and Minimum Academic Standards (CCMAS);**
2. The curriculum provides for 70% minimum core courses requirements for graduation. Nigerian universities are expected to provide the remaining 30%;
3. In consonance with global best practice, the curriculum is to stimulate blended learning in its delivery;
4. Mass Communication has been unbundled to create a distinct discipline of Communications comprising degree programmes in Advertising, Broadcasting, Development Communication Studies, Film and Multimedia, Information and Media Studies, Journalism and Media Studies, Mass Communication, Public Relations and Strategic Communication;
5. Agriculture has been unbundled into programmes in its contributing components of B.Sc Agricultural Economics, B.Sc. Animal Science, B.Sc. Crop Science and B.Sc. Soil Science;
6. The unbundling of Architecture and introduction of Architecture as a new discipline with programmes like Architecture, Architectural Technology, Furniture Design, Interior Architecture Design, Landscape Architecture and Naval architecture;
7. The split of the Basic Medical Sciences discipline into two – Basic Medical Sciences and Allied Health Sciences;
8. Reduction of the General Studies (GST) course from 36 credit units to 12 credit units of 6 courses as follows:
    i. Communication in English;
    ii. Nigerian People and Culture;
    iii. Philosophy, Logic and Human Existence;
    iv. Entrepreneurship and Innovation;
    v. Venture creation; and
    vi. Peace and Conflict resolution.
9. Entrepreneurship has been repackaged with the introduction of programme-specific entrepreneurship;
10. The number of academic disciplines has been increased from 14 to 17 as follows:

    i. Administration and Management
    ii. Agriculture

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

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

Glossary of Course Codes

These are the 3-letter codes for the identification of courses offered in the various programmes in the Computing discipline as well as courses offered in other disciplines covered in the CCMAS 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 Computing discipline

Category B: Course codes for common basic courses offered to students registered in various programmes in the Computing discipline.

Category C: Course codes for courses offered by the various programmes in the Computing discipline.

Category A

Courses Offered Outside Science Discipline	**Course Code**
General Study Programme	GST
General Entrepreneurship Programme	ENT
Mathematics	MTH
Statistics	STA
Physics	PHY

Category B

Common Basic Courses	**Course code**
Computing	COS

Category C

The Programme Offering The Courses	Course Code
Computer Science	CSC
Cybersecurity	CYB
Data Sciences	DTS
Information and Communication Technology	ICT
Information Systems	INS
Information Technology	IFT
Software Engineering	SEN

Preamble

The Core Curriculum Minimum Academic Standards (CCMAS) is for the degree programmes in the Computing discipline stipulates the minimum academic requirements for the training of undergraduates in various programmes in the discipline. The document is therefore expected to be used as a guide by degree awarding institutions in Nigeria when designing curricula for Bachelor programmes in the discipline. 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 in the computing discipline.

The new core curriculum minimum academic standard (CCMAS) is intended towards producing graduates with knowledge, practical skills, soft skills and competencies to fit in for the 21st century. In addition to five general courses for the computing discipline, the global course structure of CCMAS contains 60 units of core courses. Universities are at liberty to add other relevant courses including innovative courses in computing to make up for the minimum of 120 units required for graduation by the students. The course contents for all the core courses, including the learning outcomes for each course, is provided for effective content delivery.

Programmes and Degrees

Presented in Table 1.1 is a list of programmes and degrees covered in this CCMAS document. The list covers existing programmes being currently run in various faculties/schools/colleges of computing 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 computing.

Table 1.1 List of programmes and degrees

S/N	Programme	Degree in View
1	Computer Science	B.Sc.
2	Cybersecurity	B.Sc.
3	Data Science	B.Sc.
4	Information and Communication Technology	B.Sc.
5	Information Systems	B.Sc.
6	Information Technology	B.Sc.
7	Software Engineering	B.Sc.

Philosophy

The philosophy of computing is concerned with the analysis, design, and development of software and hardware systems for specific purposes. In particular, computing encompasses a broad-based exposure to the concepts, theories, technologies of computing, practices and experiences that are utilised for solving problems in all aspects of human endeavour through building safe, reliable, secure and resilient computer systems.

Objectives of the discipline

The broad objectives of the discipline are to:

1. Apply the principles and practices of Science, Technology, Engineering and Mathematics in the design and construction of computer-based systems;
2. Advance the frontiers of computing by developing effective ways for solving computing problems;
3. Prepare students to meet the computer technology needs of business, government, healthcare, schools, and other kinds of organisations;
4. Provide training on integrating information technology solutions and business processes to meet the information needs of businesses and other enterprises, enabling them to achieve their objectives in an effective, efficient way;
5. Provide advanced coverage on developing and maintaining affordable software systems that meet customer requirements and that behave reliably and efficiently;
6. Provide training and develop competency in data engineering, big data and data analytics; and
7. Provide technical knowledge, principles, technologies and tools required for safeguarding the computer systems, cyberspace and network infrastructure of organisations as well as the data stored on those systems.

Basic Admission Requirements and Expected Duration of the Programmes

There are two different pathways by which candidates can be admitted into programmes in the discipline:

1. Unified Tertiary Matriculation Examination (UTME)
2. Direct Entry

Unified Tertiary Matriculation Examination (UTME) Pathway

In addition to appropriate UTME score, a candidate must possess five Senior Secondary Certificate (SSC)-credit passes including English Language, Mathematics, Physics and any other relevant Science subjects in not more than two sittings.

Direct Entry (3-Year Degree Programme)

A minimum of a credit at the University/National Diploma or NCE with other five Senior School Certificate (SSC) credit passes in relevant science subjects three (3) of which must be in English Language, Mathematics, Physics.

Minimum duration

The minimum duration of computing programmes is four (4) academic sessions or eight (8) consecutively-run semesters 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 or six (6) consecutively-run semesters.

Graduation requirements

To be eligible for the award of the Bachelor degree in any of the Computing degree programme, a student must have:

1. passed all the core courses, university and faculty/school required courses and electives;
2. accumulated a minimum of 120 course units for students admitted through UTME and 90 course units for students admitted to 200 level; and
3. attain a minimum CGPA of 1.00.

To graduate, a student must be found worthy in character throughout the period of his/her studentship and must accumulate the total units prescribed for the programme from Core, Faculty and General Studies courses as well as SIWES, Seminar and Final Year Project.

General Definition of Common Terms and Principles Governing the Course Unit System and Graduation

Credit course system description

General definition of common terms and principles governing the course unit system and graduation

Course System

All programmes in the Nigerian University System (NUS) shall be run on a modularised system, commonly referred to as Course Unit System. All courses should therefore be sub-divided into more or less self-sufficient and logically consistent packages that are taught within a semester and examined at the end of that particular semester.

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. In addition to the current 15 weeks semester system, universities should be encouraged to inaugurate a blended system which is based partly on physical contacts and partly using virtual or online platforms.
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 I courses are 100, 101 and Level II courses are 200, 202. The second aspect of the system is that courses are assigned weights allied to Units.

Units

Consist of specified number of student-teacher contact hours per week per semester. Units are used in two complementary ways: one, as a measure of course weighting, and the other, as an indicator of student workload.

1. As a measure of course weighting for each unit course, 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 lectures per week per semester or one 1-hour lecture plus 3-hour practical per week per semester.

2. As a measure of workload, "One Credit Unit" means one hour of lecture or one hour of tutorial per week per semester. For other forms of teaching requiring student-teacher contact, the following equivalents may apply:

   two hours of seminar: three hours of laboratory or field work, Clinical practice/practicum, studio practice or stadium sporting activity, six hours of teaching practice; four weeks of industrial attachment where applicable.

Normally, in the Credit Course 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 or she 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. Prerequisite courses must be taken and passed before a particular course at a higher level.

Grading of courses

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

Table 1.2 Grade point system

Mark %	**Letter Grade**	**Grade Point**
70 – 100	A	5.0
60 – 69	B	4.0
50 – 59	C	3.0
45 – 49	D	2.0
40 – 44	E	1.0
0 - 39	F	0

Grade Point Average and Cumulative Grade Point Average

For the purpose of determining a student's standing at the end of every semester, the Grade Point Average (GPA) system shall be used. The GPA is computed by dividing the 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.

Table 1.3 Calculation of GPA or CGPA

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

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

Degree classification

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 summarised in Table 1.4. It is important to note that the CGPA shall be calculated and expressed correctly to two decimal places.

Table 1.4 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
1.00 – 1.49	Pass

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.

Probation
A student whose Cumulative Grade Point Average is below 1.00 at the end of a particular year of study, earns a period of probation for one academic session. 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 workload is complied with; and
ii. the prerequisite courses for the higher-level courses have been passed.

Withdrawal
A candidate whose Cumulative Grade Point Average is below 1.00 at the end of a particular year of probation should be required to withdraw from the University.

Evaluation

Techniques of student assessment
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.

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.

Continuous assessments

1. Continuous assessment shall be done through essays, tests, homework, practical exercises, etc.
2. Scores from continuous assessment shall normally constitute 30% of the full marks for courses which are primarily theoretical.
3. For courses which are partly practical and partly theoretical, scores from continuous assessment may constitute 40% of the final marks.

4. 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.

Examinations

In addition to continuous assessment, final examinations should normally be given for every course at the end of each semester. All courses shall be graded out of a maximum of 100 marks comprising:

Final Examination: 60% - 70%

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

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.

External examiner system

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

SIWES rating and assessment

All students taking any degree in Computing 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.

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:

1. improvement in the effectiveness of course delivery;
2. continual update of lecture materials to incorporate emerging new concepts;
3. effective usage of teaching aids and tools to maximise impact of knowledge on students; and
4. 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.

Maintenance of curricular relevance

Using the CCMAS as a 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:

1. 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.
2. 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.
3. 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.
4. how the teaching and learning methods meet or fall short of current and future standards of comparable programmes.
5. the quality of teaching and learning materials used.
6. 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.
7. the views of employers and community members on the quality and relevance of the curriculum.

Performance evaluation criteria

The accreditation of the Computing 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:

1. ensure that at least the provisions of the benchmark minimum academic standards are attained, maintained and enhanced;
2. 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; and
3. 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.

COURSE STRUCTURE AND SYNOPSES OF COMMON COURSES FOR UNDERGRADUATE DEGREE PROGRAMMES IN COMPUTING

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

Common courses

The common courses are basically in the following four categories:

1. Courses in core basic sciences of Mathematics and Physics
2. Faculty courses (COS)
3. General Studies (GST)
4. Entrepreneurship
5. Student Industrial Work Experience (SIWES)

Common basic courses

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

From Faculty of Science

Course Code	Course Title	Course Units
MTH101	General Mathematics I	3
MTH 102	General Mathematics II	3
PHY101	General Physics I	3
PHY 102	General Physics II	3
PHY107	General Practical Physics I	1
PHY 108	General Practical Physics II	1

From Faculty of Computing

The basic computing courses which students in the discipline have to register for are:

Course Code	Course Title	Course Units
COS 101	Introduction to Computing	3
COS 102	Problem Solving	3
COS 201	Computer Programming I	3
COS 202	Computer Programming II	3
COS 409	Research Methodology and Technical Report Writing	3

General Studies (GST)

Students are expected to pass a minimum of 10 units of GST courses.

General Studies: Course structure

Course Code	**Course Title**	**Units and Status**	**LH**	**PH**
GST 111	Communication in English	2C	15	45

GST 112	Nigerian Peoples and Culture	2C	30	0
GST 212	Philosophy, Logic and Human Existence	2C	30	0
ENT 211	Entrepreneurship and Innovation	2C	30	0
GST 312	Peace and Conflict Resolution	2C	30	0
ENT 312	Venture Creation	2C	15	45
	TOTAL	12 units		

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 coordinate SIWES in all programmes that have SIWES component to shoulder the following responsibilities:

1. 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;
2. 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;
3. Conducting follow-up activities regarding all placements by checking regularly each student's job performance through company visits and individual student interviews;
4. 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;
5. Providing necessary advice to students as to the relevance of their chosen field to the industrial requirements of the country;
6. Organising and conducting students' seminars on Work Reports; and
7. Liaison with NUC, ITF, other agencies and industries on student industrial training programme of the University.

Students are expected to have 12 weeks of industrial attachment in 200 level and 300 level long vacation making a total of 24 weeks of industrial attachment. It should be noted that Industrial Training as a course involves the following:

1. Working successfully in the industry for the specified period;
2. Submission of a Work Report to the coordinating office at the end of the training period; and
3. 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 CSC 299 will be industrial attachment for Computer Science Students at 200 level while CSC 399 represents industrial attachment for Computer Science Students at 300 level. Each industrial attachment course is a 3 unit course.

B.Sc. Computer Science

Overview

The B.Sc. Computer Science programme teaches the essential ideas of Computer Science emphasizing the core elements of computer programming, networking, and futuristic technology, demystifying and bringing patterns to life with practicals. Students of this programme are equipped with the study of the algorithmic process and the computational machines ranging from algorithms, practical issues in implementing computing systems in the hardware as well as the software. The graduates of this programme will understand the impact of computing and its application, as well as acquire skills in Computer Programming, Analysis of systems and procedures, and Software Development.

Philosophy

The philosophy of Computer Science programme is to provide broad and high quality education that emphasises the theoretical and algorithmic foundations of computing, which guide design, implementation and application of computation systems.

Objectives

The specific objectives are to:

1. create in students the awareness of and enthusiasm for Computer Science and its capabilities;
2. provide students with a broad and balanced foundation of Computer Science knowledge and practical skills;
3. prepare students to formulate real world problems in Computer Science, employ problem-solving skills and use appropriate tools and technologies to obtain valid and realistic solutions;
4. develop in students the ability to analyse, evaluate and propose alternative solutions to given software and/or algorithm designs;
5. develop students' abilities in self-management and teamwork;
6. prepare students to be proficient, professional and ethical in their careers;
7. prepare students to communicate effectively both orally and in writing; and
8. develop in students the ability to engage in life-long learning and growth in Computer Science and to be potential job creators.

Unique Features of the Programme

The unique features of the programme are:

1. deliberate emphasis on coverage and developing competence on the usage of open source software;
2. additional hands-on practical component in a number of courses to emphasise students' engagement in the learning process for better learning and development of soft skills; and
3. emphasis on formal methods and algorithmic coverage of computing concepts and principles.

Employability Skills

In Nigeria, like in many other countries, there is an abundance of opportunities for people with computing skills. However, given the intense competition in the job market, a good Computer Science degree may be necessary but not sufficient for employment. In addition to a good degree, employers are increasingly requiring candidates to demonstrate employability skills such as communication and teamwork, organisation and management, critical thinking, leadership, technology skills and self-management. The courses in this programme have been tailored to help develop and enhance acquisition of these skills by graduates of the programme.

21st Century Skills

Among the 21st Century skills for the programme are:

1. creativity;
2. information literacy;
3. media literacy;
4. flexibility;
5. social skills;
6. Problem solving;
7. Collaboration;
8. Global awareness;
9. Innovation skills; and
10. Critical thinking.

Admission and Graduation Requirements

Admission requirements

4 Year Degree Programme

In addition to appropriate UTME-Score, a candidate must possess five Senior Secondary Certificate (SSC)-credits passes including English Language, Mathematics, Physics and any other relevant Science subjects in not more than two sittings.

3 Year Degree Programme:

Direct Entry

A minimum of a credit at the University/National Diploma or NCE with other five Senior Secondary Certificate (SSC) credit passes in relevant Science subjects three of which must be in English Language, Mathematics, Physics.

Minimum duration

The minimum duration of the Computer Science degree programme is four academic sessions for UTME. However, it is three academic sessions for candidates admitted to the 200 Level.

Graduation requirements

To be eligible for the award of the Bachelor degree in Computer Science, a student must have:

1. passed all the core courses, university and faculty/school required courses and electives;
2. accumulated a minimum of 120 course units for students admitted through UTME and 90 course units for students admitted to 200 level; and
3. attain a minimum CGPA of 1.00.

To graduate, a student must be found worthy in character throughout the period of his/her studentship and must accumulate the total units prescribed for the programme from Core, Faculty and General Studies courses as well as SIWES, Seminar and Final Year Project.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	0
MTH 101	Elementary Mathematics I	2	C	30	0
MTH 102	Elementary Mathematics II	2	C	30	0
PHY 101	General Physics I	2	C	30	0
PHY 102	General Physics II	2	C	30	0
PHY 107	General Practical Physics I	1	C	0	45
PHY 108	General Practical Physics II	1	C	0	45
STA 111	Descriptive Statistics	3	C	45	0
COS 101	Introduction to Computing Sciences	3	C	30	45
COS 102	Problem Solving	3	C	30	45
TOTAL		**23**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	0
ENT 211	Entrepreneurship and Innovation	2	C	30	0
MTH 201	Mathematical Methods I	2	C	30	0
MTH 202	Elementary Differential Equations	2	C	30	0
COS 201	Computer Programming I	3	C	30	45
COS 202	Computer Programming II	3	C	30	45
CSC 203	Discrete Structures	2	C	30	0
CSC 299	SIWES I	3	C	0	135
IFT 211	Digital Logic Design	2	C	15	45

IFT 212	Computer Architecture and Organisation	2	C	15	45
SEN 201	Introduction to Software Engineering	2	C	30	0
TOTAL		**25**			

NOTE: ***SIWES will take place during long vacations of 200 Level and 300 Level.

300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	0
ENT 312	Venture Creation	2	C	15	45
CSC 301	Data Structures	3	C	30	45
CSC 308	Operating Systems	3	C	30	45
CSC 309	Artificial Intelligence	2	C	15	45
CSC 322	Computer Science Innovation and New Technologies	2	C	15	45
CSC 399	SIWES II	3	C	0	135
CYB 201	Introduction to Cybersecurity and Strategy	2	C	30	0
DTS 304	Data Management I	3	C	30	45
ICT 305	Data Communication System & Network	3	C	30	45
TOTAL		**25**			

SIWES II now holds during the long vacation of 300L

400 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
COS 409	Research Methodology and Technical Report Writing	3	C	45	0
CSC 401	Algorithms and Complexity Analysis	2	C	30	0
CSC 402	Ethics and Legal Issues in Computer Science	2	C	30	0
CSC 497	Final Year Project I	3	C	0	135
CSC 498	Final Year Project II	3	C	0	135
INS 401	Project Management	2	C	30	0
TOTAL		**15**			

Course Contents and Learning Outcomes

100 Level

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

Learning Outcomes

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

1. identify possible sound patterns in English language;
2. list notable language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents

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

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

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

1. explain basic definition of Set, Subset, Union, Intersection, Complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify the various types of numbers; and
5. solve some problems using Binomial theorem.

Course Contents

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

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

Learning Outcomes

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

1. distinguish types of rules in Differentiation and Integration;
2. describe the meaning of Function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents

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

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

Learning Outcomes

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

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

Course Contents

Space and time. Units and dimension, Vectors and Scalars, Differentiation of vectors. Displacement, velocity and acceleration. Kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). Relative motion. Application of Newtonian mechanics. Equations of motion. Conservation principles in physics, Conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass. Rotational motion. Torque, vector product, moment, rotation of coordinate axes and angular momentum. Polar coordinates. Conservation of angular momentum. Circular motion. Moments of inertia, gyroscopes and precession. Gravitation: Newton's Law of Gravitation, Kepler's laws of planetary motion, Gravitational potential energy, Escape velocity, Satellites motion and orbits.

PHY 102: General physics II (Electricity & magnetism) (2 Units C: LH 30)

Learning Outcomes

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

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

8. determine the characteristics of ac voltages and currents in resistors, capacitors, and Inductors.

Course Contents

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

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

Learning Outcomes

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

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents

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

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

Learning Outcomes

On completion, the student should be able to:

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

Course Contents

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

STA 111: Descriptive Statistics (3 Units C: LH 45)

Learning Outcomes

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

1. explain the differences between permutation and combination;
2. explain the concept of random variables and relate it to probability and distribution functions;
3. describe the basic distribution functions; and
4. explain the concept of exploratory data analysis.

Course Contents

Permutation and combination. Concepts and principles of probability. Random variables. Probability and distribution functions. Basic distributions: Binomial, geometric, Poisson, normal and sampling distributions; exploratory data analysis.

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

Learning Outcomes

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

1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents

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

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

COS 102: Problem Solving (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. explain problem solving processes;
2. demonstrate problem solving skills;
3. describe the concept of algorithms development and properties of algorithms;
4. discuss the solution techniques of solving problem;
5. solve computer problems using algorithms, flowcharts, pseudocode; etc.; and
6. solve problems using programming language using C, PYTHON, etc.

Course Contents

Introduction to the core concepts of computing. Problems and problem-solving. The identification of problems and types of problems (routine problems and non-routine problems). Method of solving computing problems (introduction to algorithms and heuristics). Solvable and unsolvable problems. Solution techniques of solving problems (abstraction, analogy, brainstorming, trial and error, hypothesis testing, reduction, literal thinking, means-end analysis, method of focal object, morphological analysis, research, root cause analysis, proof, divide and conquer). General Problem-solving process. Solution formulation and design: flowchart, pseudocode, decision table, decision tree. Implementation, evaluation and refinement. Programming in C, Python etc.

Lab Work: Use of simple tools for algorithms and flowcharts; writing pseudocode; writing assignment statements, input-output statements and condition statements; demonstrating simple programs using any programming language (Visual Basic, Python, C)

200 Level

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

Learning Outcomes

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

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

Course Contents

Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of

inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

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

Learning Outcomes

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

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

Course Contents

Concept of Entrepreneurship (Entrepreneurship, Intrapreneurship/Corporate Entrepreneurship). Theories, Rationale and relevance of Entrepreneurship (Schumpeterian and other perspectives, risk-taking, necessity and opportunity-based entrepreneurship and creative destruction). Characteristics of Entrepreneurs (Opportunity seeker, risk taker, natural and nurtured, problem solver and change agent, innovator and creative thinker). Entrepreneurial thinking (Critical thinking, Reflective thinking, and Creative thinking). Innovation (Concept of innovation, Dimensions of innovation, Change and innovation, Knowledge and innovation). Enterprise formation, partnership and networking (Basics of business plan, Forms of business ownership, business registration and forming alliances and joint ventures). Contemporary Entrepreneurship Issues (knowledge, skills and technology, intellectual property, virtual office, networking). Entrepreneurship in Nigeria (Biography of inspirational entrepreneurs, youth and women entrepreneurship, Entrepreneurship support institutions, Youth enterprise networks and environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

MTH 201: Mathematical Methods I (2 Units C: LH 30)

Learning Outcomes

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

1. describe Real-valued functions of a real variable;
2. solve some problems using Mean value Theorem and Taylor Series expansion; and
3. evaluate Line Integral, Surface Integral and Volume Integrals.

Course Contents
Real-valued functions of a real variable. Review of differentiation and integration and their applications. Mean value theorem. Taylor series. Real-valued functions of two and three variables. Partial derivatives chain rule, extrema, Lagrangian multipliers. Increments, differentials and linear approximations. Evaluation of line, integrals. Multiple integrals.

MTH 202: Elementary Differential Equations (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. define the following: order and degree of a differential equation;
2. describe some techniques for solving first and second order linear and non-linear equations; and
3. solve some problems related to geometry and physics.

Course Contents
Derivation of differential equations from primitive, geometry, physics, etc. order and degree of differential equation. Techniques for solving first and second order linear and non-linear equations. Solutions of systems of first order linear equations. Finite linear difference equations. Application to geometry and physics.

COS 201: Computer Programming I (3 Units C1: LH 30; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. identify different programming paradigms and their approaches to programming;
2. write programmes using basic data types and strings;
3. design and implement programming problems using selection;
4. design and implement programming problems using loops;
5. use and implement classes as data abstractions in an object-oriented approach;
6. implement simple exception handling in programmes;
7. develop programmes with input/output from text files; and
8. design and implement programming problems involving arrays.

Course Contents
Introduction to computer programming. Functional programming; Declarative programming; Logic programming; Scripting languages. Introduction to object-orientation as a technique for modelling computation. Introduction of a typical object-oriented language, such as Java. Basic data types, variables, expressions, assignment statements and operators. Basic object-oriented concepts: abstraction; objects; classes; methods; parameter passing; encapsulation. Introduction to Strings and string processing; Simple I/O; control structures; Arrays; Simple recursive algorithms; inheritance; polymorphism.
Lab work: Programming assignments involving hands-on practice in the design and implementation of simple algorithms such as finding the average, standard deviation, searching and sorting. Practice in developing and tracing simple recursive algorithms. Developing programmes involving inheritance and polymorphism.

COS 202: Computer Programming II (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. develop solutions for a range of problems using object-oriented programming;
2. use modules/packages/namespaces for programme organisation;
3. use API in writing applications;
4. apply divide and conquer strategy to searching and sorting problems using iterative and/or recursive solutions;
5. explain the concept of exceptions in programming and how to handle exceptions in programmes;
6. write simple multithreaded applications; and
7. design and implement simple GUI applications.

Course Contents

This course is a continuation of CSC201. Review and coverage of advanced object-oriented programming - polymorphism, abstract classes and interfaces. Class hierarchies and programme organisation using packages/namespaces. Use of API – use of iterators/enumerators, List, Stack, Queue from API; Searching; sorting; Recursive algorithms; Event-driven programming: event-handling methods; event propagation; exception handling. Applications in Graphical User Interface (GUI) programming.

Lab work: Programming assignments leading to extensive practice in problem-solving and programme development with emphasis on object-orientation. Solving basic problems using static and dynamic data structures. Solving various searching and sorting algorithms using iterative and recursive approaches. GUI programming.

CSC 203: Discrete Structures (2 Units C: LH 30)

Learning Outcomes

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

1. convert logical statements from informal language to propositional and predicate logic expressions;
2. describe the strengths and limitations of propositional and predicate logic;
3. outline the basic structure of each proof technique (direct proof, proof by contradiction, and induction) described in this unit;
4. apply each of the proof techniques (direct proof, proof by contradiction, and induction) correctly in the construction of a sound argument;
5. apply the pigeonhole principle in the context of a formal proof;
6. compute permutations and combinations of a set, and interpret the meaning in the context of the particular application;
7. map real-world applications to appropriate counting formalisms, such as determining the number of ways to arrange people around a table, subject to constraints on the seating arrangement, or the number of ways to determine certain hands in cards (e.g., a full house); and
8. solve a variety of basic recurrence relations.

Course Contents

Propositional Logic. Predicate Logic. Sets. Functions. Sequences and Summation. Proof Techniques. Mathematical induction. Inclusion-exclusion and Pigeonhole principles. Permutations and Combinations (with and without repetitions). The Binomial Theorem. Discrete Probability. Recurrence Relations.

CSC 299: SIWES I (3 Units C: PH 135)

Learning Outcomes

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

1. explain how a typical computer firm/unit operates;
2. describe the various assignments carried out and the skills acquired during the SIWES period; and
3. submit a comprehensive report on the knowledge acquired and the experience gained during the exercise.

Course Contents

Students are attached to private and public organisations for a period of three months during the second-year session long break with a view to making them acquire practical experience and to the extent possible, develop skills in all areas of Computer Science. Students are supervised during the training period and shall be expected to keep records designed for the purpose of monitoring their performance. They are also expected to submit a report on the experience gained and defend their reports.

IFT 211: Digital Logic Design (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. explain why everything is data, including instructions, in computers;
2. describe how negative integers, fixed-length numbers, and non-numeric data are represented;
3. convert numerical data from one format to another;
4. describe computations as a system characterised by a known set of configurations with transitions from one unique configuration (state) to another (state);
5. describe the distinction between systems whose output is only a function of their input (combinational) and those with memory/history (sequential);
6. describe a computer as a state machine that interprets machine instructions;
7. articulate that there are many equivalent representations of computer functionality, including logical expressions and gates, and be able to use mathematical expressions to describe the functions of simple combinational and sequential circuits; and
8. design the basic building blocks of a computer: arithmetic-logic unit (gate-level), registers (gate-level), central processing unit (register transfer-level), and memory (register transfer-level).

Course Contents

Introduction to information representation and number systems. Boolean algebra and switching theory. Manipulation and minimisation of completely and incompletely specified Boolean functions. Physical properties of gates: fan-in, fan-out, propagation delay, timing

diagrams and tri-state drivers. Combinational circuits design using multiplexers, decoders, comparators and adders. Sequential circuit analysis and design, basic flip-flops, clocking and timing diagrams. Registers, counters, RAMs, ROMs, PLAs, PLDs, and FPGAs.
Lab Work: Simple combinational gates (AND, OR, NOT, NAND, NOR); Combinational circuits design using multiplexers, decoders, comparators and adders. Sequential circuit analysis and design using basic flip-flops (S-R, J-K, D, T flip-flops); Demonstration of registers, counters, RAMs, ROMs, PLAs, PLDs, and FPGAs.

IFT 212: Computer Architecture and Organisation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students will be able to:
1. explain the organisation of the classical von Neumann machine and its major functional units;
2. construct simple assembly language programme segments;
3. describe how fundamental high-level programming constructs are implemented at the machine-language level;
4. discuss the concept of control points and the generation of control signals using hardwired or microprogrammed implementations;
5. describe how the use of memory hierarchy (cache, virtual memory) is used to reduce the effective memory latency; and
6. explain the concept of interrupts and describe how they are used to implement I/O control and data transfers.

Course Contents
Principles of computer hardware and instruction set architecture. Internal CPU organisation and implementation. Instruction format and types, memory, and I/O instructions. Dataflow, arithmetic, and flow control instructions, addressing modes, stack operations, and interrupts. Data path and control unit design. RTL, microprogramming and hardwired control. The practice of assembly language programming. Memory hierarchy. Cache memory, Virtual memory. Cache performance. Compiler support for cache performance. I/O organisations.
Lab work: Practical demonstration of the architecture of a typical computer. Illustration of different types of instructions and how they are executed. Simple Assembly Language programming. Demonstration of interrupts. Programming assignments to practice MS-DOS batch programming, Assembly Process, Debugging, Procedures, Keyboard input, Video Output, File and Disk I/O, and Data Structure. Demonstration of Reduced Instruction Set Computers. Illustration of parallel architectures and interconnection networks.

SEN 201: Introduction to Software Engineering (2 units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. describe the concept of the software life cycle;
2. explain the phases of requirements analysis, design, development, testing and maintenance in a typical software life cycle;
3. differentiate amongst the various software development models;
4. utilise UML for object-oriented analysis and design;

5. describe different design architectures;
6. explain the various tasks involved in software project management; and
7. describe the basic legal issues related to Software Engineering.

Course Contents

Software Engineering concepts and principles. Design, development and testing of software systems. Software processes: software lifecycle and process models. Process assessment models. Software process metrics. Life cycle of software system. Software requirements and specifications. Software design. Software architecture. Software metrics. Software quality and testing. Software architecture. Software validation. Software evolution: software maintenance; characteristics of maintainable software; re-engineering; legacy systems; software reuse. Software Engineering and its place as a computing discipline. Software project management: team management; project scheduling; software measurement and estimation techniques; risk analysis; software quality assurance; software configuration management. Software Engineering and law.

300 Level

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

Learning Outcomes

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

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

Course Contents

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

Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis.

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

Learning Outcomes

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

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

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/market research, Unutilised resources, Social and climate conditions, and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (venture capital, equity finance, microfinance, personal savings, small business investment organisations, and business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first mover advantage, e-commerce business models and successful e-commerce companies,). Small business management/family business: Leadership & Management, basic bookkeeping, nature of family business and family business growth model. Negotiation and business communication (Strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological solutions (the concept of market/customer solution, customer solution, and emerging technologies, business applications of new technologies- Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoT), Blockchain, Cloud Computing, renewable energy, etc. digital business and e-commerce strategies).

CSC 301: Data Structures (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. discuss the appropriate use of built-in data structures;
2. apply object-oriented concepts (inheritance, polymorphism, design patterns, etc.) in software design;
3. implement various data structures and their algorithms, and apply them in implementing simple applications;

4. choose the appropriate data structure for modelling a given problem;
5. analyse simple algorithms and determine their efficiency using big-O notation; and
6. apply the knowledge of data structures to other application domains like data compression and memory management.

Course Contents

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.

Lab work: Writing C^{+}/C^{++} functions to perform practical exercises and implement using the algorithms on arrays, records, string processing, queues, trees, pointers and linked structures.

CSC 308 Operating System (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. recognise operating system types and structures;
2. describe OS support for processes and threads;
3. recognise CPU scheduling, synchronisation, and deadlock;
4. resolve OS issues related to synchronisation and failure for distributed systems;
5. explain OS support for virtual memory, disk scheduling, I/O, and file systems;
6. identify security and protection issues in computer systems; and
7. use C and Unix commands, examine behaviour and performance of Linux, and develop various system programmes under Linux to make use of OS concepts related to process synchronisation, shared memory, mailboxes, file systems, etc.

Course Contents

Fundamentals of operating systems design and implementation. History and evolution of operating systems. Types of operating systems. Operating system structures. Process management: processes, threads, CPU scheduling, process synchronisation. Memory management and virtual memory. File systems; I/O systems; Security and protection; Distributed systems; Case studies.

Lab work: Practical hands-on engagement to facilitate understanding of the material taught in the course. All the process, memory, file and directory management issues will be demonstrated under the LINUX operating system. Also UNIX commands will be briefly discussed. Alternatively, hands-on exposure may be through the use of operating systems developed for teaching, like TempOS, Nachos, Xinu or MiniOS. Another possibility is through programming exercises that implement and simulate algorithms taught. Simulation of CPU scheduling algorithms, producer-consumer problem, memory allocation algorithms, file organisation techniques, deadlock algorithms and disk scheduling algorithms.

CSC 309: Artificial Intelligence (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. explain AI fundamentals, concepts, goals, types, techniques, branches, applications, AI technology and tools;

2. discuss intelligent agents, their performance, examples, faculties, environment and architectures, and determine the characteristics of a given problem that an intelligent system must solve;
3. describe the Turing test and the "Chinese Room" thought experiment, and differentiate between the concepts of optimal reasoning/behaviour and human-like reasoning/behaviour;
4. describe the role of heuristics and the trade-offs among completeness, optimality, time complexity, and space complexity;
5. analyse the types of search and their applications in AI and describe the problem of combinatorial explosion of search space and its consequences;
6. demonstrate knowledge representation, semantic network and frames along with their applicable uses;
7. practice Natural Language Processing, translate a natural language (e.g., English) sentence into a predicate logic statement, convert a logic statement into clause form, apply resolution to a set of logic statements to answer a query; and
8. analyse programming languages for AI and expert systems technology, and employ application domains of AI.

Course Contents

Overview of Artificial Intelligence. History of AI. Goals of AI. AI Technique. Types of AI. Branches and applications of AI. Advantages and Disadvantages. Introduction to Intelligent Agents. Agent Performance, Examples of Agents, Agent Faculties, Rationality, Agent Environment. Agent Architectures. Search. General Classes of AI Search Algorithm Problems. Problem Solving by Search. Types of AI Search Techniques and Strategies. Introduction to the types of problems and techniques in AI. Problem-Solving methods. Major structures used in AI programmes. Knowledge Representation. KR and Reasoning Challenges. KR Languages. Knowledge representation techniques such as predicate logic, non-monotonic logic, and probabilistic reasoning. Semantic Network - types of relationships, semantic network inheritance, types and components. Introduction to Frames. Natural Language Processing (NLP). Introduction to natural language understanding and various syntactic and semantic structures. Introduction to Expert Systems - characteristics, components, types, requirements, technology, development. Programming Languages for AI. Introduction to computer image recognition.

Lab work: Group practical in (i) Turing test practical - Students can act out their own version of the Turing test (iii) Facial recognition practical to aid in teaching students how machine learning works with students simulating a facial recognition algorithm. Practical applications of NLP in groups – (i) Question Answering focuses on building systems that automatically answer the questions asked by humans in a natural language (ii) Spam detection application for detecting unwanted e-mails getting to a user's inbox (iii) Sentiment analysis/opinion mining should be used on the web to analyse the attitude, behaviour, and emotional state of the sender, implemented through a combination of NLP and statistics (iv) Practical exercise of machine translation used to translate text or speech from one natural language to another natural language such as the Google Translator (v) Developing a model to provide word processor software for the spelling correction (vi) Developing a model for speech recognition for converting spoken words into text (vii) Implementing a Chatbot to provide the staff/student's chat services. OR

Group Practical exercise on agents and its environment using simulation of a colony of ants foraging for food; model simulating a message between agents; model simulating the flocking behaviour of birds; model to apply standard search algorithm to the classic search problem of missionaries and cannibals, and how to use communicating agents for searching networks.

Some computer AI animation exercises for any branch of AI. Practical exercise on simple robots coupling and programming. Group project of building a lawn robot for trimming grasses, or any simple design and implementation of robotics.

CSC 322: Computer Science Innovation and New Technologies (2 Units C: LH 30)

Learning Outcomes

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

1. explain business models;
2. identify some entrepreneurial opportunities available in IT;
3. describe business plan and business startup process;
4. explain business feasibility and strategy;
5. explain marketing strategies; and
6. discuss business ethics and legal issues.

Course Contents

Fundamental concepts of innovation and business ideas in general. Product development. Business leadership. Digital marketing. Entrepreneurial opportunities in IT. Legal issues and Business ethics. New venture creation process. Business feasibility planning. Market research. Business strategy. Business models and Business plans. Technical presentations. Report on a successful entrepreneurial outfit.

CSC 399: SIWES II (3 Units C: PH 135)

Learning Outcomes

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

1. explain how a typical computer firm/unit operates;
2. describe the various assignments carried out and the skills acquired during the SIWES period; and
3. submit a comprehensive report on the knowledge acquired and the experience gained during the exercise.

Course Contents

Students are attached to private and public organisations for a period of three months during the second-year session long break with a view to making them acquire practical experience and to the extent possible, develop skills in all areas of Computer Science. Students are supervised during the training period and shall be expected to keep records designed for the purpose of monitoring their performance. They are also expected to submit a report on the experience gained and defend their reports.

CYB 201: Introduction to Cybersecurity and Strategy (2 Units C: LH 30)

Learning Outcomes

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

1. explain cybersecurity concepts, its methods, elements, and terminologies of cybersecurity -cyber, security, threat, attack, defence, and operations;
2. describe common cyber-attacks and threats, cybersecurity issues, challenges and proffered solutions, and build an enhanced view of main actors of cyberspace and cyber operations;
3. apply the techniques for identifying, detecting, and defending against cybersecurity threats, attacks and protecting information assets;
4. explain the impact of cybersecurity on civil and military institutions, privacy, business and government applications;
5. identify the methods and motives of cybersecurity incident perpetrators, and the countermeasures employed by organisations and agencies to prevent and detect those incidences and software application vulnerabilities; and
6. state the ethical obligations of security professionals, evaluate cybersecurity and national security strategies to the typologies of cyber-attacks that require policy tools and domestic response, and define the cybersecurity requirements and strategies evolving in the face of big risk.

Course Contents

Basic concepts: cyber, security, confidentiality, integrity, availability, authentication, access control, non-repudiation and fault-tolerant methodologies for implementing security. Security policies, best current practices, testing security, and incident response, Risk management, disaster recovery and access control. Basic cryptography and software application vulnerabilities. Evolution of cyber-attacks. Operating system protection mechanisms, intrusion detection systems, basic formal models of security, cryptography, steganography, network and distributed system security, denial of service (and other) attack strategies, worms, viruses, transfer of funds/value across networks, electronic voting, secure applications. Cybersecurity policy and guidelines. Government regulation of information technology. Main actors of cyberspace and cyber operations. Impact of cybersecurity on civil and military institutions, privacy, business and government applications; examination of the dimensions of networks, protocols, operating systems, and associated applications. Methods and motives of cybersecurity incident perpetrators, and the countermeasures employed by organisations and agencies to prevent and detect those incidences. Ethical obligations of security professionals. Trends and development in cybersecurity. Software application vulnerabilities. Evolution of cybersecurity and national security strategies, requirements to the typologies of cyber-attacks that require policy tools and domestic response. Cybersecurity strategies evolving in the face of big risk. Role of standards and frameworks.

DTS 304: Data Management I (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. describe the components of a database system and give examples of their use;
2. describe the differences between relational and semi-structured data models;
3. explain and demonstrate the concepts of entity integrity constraint and referential integrity constraint;
4. apply queries, query optimisations and functional dependencies in relational databases;
5. describe properties of normal forms and explain the impact of normalisation on the efficiency of database operations;
6. describe database security and integrity issues and their importance in database design; and
7. explain the concepts of concurrency control and recovery mechanisms in databases.

Course Contents

Information Management Concepts. Information storage & retrieval. Information management applications. Information capture and representation. Analysis and indexing - search, retrieval, information privacy. Integrity and security. Scalability, Efficiency and Effectiveness. Introduction to database systems. Components of database systems. DBMS functions. Database architecture and data independence. Database query language. Conceptual models. Relational data models. Semi-structured data models. Relational theory and languages. Database Design. Database security and integrity. Introduction to query processing and optimisation. Introduction to concurrency and recovery.

Lab work: Practical exercise on information representation, capture, storage and retrieval. Learn how to analyse data and index for easy searching and indexing. Practical on creating database files and models. How to create and use various database designs. How to query the created database. Methods of concurrency and recovery in database. Learn how to secure the database.

ICT 305: Data Communication Systems and Network (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. explain data transmission over layered networks;
2. list and explain common internet technologies and protocols; and
3. explain network operating system.

Course Contents

Types and sources of data. Simple communications network. Transmission definitions, one way transmission, half duplex transmission, transmission codes, transmission modes, parallel transmission, serial transmission, bit synchronisation, character synchronisation, character synchronisation, synchronous transmission, asynchronous transmission, efficiency of transmission. Introduction to network protocol. Seven Layer ISO-OSI standard protocols and network architecture. Transport protocols, session services protocols, and other protocols. Institute of Electrical and Electronics Engineering 802 standards. Error control and Data

Compression: Forward Error Control; error detection methods; parity checking; linear block codes, cyclic redundancy checking; feedback error control, data compression, Huffman coding and dynamic Huffman coding. Local Area Networks: medium access control techniques – Ethernet, token bus and token ring; fibre distributed data interface, metropolitan area network. Peer-to-peer, Client Server. Client-Server Requirements: GUI design standards, interface independence, platform independence, transaction processing, connectivity, reliability, backup, and recovery mechanisms. Features and benefits of major recovery mechanisms. Network OS: (e.g., Novell NetWare, UNIX/LINUX, OS/2 & Windows NT). INTERNET: Definition, architecture, services, internet addressing. Internet protocol, IPv4, IPv6.

Lab Work: Demonstration of simple communications networks. Illustration of applications at the various levels of the OSI model. Demonstration of different types of Local Area Networks (LANs). Illustration of Metropolitan Area Networks. Illustration of Error Detection and Error Correction techniques. Demonstration of Network Operating Systems.

400 Level

COS 409: Research Methodology and Technical Report Writing (3 Units C: LH 45)

Learning Outcomes

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

1. distinguish qualitative and quantitative research methodologies and their applications;
2. identify and define a research problem in a given area;
3. identify different methods of data collection and select the methods appropriate to a given situation;
4. design and conduct simple research including analysis and interpretation of research results;
5. document research problem, methodology all the way to research report writing;
6. defend the written research report; and
7. familiarise themselves with ethical issues in the conduct of research.

Course Contents

Foundations of Research. Types of Research. Research Approaches. Significance of Research. Research Methods versus Methodology. Research Process. Criteria and Strategy for Good Research. Problems Encountered by Researchers in Nigeria. Principles of Scientific Research. Scientific investigation. Problem formulation. Definition and technique of the Research Problem. Selection of Appropriate Method for Data Collection- Primary Data and Secondary Data. Guidelines for Constructing Questionnaire/Schedule. Guidelines for Successful Interviewing. Difference between Survey and Experiment. Eloping Research Proposal and Research Plan. Formulation of working hypothesis and Testing. Literature review. Procedure for reviewing related relevant studies and referencing cited works. Types of Reports. Technical Report Writing. Layout and mechanics of writing a Research Report. Standard Techniques for Research Documentation. Sampling Design. Different Types of Sample Designs. Steps in Sampling Design. Criteria of Selecting a Sampling Procedure. Methods of analysis. Processing and Analysis of Data Elements/Types of Analysis. Interpretation and Presentation of results. How to prepare References and Bibliography.

CSC 401: Algorithms and Complexity Analysis (2 Units C: LH 30)

Learning Outcomes

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

1. explain the use of big-O, omega, and theta notation to describe the amount of work done by an algorithm,
2. use big-O, omega, and theta notation to give asymptotic upper, lower, and tight bounds on time and space complexity of algorithms,
3. determine the time and space complexity of simple algorithms,
4. deduce recurrence relations that describe the time complexity of recursively defined algorithms,
5. solve elementary recurrence relations,
6. for each of the strategies (brute-force, greedy, divide-and-conquer, recursive backtracking, and dynamic programming), identify a practical example to which it would apply,
7. use pattern matching to analyse substrings, and
8. use numerical approximation to solve mathematical problems, such as finding the roots of a polynomial.

Course Contents

Basic algorithmic analysis. Asymptotic analysis of Upper and average complexity bounds. Standard Complexity Classes. Time and space trade-offs in analysis recursive algorithms. Algorithmic Strategies. Fundamental computing algorithms. Numerical algorithms. Sequential and Binary search algorithms. Sorting algorithms, Binary Search trees. Hash tables. Graphs and their representation.

CSC 402: Ethics and Legal Issues in Computer Science (2 Units C: LH 30)

Learning Outcomes

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

1. state laws and regulations related to ethics;
2. identify and explain relevant codes of ethics for computing practice;
3. identify social and ethical issues in different areas of computing practice;
4. review real-life ethical cases and be able to develop ethical resolutions and policies;
5. explain the consequences of ignoring and non-compliance with ethical provisions; and
6. develop a sound methodology in resolving ethical conflicts and crisis.

Course Contents

Addresses social, ethical, legal and managerial issues in the application of Computer Science to the information technology industry. Through seminars and case studies, human issues confronting Computer Science graduates will be addressed. Topics include managerial and personal ethics, computer security, privacy, software reliability, personal responsibility for the quality of work, intellectual property, environment and health concerns, and fairness in the workplace.

CSC 497: Final Year Project I (3 Units C: PH 135)

Learning Outcomes

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

1. identify a researchable project topic in Computer Science;
2. search and review literature pertinent to identified problem statement;
3. acknowledge and reference sources of information used in the research report;
4. conceptualise and design a research methodology to address an identified problem;
5. determine tools for analysing data collected based on research objectives;
6. write a coherent proposal on the research project to be conducted; and
7. orally present the written project proposal.

Course Contents

An independent or group investigation of appropriate software, hardware, communication and networks or IT related problems in Computer Science carried out under the supervision of a lecturer. Before registering, the student must submit a written proposal to the supervisor to review. The proposal should give a brief outline of the project, estimated schedule of completion, and computer resources needed. A formal written report is essential and an oral presentation may also be required.

CSC 498: Final Year Project II (3 Units C: PH 135)

Learning Outcomes

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

1. demonstrate technical skills in Computer Science;
2. demonstrate generic transferable skills such as communication and team work;
3. produce a technical report in the chosen project;
4. defend the written project report; and
5. appreciate the art of carrying out full-fledged research.

Course Contents

This is a continuation of CSC 497. This contains the implementation and the evaluation of the project. A formal written report, chapters 4-5 have to be approved by the supervisor. A final report comprising chapters 1 - 5 will be submitted to the department for final grading. An oral presentation is required.

INS 401 Project Management (2 Units C: LH 30)

Learning Outcomes

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

1. describe project management planning;
2. describe project scheduling;
3. explain management of project resources;
4. discuss project procurement, monitoring and execution; and
5. explain project communication and time management.

Course Contents

Introduction to Project Management. The Project Management Lifecycle: Project management and systems development or acquisition. The project management context. Technology and techniques to support the project management lifecycle, and Project management processes. Managing Project Teams: Project team planning, motivating team members, Leadership, power and conflict in project teams, and managing global project teams. Managing project communication and enhancing team communication. Project Initiation and Planning. Managing Project Scope: Project initiation, how organisations choose projects, Activities, and Developing the project charter. Managing Project Scheduling: Common problems in project scheduling, and Techniques for project scheduling. Managing Project Resources: Types of resources (human, capital, time), and Techniques for managing resources. Project quality and tools to manage project quality. Managing project risk and tools for managing project risk. Managing Project Procurement: Alternatives to systems development, External acquisition, Outsourcing-domestic and offshore. Steps in the procurement process, and managing the procurement process. Project Execution, Control and Closure: Managing project execution, monitoring progress and managing change. Documentation and communication, and Common problems in project execution. Managing Project Control and Closure: Obtaining information, Cost control, Change control, administrative closure, Personnel closure, Contractual closure and Project auditing.

Minimum Academic Standards

Equipment

A Computer Science programme should have at least three categories of laboratories: software, network and hardware laboratories. Best practice requires a staff to students' ratio of 1:20 for laboratory practical. Therefore, multiple small laboratories are preferable to a few large ones. Courses with large enrolments should have the students partitioned into groups to ensure each student has a computer/practice equipment to themselves during practical sessions. Laboratory sessions should be conducted by staff to ensure close monitoring and effective achievement of Learning Outcomes.

Software laboratory

Software laboratory support programming and other courses requiring use of software tools. Requirements for the software laboratory include:

1. Computer systems with capacity to run software systems for all lab-based courses (e.g., Desktop PC with minimum of 1,6 GHz or faster processor with at least 2 GB RAM and 500 GB hard disk space.) A maximum of 3 students to 1 computer system is recommended.
2. Programming environment and tools (e.g., Compilers/interpreters, debuggers, etc. for Java, Python, compiler compilers, e.g., flex, yacc, SableCC, etc,)
3. Operating systems environments and tools (e.g., Windows, LINUX, TempOS, Nachos, Xinu or MiniOS)
4. Tools for systems analysis and design (e.g., Unified Modelling Language (UML))
5. Computer maintenance tools like dust blowers and toolbox
6. Overhead projector
7. Power backup

Network laboratory

A separate network laboratory is required to expose students to practice on net-centric courses. Requirements for the network laboratory include:

1. Computer systems (hosts running LINUX or Windows). A maximum of 3 students to 1 computer system is recommended.
2. Routers, Switches, Radio modems, etc.
3. Dialup modems and PABXs
4. Patch panels
5. Simulation software like Packet tracer, NS Simulator or others
6. LAN testers, crimping tools, etc.
7. Practical consumables (RJ-45 connectors, twisted pair cable, etc.)

Hardware laboratory

The hardware laboratory should provide facilities required for hardware-related practicals. Requirements for the hardware laboratory include:

1. NAND, NOR, XOR, AND, OR gates
2. Multiplexers
3. Master-slave flip-flops
4. Digi-Designer Logic Board, etc
5. Dual–trace oscilloscope
6. Digital Proto-Board
7. Computer casing
8. Motherboard
9. ROMs/RAMs
10. Hard drives
11. CD ROMs
12. Display screens
13. Fans
14. Connectors/Jumpers, etc.

Staffing

Personnel

Academic staff

The guidelines on academic staff/student ratio of 1:20 for Computing Programmes shall apply. To start any programme in Computing, there should be a minimum of six academic staff. There is a 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. The staff structure for the academic staff is expected to be 20: 35: 45 for Professors/Readers: Senior Lecturers: Lecturers 1 and below .

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.

Ratio of junior admin staff to academic staff shall be	1:10
Ratio of senior admin staff to academic staff shall be	1:10

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.

Ratio of Senior Technical Staff to Academic Staff shall be	1:10
Ratio of Junior Technical Staff to Academic Staff shall be	1:5

Library

Universities should leverage available technology to put in place rich databases and other electronic/digital libraries and information resources. In addition, current hard copies of reference and other textual materials should be provided centrally at the level of the Faculty. A well-equipped 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 the students enrolled in each academic programme. The funding of the Library should be in line with NUC guidelines.

Classrooms, Laboratories and Offices

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
Seminar space/per student	-	1.85
Laboratory space per FTE	-	7.50
Conference room	-	37.0

Adequate space should be provided for the Department. Effort must be made to provide the Department with at least:

Two (2) large laboratories calculated according to specifications of 7.5 m^2 per FTE. At least two lecture rooms capable of seating at least sixty students at the specification of 1 m^2 per FTE.

1. A departmental conference room.
2. A seminar room.
3. A staff common room.

Office Equipment

The following equipment should be provided in the offices:

1. Computers
2. Printers
3. Photocopying machines
4. Functional internet and e-mail facilities

Classroom Space and Examination Theatres

Adequate classrooms should be provided with enough chairs, tables and lecture delivery tools such as projector, whiteboards and smart boards. Examination halls and theatres should be provided to minimise the rate of examination malpractices.

Classroom Equipment

The following equipment should be provided in the offices:

1. Multimedia projectors
2. Whiteboards or Smartboards
3. Functional internet and e-mail facilities

B.Sc. Cybersecurity

Overview

Recent developments in computing, network technologies, internet, and cloud technologies have generated the need for reliability and secure exchange of digital information that are vital to most human activities such as banking, medicine, infrastructure management and elections. As the use of information technology expands, so are the potential consequences of cyber-attacks, and the need for a skilled workforce to prevent and defend against them. However, the pool of available talent to build and certify applications designed to withstand attacks, diagnose and prevent security intrusions is inadequate to meet the growing needs all over the world. Government agencies, business organisations, industries and military are scrambling to find qualified professionals to safeguard their systems, businesses and infrastructures.

The focus of this programme is to equip students with sufficient knowledge, and skills to minimise and prevent cybersecurity threats and incidents. Students are also equipped with demonstrable abilities to gather, analyse, and present evidence of any cybersecurity bridges in organisation in a professional way. The graduates of this programme will understand the impact of cybercrime on business and the public and be able to identify and implement specific security practices, features and techniques to enhance the security of computers, computer-based systems and cyberspace.

Philosophy

The philosophy of the programme is to build capacity and develop human capital in the field of cybersecurity, to safeguard business transactions, corporate assets, critical infrastructure and all cyber operations in cyberspace, nationally and globally.

Objectives

The objectives are to:

1. produce graduates with requisite foundation knowledge of cybersecurity, skills and strategies that would enable them to detect and prevent cyber-fraud;
2. empower graduates with the ability to analyse cybersecurity threats, attacks and risks for organisations, with the capacity to develop detective codes and supportive software agents to address cybersecurity threats;
3. develop graduates with knowledge of cryptography and steganography for privacy of information on computer systems and digital forensic science techniques for the detection of cybercrimes;
4. produce graduates who can think critically about cyber intelligence security issues, develop and implement tactics strategic to cybersecurity, drawing on national and international recent case studies;
5. prepare graduates for the purpose of self-employment, cybersecurity-based job placement and professional practice in government and industries.

Unique Features of The Programme

The uniqueness of the cybersecurity programme is the introduction of big data analytics, cyber threat intelligence and cyber conflict, deep and dark web security, cyber threat hunting,

monitors and controllers, artificial intelligence cyber defence application and surveillance in cyber defence operations.

Employability Skills

Cybersecurity skills are hard skills that are required in all jobs. The employability skills are grouped into soft and hard skills along with technical and implementation skills. Graduates of Cybersecurity will have:

1. soft skills of excellent presentation and communications skills, ability to clearly articulate complex cyber-concepts, and usage of active listening skills.
2. technical skills of understanding the architecture, administration, and management of operating systems, networking, and virtualisation software; usability of firewalls and network load balancers; software development concepts and software analytics skills; common programming languages; and obtaining cybersecurity certifications essential and prerequisite for employment.
3. implementation skills of cyber hunting, cyber intelligence and cyber threat modelling; vulnerability assessment; identify the cybersecurity controls in place and how they are used; and use of the coding skills to write codes that automate cybersecurity tasks.

21st Century Skills

Cybersecurity students will be required to have the following 21st century skills:

1. Problem-solving skills;
2. Critical thinking;
3. Communication skills;
4. Creativity;
5. Collaboration;
6. Information literacy;
7. Global awareness;
8. Innovation skills; and
9. Social skills.

Admission And Graduation Requirements

Admission requirements

4 Year Degree Programme

In addition to appropriate UTME-Score, a candidate must possess five Senior Secondary Certificate (SSC)-credits passes including English Language, Mathematics, Physics and any other relevant Science subjects in not more than two sittings.

3 Year Degree Programme:

Direct Entry

A minimum of a credit at the University/National Diploma or NCE with other five Senior Secondary Certificate (SSC) credit passes in relevant Science subjects three of which must be in English Language, Mathematics, Physics.

Minimum duration

The minimum duration of the Cybersecurity degree programme is four academic sessions for UTME students, however, it is three academic sessions for candidates admitted to the 200 Level.

Graduation requirements

To be eligible for the award of the Bachelor degree in Cybersecurity, a student must have:

1. Passed all the core courses, university and faculty/school required courses and electives.
2. Accumulated a minimum of 120 course units for students admitted through UTME and 90 course units for students admitted to 200 level.
3. Attain a minimum CGPA of 1.00.

To graduate, a student must be found worthy in character throughout the period of his/her studentship and must accumulate the total units prescribed for the programme from Core, Faculty and General Studies courses as well as SIWES, Seminar and Final Year Project.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	0
MTH 101	Elementary Mathematics I	2	C	30	0
MTH 102	Elementary Mathematics II	2	C	30	0
PHY 101	General Physics I	2	C	30	0
PHY 102	General Physics II	2	C	30	0
PHY 107	General Practical Physics I	1	C	0	45
PHY 108	General Practical Physics II	1	C	0	45
STA 111	Descriptive Statistics	3	C	45	0
COS 101	Introduction to Computing Sciences	3	C	30	45
COS 102	Problem Solving	3	C	30	45
	TOTAL	**23**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	0
ENT 211	Entrepreneurship and Innovation	2	C	15	45
COS 201	Computer Programming I	3	C	30	45

COS 202	Computer Programming II	3	C	30	45
CYB 201	Introduction to Cybersecurity and Strategy	2	C	30	0
CYB 203	Cybercrime, Law and Countermeasures	2	C	30	0
CYB 299	SIWES I	3	C	0	135
INS 204	Systems Analysis and Design	3	C	30	45
SEN 201	Introduction to Software Engineering	2	C	30	0
	TOTAL	**22**			

NOTE: ***SIWES I and II will take place during long vacations of 200 Level and 300 Level.

300 Level

Course Code	**Course Title**	**Unit(s)**	**Status**	**LH**	**PH**
GST 312	Peace and Conflict Resolution	2	C	30	0
ENT 312	Venture Creation	2	C	15	45
CYB 301	Cryptography Techniques, Algorithms and Applications	2	C	15	45
CYB 302	Biometrics Security	2	C	15	45
CYB 303	Cybersecurity Risks Analysis, Challenges and Mitigation	2	C	30	0
CYB 304	Information and Big Data Security	2	C	15	45
CYB 305	Digital Forensics and Investigation Methods	2	C	15	45
CYB 322	Cybersecurity Innovation and New Technologies	2	C	15	45
CYB 399	SIWES II	3	C	0	135
CSC 309	Artificial Intelligence	2	C	15	45
	TOTAL	**21**			

400 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
COS 409	Research Methodology and Technical Report Writing	3	C	45	0
CYB 401	Systems Vulnerability Assessment and Testing	2	C	15	45
CYB 402	Steganography-Access Methods and Data Hiding	2	C	15	45
CYB 403	Cyber Threat Intelligence and Cyber Conflict	2	C	30	0
CYB 404	Cloud Computing Security	2	C	30	0
CYB 405	Ethical Hacking and Reverse Engineering	2	C	15	45
CYB 406	Deep and Dark Web Security	2	C	15	45
CYB 497	Final Year Project I	3	C	0	135
CYB 498	Final Year Project II	3	C	0	135
	TOTAL	**21**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH15; PH 45)

Learning Outcomes

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

1. identify possible sound patterns in English Language;
2. list notable language skills;
3. classify word-formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents

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

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

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

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

1. understand the basic definition of Set, Subset, Union, Intersection, Complements, and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. understand various types of numbers; and
5. solve some problems using the Binomial theorem.

Course Contents

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

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

Learning Outcomes

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

1. understand types of rules in Differentiation and Integration;
2. understand the meaning of Function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents

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

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

Learning Outcomes

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

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

Course Contents

Space and time; units and dimension, Vectors and Scalars, Differentiation of vectors: displacement, velocity and acceleration; kinematics; Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation); Relative motion; Application of Newtonian mechanics; Equations of motion; Conservation principles in physics, Conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass; Rotational motion; Torque, vector product, moment, rotation of coordinate axes and angular momentum. Polar coordinates; conservation of angular momentum; Circular motion; Moments of inertia, gyroscopes and precession; Gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General physics II (Electricity & magnetism) (2 Units C: LH 30)

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;

4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents

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

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

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

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

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

STA 111: Descriptive Statistics (3 Units C: LH 45)

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

1. explain the basic concepts of descriptive statistics.
2. present data in graphs and charts.
3. differentiate between measures of location, dispersion and partition.
4. describe the basic concepts of Skewness and Kurtosis as well as their utility function in a given data set.
5. differentiate rates from ratio and how they are use.
6. compute the different types of index number from a given data set and interpret the output.

Course content
Statistical data. Types, sources and methods of collection. Presentation of data. Tables chart and graph. Errors and approximations. Frequency and cumulative distributions. Measures of location, partition, dispersion, skewness and Kurtosis. Rates, ratios and index numbers.

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

Learning Outcomes

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

1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents

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

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

COS 102: Problem Solving (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. explain problem solving processes;
2. demonstrate problem solving skills;
3. describe the concept of algorithms development and properties of algorithms;
4. discuss the solution techniques of solving problem;
5. solve computer problems using algorithms, flowcharts, pseudocode; etc.; and
6. solve problems using programming language using C, PYTHON, etc.

Course Contents

Introduction to the core concepts of computing. Problems and problem-solving. The identification of problems and types of problems (routine problems and non-routine problems). Method of solving computing problems (introduction to algorithms and heuristics). Solvable and unsolvable problems. Solution techniques of solving problems (abstraction, analogy, brainstorming, trial and error, hypothesis testing, reduction, literal thinking, means-end analysis, method of focal object, morphological analysis, research, root cause analysis,

proof, divide and conquer). General Problem-solving process. Solution formulation and design: flowchart, pseudocode, decision table, decision tree. Implementation, evaluation and refinement. Programming in C, Python etc.

Lab Work: Use of simple tools for algorithms and flowcharts; writing pseudocode; writing assignment statements, input-output statements and condition statements; demonstrating simple programs using any programming language (Visual Basic, Python, C)

200 Level

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

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

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

7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents

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

COS 201: Computer Programming I (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. explain the principles of good programming and structured programming concepts;
2. explain the programming constructs, syntax and semantics of a higher-level language;
3. describe the chosen programming language variables, types, expressions, statements and assignment; simple input and output;
4. describe the programme control structures, functions and parameter passing, and structured decomposition; and
5. develop simple programmes in the taught programming language as well as debug and test them.

Course Contents

Essentials of computer programming. Types of programming: Functional programming; Declarative programming; Logic programming; object-oriented programming. Scripting languages; structured programming principles. Basic data types, variables, expressions, assignment statements, and operators. Basic object-oriented concepts: abstraction; objects; classes; methods; parameter passing; encapsulation. Class hierarchies and programme organisation using packages/namespaces. Use of API – use of iterators/enumerators, List, Stack, Queue from API. Searching; sorting; Recursive algorithms. Event-driven programming: event-handling methods; event propagation; exception handling. Introduction to Strings and string processing. Simple I/O; control structures; Arrays. Simple recursive algorithms; inheritance; polymorphism.

Lab work: Programming assignments; design and implementation of simple algorithms, e.g., average, standard deviation, searching and sorting. Developing and tracing simple recursive algorithms. Inheritance and polymorphism.

COS 202: Computer Programming II (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. demonstrate the principles of good programming and structured programming concepts;
2. demonstrate string processing, internal searching, sorting, and recursion;
3. demonstrate the basic use of OOP concepts: classes, objects, inheritance, polymorphism, data abstraction;
4. apply the tools for developing, compiling, interpreting and debugging programmes; and
5. demonstrate the use of syntax and data objects, operators. Central flow constructs, objects and classes programming, Arrays, methods, Exceptions, Applets and the Abstract, OLE, Persistence, Window Toolkit.

Course Contents

Review and coverage of advanced object-oriented programming - polymorphism, abstract classes and interfaces. Class hierarchies and programme organisation using packages/namespaces. Use of API – use of iterators/enumerators. List. Stack. Queue from API. Searching. Sorting. Recursive algorithms. Event-driven programming: event-handling methods; event propagation; exception handling. Applications in Graphical User Interface (GUI) programming.

Lab work: Programming assignments leading to extensive practice in problem-solving and programme development with emphasis on object-orientation. Solving basic problems using static and dynamic data structures. Solving various searching and sorting algorithms using iterative and recursive approaches. GUI programming.

CYB 201: Introduction to Cybersecurity and Strategy (2 Units C: LH 30)

Learning Outcomes

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

1. explain cybersecurity concepts, its methods, elements, and terminologies of cybersecurity, security, threat, attack, defence, and operations;
2. describe common cyber-attacks and threats, cybersecurity issues, challenges and proffered solutions, and build an enhanced view of main actors of cyberspace and cyber operations;
3. apply the techniques for identifying, detecting, and defending against cybersecurity threats, attacks and protecting information assets;
4. explain the impact of cybersecurity on civil and military institutions, privacy, business and government applications;
5. identify the methods and motives of cybersecurity incident perpetrators, and the countermeasures employed by organisations and agencies to prevent and detect those incidences and software application vulnerabilities; and
6. state the ethical obligations of security professionals, evaluate cybersecurity and national security strategies to the typologies of cyber-attacks that require policy tools and domestic response, and define the cybersecurity requirements and strategies evolving in the face of big risk.

Course Contents

Basic concepts: cyber, security, confidentiality, integrity, availability, authentication, access control, non-repudiation and fault-tolerant methodologies for implementing security. Security policies, best current practices, testing security, and incident response. Risk management,

disaster recovery and access control. Basic cryptography and software application vulnerabilities. Evolution of cyber-attacks. Operating system protection mechanisms, intrusion detection systems, basic formal models of security, cryptography, steganography, network and distributed system security, denial of service (and other) attack strategies, worms, viruses, transfer of funds/value across networks, electronic voting, secure applications. Cybersecurity policy and guidelines. Government regulation of information technology. Main actors of cyberspace and cyber operations. Impact of cybersecurity on civil and military institutions, privacy, business and government applications; examination of the dimensions of networks, protocols, operating systems, and associated applications. Methods and motives of cybersecurity incident perpetrators, and the countermeasures employed by organisations and agencies to prevent and detect those incidences. Ethical obligations of security professionals. Trends and development in cybersecurity. Software application vulnerabilities. Evolution of cybersecurity and national security strategies, requirements to the typologies of cyber-attacks that require policy tools and domestic response. Cybersecurity strategies evolving in the face of big risk. Role of standards and frameworks.

CYB 203: Cybercrime, Law and Countermeasures (2 Units C: LH 30)

Learning Outcomes

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

1. discuss cybercrimes, including computer crimes, internet fraud, e-commerce, and threats to the national infrastructure;
2. review the policies, legal issues, investigative techniques and strategies, implications for investigation and enforcement on a global scale;
3. analyse the cyber law of Nigeria and some other countries with the penalties attached to each of the cyber laws;
4. describe cyber law application at the international and national levels with examples from Africa, European, North American, South American and Asian countries;
5. compare the cyber law framework and countermeasures in Nigeria with other countries; and
6. state the challenges and opportunities for enforcement of cyber law in Nigeria.

Course Contents

General introduction on cybercrime. Definition of cybercrime. Types and categories of cybercrime and threats to the national critical infrastructure. Investigation process and procedure for cybercrime. Strategies of cybercrime perpetrators. Possible ways of curbing/preventing them. Technical aspects of computer cybercrime investigations, threats, and types of attacks and defences used by terrorists and criminals. Successful use of online social networks for cybercrime investigation. Concepts, trends, and methods in computer and network forensics investigations. Skills and knowledge in digital evidence collection and evaluation. Policies, legal issues, international jurisdiction, and privacy issues. Introduction to cyber law and countermeasures. Studies in cyber law application at the international and national levels with examples from European, North American, South American and Asian Countries. The cyber law framework in Nigeria. Challenges and opportunities for cyber law and countermeasure enforcement in Nigeria.

CYB 299: SIWES I (3 Units C: PH 135)

Learning Outcomes

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

1. assess their knowledge of cybersecurity, its application, preventive measures and defence of the cyber environment;
2. explain how a typical cybersecurity unit/department of an organisation operates;
3. describe the various assignments carried out and the skills acquired during the SIWES period; and
4. submit a comprehensive report on the knowledge acquired and the experience gained during the exercise.

Course Contents

Students are attached to private and public organisations for a period of three months during the second year session long break with a view to making them acquire practical experience and to the extent possible, develop skills in all areas of Cybersecurity. Students are supervised during the training period and shall be expected to keep records designed for the purpose of monitoring their performance. They are also expected to submit a report on the experience gained and defend their reports.

INS 204: Systems Analysis and Design (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. describe system requirements gathering techniques;
2. explain data modelling technique (entity relationship modelling);
3. explain process modelling technique (data flow diagram);
4. describe system architectural design;
5. describe process and database design; and
6. explain user interface design.

Course Contents

Structured approach to analysis and design of information systems for businesses. Software development life cycle. Structured top-down and bottom-up design. Dataflow diagramming. Entity relationship modelling. Computer aided software engineering. Input and output, prototyping design and validation. File and database design. Design of user interfaces. Comparison of structured and object-oriented design.

Lab work: Practical exercises on software development life cycle (SDLC) activities with different case studies. Use of different information systems case studies to apply the knowledge of structured top-down and bottom –up design, dataflow diagram and entity relationship models.

SEN 201: Introduction to Software Engineering (2 units; C) (LH 30)

Learning Outcomes

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

1. describe the concept of the software life cycle;
2. explain the phases of requirements analysis, design, development, testing and maintenance in a typical software life cycle;
3. differentiate amongst the various software development models;
4. utilise UML for object oriented analysis and design;
5. describe different design architectures;
6. explain the various tasks involved in software project management; and
7. describe the basic legal issues related to Software Engineering.

Course Contents

Software Engineering concepts and principles. Design, development and testing of software systems. Software processes: software lifecycle and process models. Process assessment models. Software process metrics. Life cycle of software system. Software requirements and specifications. Software design. Software architecture. Software metrics. Software quality and testing. Software architecture. Software validation. Software evolution: software maintenance; characteristics of maintainable software; re-engineering; legacy systems; software reuse. Software Engineering and its place as a computing discipline. Software project management: team management; project scheduling; software measurement and estimation techniques; risk analysis; software quality assurance; software configuration management. Software Engineering and law.

300 Level

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

Learning Outcomes

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

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

Course Contents

Concepts of Peace, Conflict, and Security in a multi-ethnic nation. Types and Theories of Conflicts: Ethnic, Religious, Economic, Geo-political Conflicts; Structural Conflict Theory, Realist Theory of Conflict, Frustration-Aggression Conflict Theory. Root causes of Conflict and Violence in Africa: Indigene and settlers Phenomenon; Boundaries/border disputes; Political disputes; Ethnic disputes and rivalries; Economic Inequalities; Social disputes; Nationalist Movements and Agitations; Selected Conflict Case Studies – Tiv-Jukun; Zango Kataf, Chieftaincy, and Land disputes, etc. Peace Building, Management of Conflicts and Security:

Peace & Human Development. Approaches to Peace & Conflict Management --- (Religious, Government, Community Leaders, etc.). Elements of Peace Studies and Conflict Resolution: Conflict dynamics assessment Scales: Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice; The Nigeria Legal System. Insurgency and Terrorism. Peace Mediation and Peace Keeping. Peace & Security Council (International, National, and Local levels) Agents of Conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution, ADR. a) Dialogue b). Arbitration, c). Negotiation d). Collaboration, etc. Roles of International Organisations in Conflict Resolution. (a). The United Nations, UN, and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping. Media and Traditional Institutions in Peace Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis

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

Learning Outcomes

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

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

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/market research, Unutilised resources, Social and climate conditions, and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (venture capital, equity finance, microfinance, personal savings, small business investment organisations, and business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first mover advantage, e-commerce business models and successful e-commerce companies,). Small business management/family business: Leadership & Management, basic bookkeeping, nature of family business and family business growth model. Negotiation and business communication (Strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological solutions (the concept of market/customer solution, customer solution, and emerging technologies, business applications of new technologies- Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoT), Blockchain, Cloud Computing, renewable energy, etc. digital business and e-commerce strategies).

CYB 301: Cryptography Techniques, Algorithms and Applications (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. define cryptography means, simple cryptosystems, symmetric and asymmetric cryptography, symmetric cryptosystems and asymmetric cryptosystems;
2. differentiate key management and encryption algorithms, types of cryptography and cryptographic techniques;
3. practice cryptanalysis of cipher and how to use protocols, hashing, digital signatures, and certificates;
4. examine the certificate authorities, policies, procedures, and methods for the proper use of cryptography in secure systems;
5. identify public-key cryptography and discrete algorithms, cryptography and its mathematical background, and understand hash functions, data integrity, authentication, algorithmic number theory, primality testing and true primality testing; and
6. discuss factoring integers, RSA, security of RSA encryption, security of RSA key generation, discrete logarithm cryptographic schemes.

Course Contents

Introduction to cryptography, symmetric and asymmetric cryptography, key management, and encryption algorithms. Introduction to simple cryptosystems. Cryptanalysis. Stream ciphers, Block ciphers and Feistel ciphers. Multiple encryption. Hash functions. Data integrity, authentication, and perfect secrecy. Public-key cryptography and discrete algorithms-ELGamal cryptography. Algorithms for the discrete logarithm problem. Algorithmic number theory. Probabilistic primality testing. Security of ELGamal and RSA Encryption, and RSA Key Generation. Discrete logarithm cryptographic schemes. Conventional and public-key cryptography. Selected cryptosystems, including Data Encryption Standard (DES) and Rivest-Shamir-Adleman (RSA) algorithm. AES encryption algorithm, a symmetric 128-bit block data encryption technique. PKI, SSL, and VPN. Digital signatures, pseudo-random number generation, cryptographic protocols and cryptanalytic techniques. Use of protocols, hashing and certificates and certificate authorities. Policies, procedures, and methods for the proper use of cryptography in secure systems. Applications of cryptography to signal.

Lab work: Practical exercise on writing cryptography algorithms. Work on cryptographic techniques. Practice cryptanalysis of cipher and how to use protocols. Understand hash functions and learn how to hash, produce secured digital signatures and certificates. Learn the procedures and methods for the proper use of cryptography in secure systems. Practice primality testing. Practical assignments on ELGamal, DES and RSA encryption security, generation of RSA key and discrete logarithm cryptographic schemes.

CYB 302: Biometrics Security (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. discuss biometric algorithms and data analysis along with digital image/signal processing;

2. apply automated biometric identification: hands-fingers, palms and hands; heads-face, voice and eyes and other biometrics;
3. develop methods of obtaining biometric data and matching basics;
4. practice biometric authentication, enrolment, matching performance, setting a threshold. biometric authentication, matching data, ground truth, calculating errors rates and graphs;
5. create storage of biometric data elements, quality, upgrades, data security and integrity;
6. analyse privacy issues, security strength, recognition rates and other aspects of biometrics, passwords and smart cards; and
7. explore applications of biometrics and future trends.

Course Contents

Introduction to biometrics and digital image processing. Matlab in biometric image/signal processing. Biometric algorithms and systems with emphasis on face, fingerprint, eyes (iris), speech (voice). Automated biometric identification multimodal biometrics. Biometric data: raw data, template data, and data methods. Biometric matching basics: biometric authentication, enrolment, correct user, and incorrect user. Match threshold and matching performance. Setting a threshold. Biometric authentication: matching data, ground truth, calculating errors rates and graphs. Biometric data: Storage of biometric data elements, transactions, errors and quality upgrades. Data security and integrity. Privacy issues and other aspects of biometrics. Applications of biometrics and future trends. Challenging issues: security strength and recognition rates. Alternatives of passwords and smart cards.

Lab work: Practical exercise on biometric capture, image processing, matching threshold and performance. Learn the practical aspect of automated biometric identification of multimodal, authentication and calculation of error rates. Work on biometric algorithms, privacy and security of stored biometric data.

CYB 303: Cybersecurity Risks Analysis, Challenges and Mitigation (2 Units C; LH 30)

Learning Outcomes

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

1. describe the cybersecurity risks, how to avoid/prevent them and state the cybersecurity challenges and the path forward;
2. apply the decision and risk analysis techniques, and devise how to mitigate risks and vulnerabilities;
3. develop the effective use of assessments for cybersecurity risk mitigation in the cloud and how to use proactive measures to mitigate critical cybersecurity challenges;
4. analyse the implications of information technology to national development, cyber-attacks, control, distribution and safety of information with a review of the economic and geopolitical factors that have made African countries vulnerable to cyber-attacks;
5. review what information security means and the principles of applied information security management, and examine the governance and security policy, threat and vulnerability management, risk assessment and management frameworks, information leakage, crisis management and legal security implementation considerations;
6. explore ISO 27000 series and the Plan-Do-Check-Act model, and assess threats and vulnerabilities, incident response, forensics and investigations; and
7. describe how to deal with classified/sensitive data, legal and regulatory drivers and practical considerations when implementing the frameworks to address current and future threats.

Course Contents

Principles of applied information security management. Cybersecurity challenges. Cybersecurity risks, challenges and the path forward. Recognising risks. Overview of decision and risk analysis techniques. Mitigating risks and vulnerabilities. Effective use of assessments for cybersecurity risk mitigation. Mitigating cybersecurity risk with the cloud. Proactive measures mitigate critical cybersecurity challenges. Critical corporate and military cybersecurity risks. Evolving challenges in cyber risk management. The social implication of information technology to national development, cyber-attacks, control, distribution and safety of information. Economic and geopolitical factors that have made African countries vulnerable to cyber-attacks and the steps that can be taken to address this. Governance and security policy. Threat and vulnerability management. Incident management, risk assessment and risk management frameworks. Information leakage, crisis management and business continuity. Legal and compliance, security awareness and security implementation considerations. ISO 27000 series and the Plan-Do-Check-Act model. Assessment of threats and vulnerabilities. Incident response, forensics and investigations. Dealing with classified/sensitive data. Legal and regulatory drivers and issues. Certification. Common criteria, security education and training. Practical considerations when implementing the frameworks to address current and future threats.

Lab work: Practical approach to cyber hygiene. Practice cybersecurity risk mitigation in the cloud and how to use proactive measures to mitigate the learned challenges. Work on applying the decision and risk analysis techniques. Master how to mitigate risks and vulnerabilities.

CYB 304: Information and Big Data Security (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. describe information security, big data, big data characteristics, techniques, tools and technologies, operational and analytical big data;
2. explore information and big data security, challenges, requirements, and the lifecycle security management;
3. identify the basic policies on information and big data security methodologies;
4. apply knowledge of information and big data security risk management, security;
5. policies, security in the systems-engineering process and big data handling techniques;
6. examine big data skills, adoption, platform, components and governance, and how to use the cloud for big data;
7. analyse how big data is driving organisational change, and essential analytical tools and techniques used in developing big data solutions; and
8. apply machine learning techniques, analyse big data recommendations, and cloud-based big data analysis.

Course Contents

Introduction to big data. Small data vs. big data. What is big data? The evolution of data/big data. Big data characteristics-3Vs/6Vs. Unique features of big data. Importance of big data? Why does big data matter? Sources of big data. Formats of data. Applications of big data. Use case- issues and solutions. Big data technology. Big data as an opportunity. Example of big

data. Big data statistics. Business intelligence vs. big data vs. data mining. Big data handling and techniques. Using the cloud for big data. Big data challenges/problems. How businesses are utilising big data. Big data technologies. Operational and analytical big data. Big data skills. Big data adoption. Big data analysis in practice. Case study session, preparation of case study report and presentation. The big data platform and key aspects. Governance for big data. Big data components. Big data driven organisational change and essential analytical tools and techniques. Develop big data solutions. System and management view of information and big data security. Requirements for information and big data security. Systems-design process and lifecycle security management of information systems. Basic policies on information security and methodologies. Information-security risk management, security policies, security in the systems-engineering process. Laws related to information security and management of operational systems. Apply machine learning techniques and other big data programming languages. Analyse big data recommendations. Cloud-based big data analysis.

Lab work: Practice on data acquisition and how to initiate discovery on raw data using discovery systems. Learn Big Data analytics skills. Practical procedure for the crafting of an enterprise-scale cost-efficient Big Data and machine learning solution to uncover insights and value from data. Use the practical exercises to bridge the gap between the theoretical world of technology with the practical ground reality of building corporate Big Data and data science platforms. Hands-on exposure to Hadoop and Spark (or any of the BD tools), build machine learning dashboards using R and R Shiny, create web-based apps using NoSQL databases. Practical assignment of information and BD security.

CYB 305: Digital Forensics and Investigation Methods (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. develop basic knowledge on digital forensic and digital evidence;
2. establish awareness of digital evidence challenges aspects of digital evidence;
3. appraise the cyber trail and its challenges;
4. review the evolution of investigative tools and the language of computer crime investigation;
5. identify the role of computers in crime, technology and law;
6. examine techniques and tools used by computer forensics investigations; and
7. apply best practices in securing, processing, acquiring, examining, and reporting on digital evidence with current technologies and methods in forensics investigation.

Course Contents

Introduction to digital forensics, digital evidence, and increasing awareness of digital evidence. Challenging aspects of digital evidence. Best practices in securing, processing, acquiring, examining and reporting on digital evidence. Cyber trail and challenging aspects of the cyber trail. Brief history of computer crime and cybercrime investigation. Cyber auditing. Evolution of investigative tools. Language of computer crime investigation. The role of computers in crime, technology and law, jurisdiction, pornography and obscenity, child pornography, privacy, copyrights and the "theft" of digital intellectual property. The investigative process and investigative reconstruction, with digital evidence. Examine techniques and tools used by computer forensics investigations such as acquisition, preservation, recovery, and analysis of

evidence obtained from portable and stationary computer storage devices, personal digital assistants (PDAs), and cell phones. Current technologies and methods as well as leading edge techniques with practical based exercises/projects and research opportunities.
Lab work: Practical exercises on how to make use of various techniques and tools for computer forensics investigations and cyber trail during cybercrime investigations. Practice cyber auditing skills. Work on applying the best practices in securing, processing, acquiring, examining and reporting on digital evidence with current technologies and methods in forensics investigation.

CYB 322: Cybersecurity Innovation and Entrepreneurship (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. explain business models;
2. identify some entrepreneurial opportunities available in Cybersecurity;
3. describe business plan and business startup process;
4. explain business feasibility and strategy;
5. explain marketing strategies; and
6. discuss business ethics and legal issues

Course Contents
Fundamental concepts of innovation, and business ideas in general. Product development. Business leadership. Digital marketing. Entrepreneurial opportunities in Cybersecurity. Legal issues and business ethics. New venture creation process. Business feasibility planning. Market research. Business strategy. Business models and business plans. Technical presentations. Report on a successful entrepreneurial outfit.

CYB 399: SIWES II (3 Units C: PH 135)

Learning Outcomes
At the end of this training, students should be able to:
1. explain how a typical cybersecurity firm operates;
2. describe the various assignments carried out and the skills acquired during the SIWES period; and
3. submit a comprehensive report on the knowledge acquired and the experience gained during the exercise.

Course Contents
Students are attached to private and public organisations for a period of three months during the third year session-long break with a view to making them acquire additional practical experience in all areas of Cybersecurity over and above what is gained in CYB 299. Students are supervised during the training period and shall be expected to keep records designed for the purpose of monitoring their performance. They are also expected to submit a report on the experience gained and defend their reports.

CSC 309: Artificial Intelligence (2Units C: LH 15; PH 45)

Learning Outcomes

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

1. explain Artificial Intelligence(AI) fundamentals, concepts, goals, types, techniques, branches, applications, AI technology and tools;
2. discuss intelligent agents, their performance, examples, faculties, environment and architectures, and determine the characteristics of a given problem that an intelligent system must solve;
3. describe the Turing test and the "Chinese Room" thought experiment, and differentiate between the concepts of optimal reasoning/behaviour and human-like reasoning/behaviour;
4. describe the role of heuristics and the trade-offs among completeness, optimality, time complexity, and space complexity;
5. analyse the types of search and their applications in AI and describe the problem of combinatorial explosion of search space and its consequences;
6. demonstrate knowledge representation, semantic network and frames along with their applicable uses;
7. practice Natural Language Processing, translate a natural language (e.g., English) sentence into a predicate logic statement, convert a logic statement into clause form, apply resolution to a set of logic statements to answer a query; and
8. analyse programming languages for AI and expert systems technology, and employ application domains of AI.

Course Contents

Overview of Artificial Intelligence. History of AI. Goals of AI. AI Technique. Types of AI. Branches and applications of AI. Advantages and Disadvantages. Introduction to Intelligent Agents. Agent Performance, Examples of Agents, Agent Faculties, Rationality, Agent Environment. Agent Architectures. Search. General Classes of AI Search Algorithm Problems. Problem Solving by Search. Types of AI Search Techniques and Strategies. Introduction to the types of problems and techniques in AI. Problem-Solving methods. Major structures used in AI programmes. Knowledge Representation. KR and Reasoning Challenges. KR Languages. Knowledge representation techniques such as predicate logic, non-monotonic logic, and probabilistic reasoning. Semantic Network - types of relationships, semantic network inheritance, types and components. Introduction to Frames. Natural Language Processing (NLP). Introduction to natural language understanding and various syntactic and semantic structures. Introduction to Expert Systems - characteristics, components, types, requirements, technology, development. Programming Languages for AI. Introduction to computer image recognition.

Lab work: Group practical in (i) Turing test practical - Students can act out their own version of the Turing test (iii) Facial recognition practical to aid in teaching students how machine learning works with students simulating a facial recognition algorithm. Practical applications of NLP in groups – (i) Question Answering focuses on building systems that automatically answer the questions asked by humans in a natural language (ii) Spam detection application for detecting unwanted e-mails getting to a user's inbox (iii) Sentiment analysis/opinion mining should be used on the web to analyse the attitude, behaviour, and emotional state of the sender, implemented through a combination of NLP and statistics (iv) Practical exercise of machine translation used to translate text or speech from one natural language to another natural language such as the Google Translator (v) Developing a model to provide word processor software for the spelling correction (vi) Developing a model for speech recognition

for converting spoken words into text (vii) Implementing a Chatbot to provide the staff/student's chat services. OR
Group Practical exercise on agents and its environment using simulation of a colony of ants foraging for food; model simulating a message between agents; model simulating the flocking behaviour of birds; model to apply standard search algorithm to the classic search problem of missionaries and cannibals, and how to use communicating agents for searching networks. Some computer AI animation exercises for any branch of AI. Practical exercise on simple robots coupling and programming. Group project of building a lawn robot for trimming grasses, or any simple design and implementation of robotics.

400 Level

COS 409: Research Methodology and Technical Report Writing (3 Units C: LH 45)

Learning Outcomes

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

1. explain research, types, approaches and significance of research;
2. discuss statement of problem, research methods, methodology, research process, criteria and strategy for good research;
3. discuss scientific investigation, problem formulation, and technique of the research problem;
4. discuss the guidelines for constructing questionnaire/schedule, guidelines for successful interviewing, research proposal and research plan; and
5. explain types of reports, technical report writing, procedures and guidelines.

Course Contents

Foundations of Research. Types of Research. Research Approaches. Significance of Research. Research Methods versus Methodology. Research Process. Criteria and Strategy for Good Research. Problems Encountered by Researchers in Nigeria. Principles of Scientific Research. Scientific investigation. Problem formulation. Definition and technique of the Research Problem. Selection of Appropriate Method for Data Collection- Primary Data and Secondary Data. Guidelines for Constructing Questionnaire/Schedule. Guidelines for Successful Interviewing. Difference between Survey and Experiment. Eloping Research Proposal and Research Plan. Formulation of working hypothesis and Testing. Literature review. Procedure for reviewing related relevant studies and referencing cited works. Types of Reports. Technical Report Writing. Layout and mechanics of writing a Research Report. Standard Techniques for Research Documentation. Sampling Design. Different Types of Sample Designs. Steps in Sampling Design. Criteria of Selecting a Sampling Procedure. Methods of analysi**s.** Processing and Analysis of Data Elements/Types of Analysis. Interpretation and Presentation of results. How to prepare References and Bibliography.

CYB 401: Systems Vulnerability Assessment and Testing (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. define systems vulnerability, assessment methods and the testing methods using techniques to effectively identify and mitigate risks to the security of a company's infrastructure;
2. describe penetration testing methodologies, practice test planning and scheduling;

3. assess information gathering, password cracking penetration testing and security analysis;
4. examine the social engineering penetration testing and security analysis, internal and external penetration testing and security analysis, router penetration testing and security analysis, and effectively report and document results;
5. evaluate operating systems fingerprinting and remote network mapping, software and operational vulnerabilities, how to overcome these vulnerabilities; and
6. execute attack surface analysis, fuzz testing, patch management, and security auditing.

Course Contents

Definition of systems vulnerability. Methods and the testing methods using different techniques. Mitigation of risks and how to enhance the security of a company's infrastructure. Penetration testing methodologies, test planning and scheduling. Information gathering. Password cracking. Penetration testing and security analysis. Social engineering, Internal and external penetration testing. Router penetration testing, security analysis, reporting and documentation. Operating systems fingerprinting. Remote network mapping. Software and operational vulnerabilities. Attack surface analysis. Fuzz testing. Patch management. Security auditing.

Lab work: Practical exercise on systems vulnerability, assessment methods and the testing methods using techniques to effectively identify and mitigate risks to the security of a company's infrastructure. Perform penetration testing using various methodologies, along with the test planning and scheduling. Work on password cracking and social engineering penetration testing and security analysis. Identify software and operational vulnerabilities in a given environment and how to overcome these vulnerabilities. Execute attack surface analysis, fuzz testing, patch management, and perform security auditing.

CYB 402: Steganography: Access Methods and Data Hiding (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. discuss secret writing and different methods and tools used for each;
2. identify why steganography is important, and how it is different from cryptography and encryption;
3. describe the uses and applications of steganography, and how to use steganography methods and work with any of the steganography types and techniques;
4. practice the different steganography techniques for encrypting the data and use data hiding methods, techniques and access methods;
5. develop the information-hiding systems, steganography algorithm and security of a steganographic algorithm;
6. analyse how to detect steganography, finding images, and verifying hidden content; and
7. organise practical experimentation of data hiding tools, investigation techniques and the latest countermeasures.

Course Contents

History of secret writing. An overview of steganography. Introduction to steganography - Definition of steganography. Why is steganography important? Steganography vs. Encryption. Uses of steganography. Problem of steganography. Steganography applications and methods. Steganography types and methods - text steganography, images steganography, video and

audio steganography. Steganography techniques. Survey of different steganography techniques for encrypting the data. Information hiding: steganography and steganalysis. Data hiding methods, techniques and access methods. Requirements for data hiding. Steganography and Business - the basics of embedding, different aspects in information-hiding systems. Steganographic algorithm. Security of a steganographic algorithm. Steganography detection, finding images, and verifying hidden content. Research and practical experimentation of data hiding tools. Research on investigation techniques and the latest countermeasures.

Lab work: Practice secret writing using different methods and tools. Learn how to use steganography methods and techniques for encrypting the data. Master data hiding methods, techniques and access methods using case study exercises. Write samples steganography algorithm and secure the algorithm. Detect elements of steganography, finding images, and verifying hidden content in a given text, image, audio and video samples.

CYB 403: Cyber Threat Intelligence and Cyber Conflict (2 Units C: LH 30)

Learning Outcomes

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

1. employ the techniques for detecting, responding to and defeating organised cybercrimes and cyberwar activities;
2. analyse successful and unsuccessful advanced persistent threats and malware campaigns, divergent national and international policies for combating cyber terrorism, and terrorist tactics worldwide;
3. describe cyber threat intelligence and its role with the knowledge of the expectation of organisations and analysts, and the indicators of compromise;
4. discuss the cyber tactical threat intelligence, the kill chain, intrusion analysis, indicator lifecycle, cyber operational threat intelligence and strategic threat intelligence;
5. assess and learn the need for information sharing and peers, models and methods for managing cyber intelligence, and master campaigns and threat actors;
6. evaluate the role and skills of a cyber threat intelligence analyst and the threat modelling; and
7. identify the evolution of counterterrorism and cyber conflict.

Course Contents

Techniques for detecting, responding to and defeating organised cybercrimes and cyberwar activities. Analysing successful and unsuccessful advanced persistent threats and malware campaigns. Analyse divergent national and international policies for combating cyber terrorism and terrorist tactics worldwide. Understanding Cyber threat intelligence - defining threats, Understanding risk, Cyber threat intelligence and its rule, Expectations of organisations and analysts, and indicators of compromise. Tactical threat intelligence. Role of a tactical threat intelligence analyst, expected skills and tradecraft. The Kill Chain and Intrusion Analysis. Indicator lifecycle. Introduction to operational threat intelligence - Role of an operational threat intelligence analyst, Need for information sharing and peers. Models and methods for managing intelligence, campaigns and threat actors. Introduction to strategic threat Intelligence - role of a strategic threat intelligence analyst. Threat modelling, Organisational change and security posturing. Event recording and incident sharing. Evolution of counterterrorism and cyber conflict.

CYB 404: Cloud Computing Security (2 Units C: LH 30)

Learning Outcomes

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

1. review the concept of cloud, cloud computing, and benefits of the cloud and knowledge of cloud-enabling technologies, virtualisation and multi-tenanting;
2. describe cloud services and service-oriented architectures, and examine the cloud reference model and cloud service models such as IaaS, PaaS and SaaS;
3. state the cloud deployment models of Public, Private, Hybrid and Community clouds and express how to build a cloud, the open standards and open source cloud management tools, architectural best practices and how to design for the cloud;
4. discuss the security in the cloud and how to efficiently secure your cloud, security for cloud computing;
5. apply the economics of the cloud, costs and payment models, have knowledge of when to use the cloud, cloud strategy, standards and the future;
6. analyse data centres, servers, data storage, data centre networking and virtualisation, cloud cube model, cloud threats, threat mitigation, cloud and security risks, real world issues with cloud computing, and cloud security alliance; and
7. distinguish the National Institute of Standards and Technology, Information Assurance Framework, Cloud Audit, Cloud Management Audit/Assurance Programme, Cloud Business Continuity Planning for secured and effective management of the cloud.

Course Contents

Introduction to cloud computing, cloud computing vendors, cloud computing threats, cloud reference model. Cloud-enabling technologies. Services, Service-Oriented Architectures. Cloud service models. Cloud deployment models. Introduction to data centres: servers, data storage, networking and virtualisation. Data centre networking. Introduction to server virtualisation software: VMware VSphere. Virtual machine management: configuration, placement and resource allocation. Power efficiency in virtual data centres. Fault tolerance in virtual data centres**.** The cloud cube model and security for cloud computing. Security in the cloud. Cloud threats, threat mitigation and security risks. Real world issues with cloud computing. Cloud security alliance. National Institute of Standards and Technology, Information Assurance Framework. Cloud audit. Cloud management audit/assurance programme, Cloud business continuity planning. Building a cloud. Architectural best practices: Designing for the cloud. Economics of the cloud. Cloud strategy. Cloud standards and the future. Security of the cloud.

CYB 405: Ethical Hacking and Reverse Engineering (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. describe the concept of ethical hacking, attacks, threats, hackers, measures and countermeasures;
2. differentiate between attacks and threats and examine the ethical hacker strategies and understand their methods;
3. review how perimeter defences work, how intruders escalate privileges and methods of security systems, intrusion detection, policy creation, and social engineering;
4. explores techniques and technologies for understanding the operation of malicious software and attacks, and learn system hacking, malware threats, sniffing, social engineering, physical security, and password vulnerabilities - cracking passwords;

5. plan reverse engineering of code and network exploits as a method for understanding and development of countermeasures;
6. develop attack phases, secure network infrastructure hacking methodology, ethical hacking plans, footprinting and reconnaissance, and scanning networks; and
7. discuss denial of service, session hijacking, hacking web servers, hacking web applications, SQL injection, hacking wireless networks, hacking mobile platforms, and how to evade IDs, firewalls, and honeypots.

Course Contents

Introduction to ethical hacking, attacks, threats, hackers, measures and countermeasures. Overview of ethical hacker strategies. Focus on how perimeter defences work, how intruders escalate privileges and methods of security systems. Intrusion detection, policy creation, social engineering. Techniques and technologies for understanding the operation of malicious software and attacks. Threats and defence mechanisms. Attack phases. Secure network infrastructure. DDoS attacks, buffer overflows and virus creation. Network Infrastructure Attacks, Hacking Methodology, Developing ethical hacking plans. Footprinting and reconnaissance. Scanning Networks. Enumeration and system hacking. Malware threats. Sniffing. Social engineering. Physical security. Password vulnerabilities - cracking passwords. Denial of Service. Session hijacking. Hacking web servers. Hacking web applications. sql injection, hacking wireless networks. Hacking mobile platforms. Evading IDS, Firewalls, and Honeypots. Explores techniques and technologies for understanding the operation of malicious software and attacks. Techniques for detection, identification and prevention. Reverse engineering of code and network exploits as a method for understanding and development of countermeasures.

Lab work: Practice the ethical hacker strategies and methods. Work on a sample perimeter defences and identify how intruders escalate privileges and methods of security systems. Practical exercises on the techniques and technologies of malicious software and attacks. Learn how to perform system hacking, mobile platform hacking, crack password, remove introduced vulnerabilities and evade IDs, firewalls, and honeypots. Apply reverse engineering of code and network exploits as a method for understanding and development of countermeasures. Utilise foot printing and reconnaissance, and scanning networks.

CYB 406: Deep and Dark Web Security (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. review Deep and Dark web terminologies;
2. describe how to access the Deep web and the Dark web with complete ease and total security;
3. investigate advanced and famous websites located on the Hidden Web (Deep and Dark Web);
4. plan, trade, buy, sell as well as mining cryptocurrencies;
5. discuss the dangers as well as precautions to be taken care of while surfing the Web, and how to use Darknet E-mail services;
6. appraise how to anonymously access the Darknet and TOR hidden services (onion services), and how to enter the dark web while staying safe and avoid the bad side of the dark web; and
7. report on the best sites to visit while on the Dark web and Deep web.

Course Contents

Dark web, deep web, clear net. Tor Onion, Silk Road. How to get on the dark web. Users of dark and deep web. Invisible Web Search Engines. Privacy and anonymity as core values of the darknet. Decentralisation on the dark web. Accessing the Deep web and the Dark web through the TOR browser. Web security. Cryptocurrencies. Overview on Dark Web and Deep Web. The Hidden side/area of the web. Deep/Dark Web Anonymity, TOR, Hidden services, TAILS, Web Security, Cryptocurrencies. Crypto Trading and Cryptomining. Cryptocurrencies, Anonymity & Security. How to install a VPN, and adequate browsers like Chrome, Opera, or Firefox with tracking technologies**.** How Does the Dark Web Work? Reasons for Accessing the Dark Web. Security issues of Dark and Deep web. How to use the Tor over VPN method - Session logs storage. Encryption of traffic. Protection against malicious Tor exit nodes. How to use Tor over VPN - bypass blocked Tor nodes, ISP visibility in accessing onion content, susceptible to end-to-end timing attacks. Tor alternatives such as I2P, Matrix.org, Orbot, Globus Secure Browser, Comodo Ice Dragon and FreeNet. Cons and Pros of Tor. Use of virtual machine software. Navigating the Dark Web. The Hidden Wiki as Wikipedia's evil twin. Search engines such as DuckDuckGo, Torch, the triple-W Virtual Library, Uncensored Hidden Wiki, and ParaZite. Commercial services. Email clients. Darknet version of social media and instant messaging - Zuckerberg's Facebook, BlackBook, Torbook, Campfire, MadIRC Chat Server. Safety on the dark web. Inside the dark and deep web. The Best Sites and Services on the Dark Web. Deep web radio. Benefits of Deep and Dark web. Cyber Threats and Dangers on the Deep/DarkWeb. How to fight hackers underground. Dark web and Deep web monitoring. **Lab work**: Install your VPN. Practice how to access the Deep web and the Dark web with enhanced security. Investigate advanced and famous websites located on the Deep and Dark Web. Practically learn how to anonymously access the darknet and TOR hidden services (onion services), and how to enter the dark web while staying safe. Try to visit the best sites and buy an educational resource.

CYB 497: Final Year Project I (3 Units C: PH 135)

Learning Outcomes

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

1. identify a researchable project topic in cybersecurity, work on the introductory aspect, under the guidance of the supervisor;
2. review relevant recent literature pertinent to identified problem statement and establish the research gap;
3. acknowledge and reference sources of information used in the research report;
4. conceptualise and design a research methodology to address an identified problem;
5. determine tools for analysing data collected based on research objectives;
6. write a coherent proposal on the research project to be conducted; and
7. orally present the written project proposal.

Course Contents

An independent or group investigation of appropriate cybersecurity related problems carried out under the supervision of a lecturer. The student must submit a written proposal to the supervisor to review. The proposal should give a brief outline of the project with the statement of problem, aim, objectives, scope, significance, research gap, proposed research

methodology, estimated schedule of completion, and resources needed. A formal written report is essential and an oral presentation may also be required.
Topics from emerging trends such as applications in artificial intelligence, steganography, quantum computing, big data, cloud security, ethical hacking, cyber hunting, internet security, penetration testing, network intrusion and prevention, threat management, cybersecurity risk mitigation in the cloud, biometrics, digital image processing, Blockchain, quantum computing, edge computing, Internet of Things, 5G security, etc.

CYB 498: Final Year Project II (3 Units C:PH 135)

Learning Outcomes
Upon completion of the project, students should be able to:
1. conduct research methodology, analyse collected data, document the project report using the recommended format, and referencing style;
2. develop the prototype or simulated model of research study along with the programming aspect, if required;
3. produce the report; and
4. prepare the PowerPoint presentation and defend the project in the final oral examination in the presence of the external examiner.

Course Contents
This is a continuation of CYB 497. This includes the research methodology, analysis of data using statistical tools, performance evaluation, standard documentation of the project, referencing style, programming of the prototype/simulation model, plagiarism and grammarly check, and PowerPoint presentation skill. The formal written report made up of chapters four and five approved by the supervisor will be submitted to the Department for final grading. An oral presentation is required.

Minimum Academic Standards

Equipment
The Cybersecurity programme should have at least three categories of laboratories/workshop: software and simulation, cybernetic workshop, and forensic laboratories. Best practice requires a staff to student' ratio of 1:20 for laboratory practical. The students can be separated into groups to ensure each student uses the required tool/equipment for themselves during practical sessions. Laboratory sessions should be conducted by staff to ensure close monitoring and effective achievement of Learning Outcomes. Students should always document their practical exercise in the course lab manual.

1. Software and simulation laboratory
This laboratory houses the cybersecurity software and is used for various laboratory and simulation exercises. There should be a maximum of three students to a computer system for effective learning and practice.
The Cybersecurity software and simulation laboratory is a dedicated space in which students can safely engage in cyber related activities, including malware detection and deactivation, and penetration testing, in a contained and controlled environment without possible impact to other campus networks. The fundamental purpose of this laboratory is to

carry out various cybersecurity software related practical on computer-based simulation environments. The laboratory would developed modelling and simulation solutions/scenarios for web threat management, two-factor authentication, teaching vulnerability scanning, AI/Machine learning, behavioural analytics, IOC verification, comprehensive reporting, incident management, endpoint and incident management, whitelisting, and blacklisting, working on Security Automation and Orchestration (SOAR) Platform; SIEM Security, Event Log Management & Big Data Analytics Platform; and Cyber Risk Framework and Fraud Detection, in order to provide more realistic student interaction.

The laboratory is equipped with high-tech facilities with equipment for use in research and teaching, having various computer systems of high storage and processing speed, accessories, tools, devices, servers and software used for practical exercises and research projects.

Some remarkable software for protecting and testing systems such as CISCO FlexPod (connects all the PCs in the labs together), OPNET (improves network strengths), NetBrain (configures networks automatically), and FireEye (used to check for intruder activity and to analyse cyber-attacks on the system) are to be acquired for the lab. Tools for systems analysis and design practical, such as the Unified Modelling Language (UML).

Programming languages: Software to obtain for the software and Simulation Lab, which also serves other Cybersecurity courses are Java, Python, Lisp, Prolog, and C++

The cybersecurity system software such as SiteLock, Heimdal CORP, AppTrana, Acunetix, WebTitan, Teramind, Barkly, Indeni, JumpCloud DaaS, ThreatAdvice, FileWall, Log360, DNIF, Tines, and Cyber Control software should be obtained for hands-on practical exercises in finding vulnerabilities; removing malware; performing WordPress database scanning; defending against all DDoS attacks; providing endpoint web security solution for malware monitoring; software management; internet traffic reporting; web scanning and filtering; DNS based web content filter; blocking malware, ransomware, and phishing; providing complete control over the web and public WIFI; detecting insider threats; preventing data loss; providing user-centric security approach to monitor and allows real-time access; identifying the risk posture of an application, patches vulnerabilities immediately; improving website performance through whole site acceleration; proactive remediation against DDoS/emerging threats through continuous monitoring in a single place; crowd-sourced cybersecurity platform for network and security infrastructure; log management; monitoring critical changes in groups and track suspicious users' behaviour.

Biometric software: Three or more of the biometric software can be obtained for the required practical - Biometric FingerPrint, MegaMatcher Standard, EasyClocking for Mac, Unlock Fingerprint for Android, BIO Key for Windows, Secret Double Octopus, LastPass, Imprivata OneSign, RSA SecurID Suite, BIO key PortalGuard IDaaS, and HyperVerge Identity Verification.

Big Data software and tools: Four or more of these open source software should be used in Information and Big Data Security practical - Hadoop, Atlas.ti, HPCC, Storm, Qubole, Cassandra, Statwing, CouchDB, Pentaho, Flink, Cloudera, Openrefine, Rapidminer, DataCleaner, Kaggle, and Hive.

Ethical hacking and penetration software and tools: Four or more of these open source software should be used in ethical hacking practical exercises - Netsparker, Acunetix, Intruder, Traceroute NG, Burp Suite, SolarWinds Security Event Manager, Aircrack, Ettercap, Angry IP Scanner, LiveAction, QualysGuard, WebInspect, Hashcat, L0phtCrack, Rainbow Crack,

IKECrack, Sboxr, Medusa, NetStumbler, SQLMap, Nessus, and Zenmap. along with the Titania Nipper, Pentest-Tools.com, Cobalt Strike, Detectify, Defendify, Bugcrowd, Horizon3.ai. These tools and software are open source and available to obtain.
Cryptography tools: These tools, namely Security Token/Authentication Token, CertMgr.exe, JCA, Docker, SignTool.exe and Authentication using Key, should be used to guide the students in the cryptography practicals.
Steganography software:Four or more of these open source software should be used in required practical situations. Hide'N'Send, OpenStego, Steghide, SSuite Piscel, QuickStego, RSteg, Crypture, Camouflage, Our Secret, Steganofile, SteganPEG, SteganographX Plus, Trojan, Anubis, Xiao Steganography, Image Steganography, SilentEye,Shusssh!, Clotho, StegoStick beta, OpenPuff, and Dound's Steganography.

Others include:

1. Computer systems
2. Software – specialised software according to area of application such as listed above. It is open source and free
3. Printers - a colour Deskjet and a LaserJet printer
4. Projector
5. Whiteboard
6. Smartboard
7. Inverter - adequate for the lab functions as backup electricity
8. Computer lab tables
9. Computer lab chairs
10. Other software tools required

2. Cybernetics workshop

The workshop will be the construction, developing and modelling testbed for new and emerging technologies and ideas in AI, Robotics, Machine Learning, Deep Learning, Augmented Reality, IoT, Intelligence Analytics, etc. Following experimentations in the various labs, the workshop provides a demonstration and production platform to merge and realise ideas from different fields of Cybersecurity discipline.

S/N	**Components**
1	Simonk Firmware 30A ESC Electronic Speed Controller with 5V 3A BEC
2	920KV CW Brushless Motor
3	920KV CCW Brushless Motor
4	APM 2.8 No Compass Flight Controller Board Bent Pin with Case
5	M7N GPS with Compass
6	4400mAh 3S1P 11.1V 30C battery
7	Radio Link T8FB 2.4GHz 8ch RC Transmitter R8EF Receiver Combo Remote control
8	IMAX RC B3 Pro Compact Balance Charger
9	Universal GPS Folding Antenna Mount Holder Metal
10	10cm Servo Receiver Extension Lead Wire Cable M/M
11	Male XT60 with Wire 14AWG 10cm
12	A Pair XT60 Bullet Connectors Plugs
13	5X Hook and & Loop Fastening Tape

14	Thick Gold Plated 3.5mm Bullet Connector (banana plug)
15	Wireless Wi-Fi Module APM Pixhawk Radio Telemetry Transmitter
16	Pairs 10x4.7 3K Carbon Fibre Propeller CW CCW 1047 Props Cons
17	Lipo Battery Voltage Tester 1S-8S Low Voltage Buzzer Alarm
18	500mm Multi-Rotor Air Frame Kit S500-PCB With Circuit Board
19	Gopro camera
20	Gimbel Mount
21	2 N single drive, single idler sprocket tank track system
22	4 wheel rack drive, mecanum wheel system
23	Rack and pinion steering system
24	Futaba continuous rotation savo motor (varying diameters)
25	Tamiya Track and Wheel Set
26	Polobus DC motor
27	Single and dual motor controllers of varying capacity
28	Arduino microcontroller
29	Raspberry pi board
30	Radio frequency remote control transceiver module
31	Push buttons and contact switches, range finders (ultrasonic, infrared, laser)
32	Localisation circuit system, GPS circuits, encoders
33	Stereo camera system
34	Light and sound sensors systems
35	Thermal cameras and sensors
36	Digital compass, gyroscopes and accelerometer
37	Piezoelectrics and RFID sensors
38	Rero Robot Construction Kit
39	Rechargeable 12 volts batteries
	Tools
1	Small and regular screwdriver sets
2	Longnose pliers
3	Cable strippers and cutters
4	Rotary tools and drills
5	Saws, vise
6	Breadboards and jumper wires
7	Breadboard power supply
8	Soldering tool kit
9	Multimeter
10	Wall adapters and Extension boxes
11	Adjustable temperature soldering section
12	Brass sponges
13	Variable power supply
14	Logic analyser
15	22 gauge hook up wire
16	Hot glue gum and tapes
17	Third hand

18	Thicker wires
19	Complete Set of Tool Box
	Software
1	CAD software
2	Programming softwares, connection interfaces and drives
3	Schematics and PCBs. Four of the AI Software such as Google Cloud Machine Learning Engine, Azure Machine Learning Studio, TensorFlow, H20.AI, Cortana, IBM Watson, Salesforce Einstein, Infosys Nia, Amazon Alexa, Google Assistance, Ayasdi, Meya, Scikit learn, Viv and Blockchain can be obtained for the required practical depending on what aspect of AI, machine learning and deep learning that is needed.
	Raw material
1	Plastic and metal sheets
2	Cardboard and woods
3	Nuts and bolts
4	Screws and clips
	Workshop furniture
1	Workshop Tables
2	Workshop Stools
3	Shelves and Cabinets

3. Digital forensic laboratory

1. Hardware requirement - FRED DX Forensic Workstation with 2 RAIDs, VPER Kit with EnCase, UltraKit v4.1 + TX1, Forensic Imager TX1 with Case, and Forensic Imager TD3 with Case.
2. Software requirement - EnCase Forensic V8 + Subscription and Forensic Toolkit + Subscription FTK 6.
3. Mobile forensics **-** UFED Touch Ultimate, UFED Analytics Desktop, UFED Camera Kit, Paraben E3: UNIVERSAL SOFTWARE, and XRY Mobile forensic extractor.

**Other specialised laboratories for universities to make available for the programme are Artificial Intelligence Laboratory, Cyber Physical Systems & Hardware Security Laboratory, IoT Enabling and Security Research Laboratory.

Staffing

Personnel

Academic staff

The guidelines on academic staff/student ratio of 1:20 for Computing Programmes shall apply. To start any programme in Computing, there should be a minimum of six academic staff. There is a 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. The staff structure for the academic staff is expected to be 20: 35: 45 for Professors/Readers: Senior Lecturers: Lecturers 1 and below.

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.

Ratio of junior admin staff to academic staff shall be 1:10

Ratio of senior admin staff to academic Staff shall be 1:10

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.

Ratio of Senior Technical Staff to Academic Staff shall be 1:10

Ratio of Junior Technical Staff to Academic Staff shall be 1:5

Library

Universities should leverage available technology to put in place rich databases and other electronic/digital libraries and information resources. In addition, current hard copies of reference and other textual materials should be provided centrally at the level of the Faculty. A well-equipped 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 the students enrolled in each academic programme. The funding of the Library should be in line with NUC guidelines.

Classrooms, Laboratories and Offices

The NUC recommends the following physical space requirement:

		m^2
1. Professor's office	-	18.50
2. Head of department's office	-	18.50
3. Tutorial teaching staff's office	-	13.50
4. Other teaching staff space	-	7.00
5. Technical staff space	-	7.00
6. Secretarial space	-	7.00
7. Seminar space/per student	-	1.85
8. Laboratory space per FTE	-	7.50
9. Conference room	-	37.0

Adequate space should be provided for the department. Effort must be made to provide the department with at least:

Two (2) large laboratories calculated according to specifications of 7.5 m^2 per FTE. At least two lecture rooms capable of seating at least sixty students at the specification of 1 m^2 per FTE.

A departmental conference room.

A seminar room.

A staff common room.

Office Equipment

The following equipment should be provided in the offices:

1. Computers;
2. Printers;
3. Photocopying machines; and
4. Functional internet and e-mail facilities.

Classroom Space and Examination Theatres

Adequate classrooms should be provided with enough chairs, tables and lecture delivery tools such as projector, whiteboards and smart boards. Examination halls and theatres should be provided to minimise the rate of examination malpractices.

Classroom Equipment

The following equipment should be provided in the offices:

1. Multimedia projectors;
2. Whiteboards or Smartboards; and
3. Functional internet and e-mail facilities.

B.Sc. Data Science

Overview

Businesses and other organisations worldwide are accumulating enormous quantities of data for market research, disaster prediction, investment analysis, manufacturing and sales, customer management and behaviour analysis, security intelligence, policy development, artificial intelligence, healthcare development, among other applications. However, a widespread shortage of professionals with knowledge on how to harvest intelligence from these data persists. This in-demand group of professionals are data scientists with comprehensive analytical and technical skills that cover all aspects of handling and analysing data. By deriving key insights from data, they will be driving the decision-making of the future, supported by interdisciplinary teams.

This curriculum is geared towards imbuing undergraduate students of Data Science with key competencies in Computational and Statistical Thinking; Mathematical Foundations; Model Building and Assessment; Data Curation, Knowledge Transference, Analytics, and Information Management.

Philosophy

The philosophy of the programme is to equip Data Science students with the foundations, methods, and implications of data science that extracts knowledge from data using techniques and theories from mathematics, statistics, computing, and information technology.

Objectives

The objectives of the B.Sc. Data Science programme are to:

1. provide students with the requisite skills needed to analyse real life problems that are computationally intensive and independently develop effective data-driven solutions for them;
2. imbibe students with the skills required to play significant roles in the four A's of data: architecture, acquisition, analysis and archiving; making them qualified for specialist Data Science jobs in the industry;
3. provide students with the necessary training and competency to dig out hidden information in the massive data of business, government, healthcare, schools, and other areas of data engineering, big data and data analytics; and
4. train students on integrating data-driven Information Technology solutions and business processes to meet the information needs of businesses and other organisations, enabling them to achieve their objectives in an effective, efficient way.

Unique Features of The Programme

This curriculum uniquely features an inclusion and emphasis on more hands-on practical and relevant skills in the areas of data analytics, machine learning, artificial intelligence, and deep learning thereby nurturing a progressive transition from knowledge-based learning to competency-based learning across all levels of study, in recognition of the changing dynamics of computing in the age of digitalisation.

Employability Skills

This course is designed to empower graduates with the most relevant skills required for productive employment in the 21st century, particularly in the areas of problem solving; teamwork and collaboration; research; digital literacy; creativity; critical thinking;

communication and presentation skills; information literacy and analysis; media literacy; and responsible digital citizenship.

21st Century Skills

Among the 21st Century skills for the programme are:

1. creativity;
2. information literacy;
3. media literacy;
4. flexibility;
5. social skills;
6. Critical thinking;
7. Creativity;
8. Problem solving;
9. Global awareness;
10. Social skills;
11. Innovation skills;
12. Flexibility; and
13. Information literacy.

Admission and Graduation Requirements

Admission requirements

4 Year Degree Programme

In addition to appropriate UTME-Score, a candidate must possess five Senior Secondary Certificate (SSC)-credits passes including English Language, Mathematics, Physics and any other relevant Science subjects in not more than two sittings.

3 Year Degree Programme:

Direct Entry

A minimum of a credit at the University/National Diploma or NCE with other five Senior Secondary Certificate (SSC) credit passes in relevant Science subjects three of which must be in English Language, Mathematics, Physics.

Minimum duration

The minimum duration of the Data Science degree programme is four academic sessions for UTME. However, it is three academic sessions for candidates admitted into the 200 Level.

Graduation requirements

To be eligible for the award of the Bachelor degree in Data Science, a student must have:

1. Passed all the core courses, university and faculty/school required courses and electives.
2. Accumulated a minimum of 120 course units for students admitted through UTME and 90 course units for students admitted to 200 level.
3. Attain a minimum CGPA of 1.00.

To graduate, a student must be found worthy in character throughout the period of his/her studentship and must accumulate the total units prescribed for the programme from Core, Faculty, General Studies courses, SIWES, Seminar, and Final Year project.

Global Course Structure
100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	0
MTH 101	Elementary Mathematics I	2	C	30	0
MTH 102	Elementary Mathematics II	2	C	30	0
PHY 101	General Physics I	2	C	30	0
PHY 102	General Physics II	2	C	30	0
PHY 107	General Practical Physics I	1	C	0	45
PHY 108	General Practical Physics II	1	C	0	45
STA 111	Descriptive Statistics	3	C	45	0
COS 101	Introduction to Computing Sciences	3	C	30	45
COS 102	Problem Solving	3	C	30	45
	TOTAL	**23**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	0
ENT 211	Entrepreneurship and Innovation	2	C	30	0
MTH 201	Mathematical Methods I	2	C	30	0
MTH 203	Sets, Logic and Algebra I	2	C	30	0
MTH 209	Introduction to Numerical Analysis	2	C	30	0
COS 201	Computer Programming I	3	C	30	45
COS 202	Computer Programming II	3	C	30	45
DTS 201	Introduction to Data Science	2	C	15	45
DTS 204	Statistical Computing Inference and Modelling	3	C	45	0

DTS 211	Introduction to R Programming	2	C	15	45
DTS 299	SIWES I	3	C	0	135
CSC 203	Discrete Structures	2	C	30	0
	TOTAL	**28**			

300 Level

Course Code	**Course Title**	**Unit(s)**	**Status**	**LH**	**PH**
GST 312	Peace and Conflict Resolution	2	C	30	0
ENT 312	Venture Creation	2	C	15	45
DTS 302	Big Data Computing	2	C	15	45
DTS 304	Data Management I	3	C	15	45
DTS 308	Ethics and Legal Issues in Data Science	2	C	30	0
DTS 316	Probability for Data Science	3	C	45	0
DTS 322	Data Science Innovation and Entrepreneurship	2	C	15	45
DTS 399	SIWES II	3	C	0	135
CYB 201	Introduction to Cybersecurity and Strategy	2	C	30	0
	TOTAL	**21**			

400 Level

Course Code	**Course Title**	**Unit(s)**	**Status**	**LH**	**PH**
COS 409	Research Methodology & Technical Report Writing	3	C	45	0
DTS 403	Data Visualisation for Data-driven Decision Making	2	C	155	45
DTS 497	Final Year Project I	3	C	0	135
DTS 498	Final Year Project II	3	C	0	135
INS 401	Project Management	2	C	30	0
	TOTAL	**15**			

Course Contents and Learning Outcomes

100 LEVEL

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

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

1. understand the basic definition of Set, Subset, Union, Intersection, Complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. understand various types of numbers; and
5. solve some problems using the Binomial theorem.

Course Contents

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

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

Learning Outcomes

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

1. understand types of rules in Differentiation and Integration;
2. understand the meaning of Function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents

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

STA 111: Descriptive Statistics: (3 Units C: LH 45)

Learning Outcomes

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

1. explain the basic concepts of descriptive statistics.
2. present data in graphs and charts.
3. differentiate between measures of location, dispersion and partition.
4. describe the basic concepts of Skewness and Kurtosis as well as their utility function in a given data set.
5. differentiate rates from ratio and how they are use.
6. compute the different types of index number from a given data set and interpret the output.

Course content

Statistical data. Types, sources and methods of collection. Presentation of data. Tables chart and graph. Errors and approximations. Frequency and cumulative distributions. Measures of location, partition, dispersion, skewness and Kurtosis. Rates, ratios and index numbers.

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

Learning Outcomes

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

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

Course Contents

Space and time; units and dimension, Vectors and Scalars, Differentiation of vectors: displacement, velocity and acceleration; kinematics; Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation); Relative motion; Application of Newtonian mechanics; Equations of motion; Conservation principles in physics, Conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass; Rotational motion; Torque, vector product,

moment, rotation of coordinate axes and angular momentum. Polar coordinates; conservation of angular momentum; Circular motion; Moments of inertia, gyroscopes and precession; Gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General physics II (Electricity & magnetism) (2 Units C: LH 30)

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors.
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents

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

electrical and mechanical resonant systems, light, heat, viscosity, etc., covered in PHY 101 and PHY 102. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

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

Learning Outcomes

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

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyses graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents

This is a continuation of the experiments designed for PHY 101 and PHY 102 some of which have been covered under PHY 107.

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

Learning Outcomes

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

1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents

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

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

COS 102: Problem Solving (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. explain problem solving processes;
2. demonstrate problem solving skills;
3. describe the concept of algorithms development and properties of algorithms;
4. discuss the solution techniques of solving problem;
5. solve computer problems using algorithms, flowcharts, pseudocode; etc.; and
6. solve problems using programming language using C, PYTHON, etc.

Course Contents

Introduction to the core concepts of computing. Problems and problem-solving. The identification of problems and types of problems (routine problems and non-routine problems). Method of solving computing problems (introduction to algorithms and heuristics). Solvable and unsolvable problems. Solution techniques of solving problems (abstraction, analogy, brainstorming, trial and error, hypothesis testing, reduction, literal thinking, means-end analysis, method of focal object, morphological analysis, research, root cause analysis, proof, divide and conquer). General Problem-solving process. Solution formulation and design: flowchart, pseudocode, decision table, decision tree. Implementation, evaluation and refinement. Programming in C, Python etc.

Lab Work: Use of simple tools for algorithms and flowcharts; writing pseudocode; writing assignment statements, input-output statements and condition statements; demonstrating simple programs using any programming language (Visual Basic, Python, C)

200 Level

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

Learning Outcomes

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

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

Course Contents

Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid

arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

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

Learning Outcomes

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

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

Course Contents

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

COS 201: Computer Programming I (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. explain the principles of good programming and structured programming concepts;
2. explain the programming constructs, syntax and semantics of a higher-level language;

3. describe the chosen programming language variables, types, expressions, statements and assignment; simple input and output;
4. describe the programme control structures, functions and parameter passing, and structured decomposition; and
5. develop simple programmes in the taught programming language as well as debug and test them.

Course Contents

Introduction to computer programming. Functional programming; Declarative programming; Logic programming; Scripting languages. Introduction to object-orientation as a technique for modelling computation. structured, and even some level of functional programming principles; Introduction of a typical object-oriented language, such as Java; Basic data types, variables, expressions, assignment statements and operators; Basic object-oriented concepts: abstraction; objects; classes; methods; parameter passing; encapsulation. Class hierarchies and programme organisation using packages/namespaces; Use of API – use of iterators/enumerators, List, Stack, Queue from API; Searching; sorting; Recursive algorithms; Event-driven programming: event-handling methods; event propagation; exception handling. Introduction to Strings and string processing; Simple I/O; control structures; Arrays; Simple recursive algorithms; inheritance; polymorphism.

Lab work: Programming assignments; design and implementation of simple algorithms e.g. average, standard deviation, searching and sorting; Developing and tracing simple recursive algorithms. Inheritance and polymorphism.

COS 202: Computer Programming II (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. demonstrate the principles of good programming and structured programming concepts;
2. demonstrate string processing, internal searching, sorting, and recursion;
3. demonstrate the basic use of OOP concepts: classes, objects, inheritance, polymorphism, data abstraction;
4. apply the tools for developing, compiling, interpreting and debugging programmes; and
5. demonstrate the use of syntax and data objects, operators, central flow constructs, objects and classes programming, arrays, methods, exceptions, applets and the abstract, OLE, persistence, window toolkit.

Course Contents

Review and coverage of advanced object-oriented programming - polymorphism, abstract classes and interfaces; Class hierarchies and programme organisation using packages/namespaces; Use of API – use of iterators/enumerators, List, Stack, Queue from API; Searching; sorting; Recursive algorithms; Event-driven programming: event-handling methods; event propagation; exception handling. Applications in Graphical User Interface (GUI) programming.

Lab work: Programming assignments leading to extensive practice in problem solving and programme development with emphasis on object-orientation. Solving basic problems using static and dynamic data structures. Solving various searching and sorting algorithms using iterative and recursive approaches. GUI programming.

MTH 201: Mathematical Methods 1 (2 Units C: LH 30)

Learning Outcomes

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

1. understand Real-valued functions of a real variable;
2. solve some problems using Mean value Theorem and Taylor Series expansion; and
3. evaluate Line Integral, Surface Integral and Volume Integrals.

Course Contents

Real-valued functions of a real variable. Review of differentiation and integration and their applications. Mean value theorem. Taylor series. Real-valued functions of two and three variables. Partial derivatives chain rule, extrema, lagrangian multipliers. Increments, differentials and linear approximations. Evaluation of line, integrals. Multiple integrals.

MTH 203: Sets, Logic and Algebra I (2 Units C: LH 30)

Learning Outcomes

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

1. solve various problems using the concepts of set theory;
2. understand Algebraic structures; and
3. understand the meaning of logic in mathematics.

Course Contents

Introduction to the language and concepts of modern Mathematics. Topics include; Basic set theory: mappings, relations, equivalence and other relations, Cartesian products. Binary logic, methods of proof. Binary operations. Algebraic structures, semi-groups, rings, integral domains, fields. Homeomorphics. Number systems; properties of integers, rationals, real and complex numbers.

MTH 209: Introduction to Numerical Analysis (2 Units C: LH 30)

Learning Outcomes

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

1. solve some numerical solutions of algebraic and transcendental equations;
2. describe curve fitting;
3. discuss error analysis;
4. calculate interpolation and approximation;
5. solve some numerical differentiation and numerical integration problems; and
6. solve some numerical problems in ordinary differential equations with initial value problems.

Course Contents
Solution of algebraic and transcendental equations. Curve fitting. Error analysis. Interpolation and approximation. Zeros of non- linear equations 'in one variable'. Systems of linear equations. Numerical differentiation and integration. Initial value problems in ordinary differential equations.

DTS 201: Introduction to Data Science (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. demonstrate the principles of working with data across distributions, sizes and ranges;
2. explain from first principles the operations that power data-driven utilities that have transformed the modern computing industry; and
3. demonstrate foundational technological processes that enable various data functions.

Course Contents
Fundamentals of Data Science. Methodology of extracting knowledge from big datasets as well as various tools and platforms for Data Science. What is Data and why is it important? Basic classification of Data (Structured, semi-structured and unstructured data), Scope of Data Science, Steps of Data Science Process: Data collection, Pre-processing, training, and testing. Rudiments of data visualisations; Distributions, Probability, and Simulations; Predictions and Models. Use cases in various domains such Image, Natural Language, Audio and Video. Basic introduction to knowledge extraction: Data mining, Business Intelligence & Knowledge management, Introduction to Big Data integration and intelligence, Introduction to Data Analytics, Introduction to programming.
Lab work: Practical experiments on data science process steps in simulated models. Practical application of the methods and tools used in data science for prediction models with some simulated exerises. Practical experiments on how to extract knowledge; how to mine valuable data from large set of data sets using data mining process and methods. Learn how to integrate business intelligence in big data along with some data analytics pratical exercises. Simple exercises on R programming to enhance the coding knowledge acquired during theory class.

DTS 204: Statistical Computing II (3 Units C: LH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. make conclusions based on statistical assumptions, models and results;
2. make inference on statistical outcomes, and real-world implications and how these outcomes are factored into decision-making processes;
3. demonstrate the various considerations that are applied both for communicating statistical solutions to real problems;
4. make conclusions based on statistical models and results by applying a broad range of statistical tools and packages; and

5. demonstrate logical, meaningful skills that bothers not just on the relevance of the data that informed the statistical outcomes, but also on the real-world implications of how these outcomes are factored into decision-making processes.

Course Contents

Population and samples. Asymptotics. Statistical models and methodologies. Random sampling distributions. Elementary time series analysis. Index numbers. Demographic measures. Estimation (point and interval) and tests of hypotheses concerning population mean and proportion (one and two sample cases). Regression and correlation. Programming in Python computer language. Computation of mean, variance and correlation. Sorting and ranking of data. Data Step Processing. Preparing Data for Analysis. Evaluating Quantitative Data. Sample Size Estimation. Basic statistical computing in regression analysis and the analysis of designed experiments. Introduction to Monte Carlo methods. Use of statistical packages like SPSS, SAS, Minitab, GENSTAT, EPI-INFO, SYSTAT.

Lab work: Practical experiments on statistical models and methodologies. Practical exercises on random sampling distribution methods. Practicals on test of hypothesis, population, mean, proportion, regression and correlation analysis. Exercise on how to sort and data from different data set. Use of SPSS for data analysis and computation.

DTS 211: Introduction to R Programming (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. utilise the R programming language for data-driven functions and utilities that have been lauded across the computing industry;
2. explain the structures, functions, and operations that power the utilities of this Language across various application domains;
3. explain the structures, functions, and operations of the language; and
4. apply the R programming language to various data-driven use-cases in practical problem domains in the real-world.

Course Contents

History and Overview of R, Installation, Introduction to R and RStudio, R interface, Cleaning and transforming data, Getting data in and out of R, Evaluation, R Objects, Numbers, Attributes, Vectors, Matrices/Arrays, Lists, Factors, Missing Values, Data Types, Structures and Frames, Names, , Displaying and plotting data, Reading lines of a Text File, Reading from a URL connection, Vectorised Operations, Dates and Times, Control Structures, Functions, Scoping Rules, Coding Standard for R, Looping, Debugging, Profiling R Code. Creating data products using R package.

Lab work: Installation of R programming language and learning the practical basics. Practical programming exercises on R programming language in getting data in and out, evaluation, computation, finding missing values and reading lines of text files. Practical exercises on R coding and debugging.

DTS 299: SIWES I (3 Units C: PH 135)

Learning Outcomes

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

1. explain how a typical Data Science firm operates;
2. expose students to the realities of the computing industry beyond the walls of the University; through an attachment with an organisation in the computing industry; and
3. apply the skills and knowledge that they have acquired in class towards solving real problems in actual working environments.

Course Contents

Students are attached to private and public organisations for a period of three months during the second-year session long break with a view to making them acquire practical experience and to the extent possible, develop skills in all areas of Data Science. Students are supervised during the training period and shall be expected to keep records designed for the purpose of monitoring their performance. They are also expected to submit a report on the experience gained and defend their reports.

CSC 203: Discrete Structures I (3 Units C: LH 45)

Learning Outcomes

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

1. convert logical statements from informal language to propositional and predicate logic expressions;
2. describe the strengths and limitations of propositional and predicate logic;
3. outline the basic structure of each proof technique (direct proof, proof by contradiction, and induction) described in this unit;
4. apply each of the proof techniques (direct proof, proof by contradiction, and induction) correctly in the construction of a sound argument;
5. apply the pigeonhole principle in the context of a formal proof;
6. compute permutations and combinations of a set, and interpret the meaning in the context of the particular application;
7. map real-world applications to appropriate counting formalisms, such as determining the number of ways to arrange people around a table, subject to constraints on the seating arrangement, or the number of ways to determine certain hands in cards (e.g., a full house); and
8. solve a variety of basic recurrence relations.

Course Contents

Propositional Logic, Predicate Logic, Sets, Functions, Sequences and Summation, Proof Techniques, Mathematical induction, Inclusion-exclusion and Pigeonhole principles, Permutations and Combinations (with and without repetitions), The Binomial Theorem, Discrete Probability, Recurrence Relations.

300 Level

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

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;

7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/market research, Unutilised resources, Social and climate conditions, and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (venture capital, equity finance, microfinance, personal savings, small business investment organisations, and business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first mover advantage, e-commerce business models and successful e-commerce companies,). Small business management/family business: Leadership & Management, basic bookkeeping, nature of family business and family business growth model. Negotiation and business communication (Strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological solutions (the concept of market/customer solution, customer solution, and emerging technologies, business applications of new technologies- Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoT), Blockchain, Cloud Computing, renewable energy, etc. digital business and e-commerce strategies).

DTS 302: Big Data Computing (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. identify Big Data;
2. identify some of the foundational tools, systems, and platforms that feature in working with Big Data across several domains;
3. install Big Data working tools on a computer; and
4. analyse Big Data contents.

Course Contents

Installation: Cloudera VM, Jupyter server. Big data retrieval and relational querying: Postgres databases, NoSQL data, MongoDB, Aerospike, and Pandas for data aggregation and working with data frames. Big Data Integration: Splunk and Datameer. Big Data Processing: Apache Spark, Hadoop, Spark Core (Spark MLlib and GraphX). Big Data Applications (Graph Processing). Big Data Streaming Platforms for Fast Data.

Lab Work: Analysing Twitter Data using Spark and MongoDB. Learn Big Data analytics skills. Practical procedure for the crafting of an enterprise-scale cost-efficient Big Data and machine learning solution to uncover insights and value from data. Use the practical exercises to bridge the gap between the theoretical world of technology with the practical ground reality of building corporate Big Data and data science platforms. Hands-on exposure to Hadoop and Spark (or any of the BD tools), build machine learning dashboards using R and R Shiny, create web-based apps using NoSQL databases. Practical assignment of BD security.

DTS 304: Data Management I (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. describe the components of a database system and give examples of their use;
2. describe the differences between relational and semi-structured data models;
3. explain and demonstrate the concepts of entity integrity constraint and referential integrity constraint;
4. apply queries, query optimisations and functional dependencies in relational databases;
5. describe properties of normal forms and explain the impact of normalisation on the efficiency of database operations;
6. describe database security and integrity issues and their importance in database design; and
7. explain the concepts of concurrency control and recovery mechanisms in databases.

Course Contents

Information Management Concepts. Information storage & retrieval. Information management applications. Information capture and representation. Analysis and indexing - search, retrieval, information privacy. Integrity and security. Scalability, Efficiency and Effectiveness. Introduction to database systems. Components of database systems. DBMS functions. Database architecture and data independence. Database query language. Conceptual models. Relational data models. Semi-structured data models. Relational theory and languages. Database Design. Database security and integrity. Introduction to query processing and optimisation. Introduction to concurrency and recovery.

Lab work: Practical exercise on information representation, capture, storage and retrieval. Learn how to analyse data and index fpor easy searching and indexing. Practical on creating database files and models. How to create and use various database designs. How to query the created database. Methods of concurrency and recovery in database. Learn how to secure the database.

DTS 308: Ethics and Legal Issues in Data Science (3 Units C: LH 45)

Learning Outcomes

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

1. identify ethical challenges and considerations when working with data of various sources, context, and compositions; and
2. contribute to global debates regarding best practices for handling sensitive data in a way that avoids harm to data subjects, while also not eroding the utilities that such data could present for various decision-making processes.

Course Contents

Legal and ethical consequences of applying Data Science. Current techniques such as Digital Data Repositories and Digital Object Identifiers as well as FAIR principles for Open Science, Open Data. Data ownership and transparency; privacy concerns and consent; and addressing unintended bias. Topics: Legal aspects of data ownership and privacy concerns, Data transparency, Ethical considerations for Data Science, Introduction to Data Repositories and

Digital Object Identifiers, Introduction to Open Science, Open Data, and Introduction to FAIR data.

DTS 316: Probability for Data Science (3 Units C: LH 45)

Learning Outcomes

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

1. analyse and interpret real-world statistical events;
2. utilise various principles and concepts from the broad theory of probability and adjoining statistical and mathematical fields;
3. apply statistical principles and concepts to analyse data; and
4. analyse and interpret real-world statistical events by applying various principles and concepts from the broad theory of probability and adjoining statistical and mathematical fields.

Course Contents

Experiments, sample spaces, outcomes and events. Generation of Statistical events from set theory (Venn diagrams). Concepts and principles of Probability (probability axioms). Random variables. The Law of Total Probability, Bayes' Theorem, Independence. Permutation and Combination. Introduction to Probability and distribution functions. The probability density function. Basic distributions: Bernoulli Trials, Binomial, Hyper geometric, Poisson, and Normal. Exploratory data analysis. Combinatorial analysis. Probability models for the study of random phenomena in finite sample generating functions and its properties. Chebyshev's inequality and limit theorems in probability. Central limit theorem. Bivariate, marginal and conditional distributions. Variance and covariance. Probability mass function. Geometric distribution. Sampling with and without replacement. Hypergeometric distribution. Bounding probabilities, tail sum formula. Markov's inequality. The exponential distribution, moments, memoryless property, hazard function. Definition of a Markov chain and probability transition matrices. Equilibrium behaviour of Markov chains: computer demonstration and ergodic, limiting and stationary interpretations. Mean and variance of linear combination of two random variables. The joint Moment generating function (MGF) and MGF of the sum. Definition of absorbing Markov chains, structural results, hitting probabilities and expected hitting times.

DST 322: Data Science Innovation and Entrepreneurship (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. explain business models;
2. identify some entrepreneurial opportunities available in IT;
3. describe business plan and business startup process;
4. explain business feasibility and strategy;
5. explain marketing strategies; and
6. discuss business ethics and legal issues.

Course Contents
Fundamental concepts of innovation, and business ideas in general. Product development. Business leadership. Digital marketing. Entrepreneurial opportunities in IT. Legal issues and Business ethics. New venture creation process. Business feasibility planning. Market research. Business strategy. Business models and Business plans. Technical presentations. Report on a successful entrepreneurial outfit.

DTS 399: SIWES II (3 Units C: PH 135)

Learning Outcomes
At the end of the course, the students should be able to:
1. appreciate the realities of the computing industry beyond the walls of the University, through an attachment with an organisation in the computing industry; and
2. apply the skills and knowledge they acquired in class towards solving real problems in actual working environments.

Course Contents
Requires 3 months of Industrial Training after the completion of 300 Level. Students' experience will be documented and presented in a Seminar.

CYB 201: Introduction to Cybersecurity and Strategy (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. explain cybersecurity concepts, its methods, elements, and terminologies of cybersecurity, threat, attack, defence, and operations;
2. describe common cyber-attacks and threats, cybersecurity issues, challenges and proffered solutions, and build an enhanced view of main actors of cyberspace and cyber operations;
3. apply the techniques for identifying, detecting, and defending against cybersecurity threats, attacks and protecting information assets;
4. explain the impact of cybersecurity on civil and military institutions, privacy, business and government applications;
5. identify the methods and motives of cybersecurity incident perpetrators, and the countermeasures employed by organisations and agencies to prevent and detect those incidences and software application vulnerabilities; and
6. state the ethical obligations of security professionals, evaluate cybersecurity and national security strategies to the typologies of cyber-attacks that require policy tools and domestic response, and define the cybersecurity requirements and strategies evolving in the face of big risk.

Course Contents
Basic concepts: cyber, security, confidentiality, integrity, availability, authentication, access control, non-repudiation and fault-tolerant methodologies for implementing security, security policies, best current practices, testing security, and incident response, risk management, disaster recovery, access control, basic cryptography and software application vulnerabilities. Evolution of cyber-attacks. Operating system protection mechanisms, intrusion detection systems, basic formal models of security, cryptography, steganography, network and

distributed system security, denial of service (and other) attack strategies, worms, viruses, transfer of funds/value across networks, electronic voting, secure applications, cybersecurity policy and guidelines. Government regulation of information technology. Main actors of cyberspace and cyber operations. Impact of cybersecurity on civil and military institutions, privacy, business and government applications; examination of the dimensions of networks, protocols, operating systems, and associated applications. Methods and motives of cybersecurity incident perpetrators, and the countermeasures employed by organisations and agencies to prevent and detect those incidences. Ethical obligations of security professionals. Trends and development in cybersecurity. Software application vulnerabilities. Evolution of cybersecurity and national security strategies, requirements to the typologies of cyber-attacks that require policy tools and domestic response. Cybersecurity strategies evolving in the face of big risk. Role of standards and frameworks.

400 Level

COS 409: Research Methodology and Technical Report Writing (3 Units C: LH 45)

Learning Outcomes

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

1. describe research, types, approaches, significance of research, research methods, research process, criteria and strategy for good research;
2. discuss the principles of scientific research, scientific investigation, problem formulation, and technique of the research problem;
3. describe the various elicitation methods;
4. develop appropriate data collection instruments;
5. conduct the literature review process; and
6. prepare briefs as well as technical reports and know how to cite referenced works and prepare references and bibliography.

Course Contents

Foundations of Research. Types of Research. Research Approaches. Significance of Research. Research Methods versus Methodology. Research Process. Criteria and Strategy for Good Research. Principles of Scientific Research. Scientific investigation. Problem Formulation and Its Techniques. Developing Research Proposal and Research Plan. Formulation of Research Questions and Hypothesis Testing. Developing Research Proposal and Research Plan. Literature Review. Procedure for Reviewing Related Relevant Studies. Methods for Collection of Primary and Secondary Data. Elicitation Techniques - Questionnaires, Interviewing, Ethnography, etc. Guidelines for Constructing Data Instruments. Methods of AnalysingData in Computing and Related Disciplines.System Design: Architectural design, input design, process design, output design. Use case analysis, sequence diagram, activity diagram, deployment diagram, etc.Types of Reports. Technical Report Writing. Layout and Mechanics of Writing a Research Report. Standard Techniques for Research Documentation. Interpretation and Presentation of Results. How to Cite Referenced Works and Prepare References and Bibliography.

DTS 403: Data Visualisation for Data-Driven Decision Making (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. utilise techniques that are applied in preparing and producing data into a form that meets the needs of particular and varied audiences; and
2. develop logical, meaningful skills that bothers not just on the relevance of the data that informed the particular outcomes, but also on the real-world implications of how these outcomes are factored into decision-making processes.

Course Contents

Various methods for presenting data for visualisation as well as how to choose between them. Fundamentals of data presentation using tables, graphs, images and video animations. Create engaging visualisations using graphs, images and video animations. Data summaries, working with tables, presenting data through graphs and plots, presenting data through video animation, creating interactive/augmented visualisation of data (ability to zoom into sections). **Lab work:** Practical experiments on different methods of presenting data for visualisation. Practice on how to use graphs, tables, images, and video on animation for data presentation.

DTS 497: Final Year Project I (3 Units C: PH 135)

Learning Outcomes

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

1. identify a researchable project topic in Data Science;
2. search and review literature pertinent to identified problem statements;
3. acknowledge and reference sources of information used in the research report;
4. conceptualise and design a research methodology to address an identified problem;
5. determine tools for analysing data collected based on research objectives;
6. write a coherent proposal on the research project to be conducted; and
7. orally present the written project proposal.

Course Contents

An independent or group investigation of appropriate software, hardware, communication and networks or IT related problems in Data Science carried out under the supervision of a lecturer. Before registering, the student must submit a written proposal to the supervisor to review. The proposal should give a brief outline of the project, estimated schedule of completion, and computer resources needed. A formal written report is essential and an oral presentation may also be required.

DTS 498: Final Year Project II (3 Units C: PH 135)

Learning Outcomes

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

1. demonstrate technical skills in Data Science;

2. demonstrate generic transferable skills such as communication and team work;
3. produce a technical report in the chosen project;
4. defend the written project report; and
5. appreciate the art of carrying out a full-fledged research.

Course Contents

This is a continuation of DTS 497. This contains the implementation and the evaluation of the project. A formal written report, chapters 4 - 5 has to be approved by the supervisor. A final report comprising chapters 1 - 5 will be submitted to the department for final grading. An oral presentation is required.

INS 401: Project Management (2 Units C: LH 30)

Learning Outcomes

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

1. describe project management planning;
2. describe project scheduling;
3. explain management of project resources;
4. discuss project procurement, monitoring and execution; and
5. explain project communication and time management.

Course Contents

Introduction to Project Management; The Project Management Lifecycle: Project management and systems development or acquisition, The project management context, Technology and techniques to support the project management lifecycle, and Project management processes; Managing Project Teams: Project team planning, Motivating team members, Leadership, power and conflict in project teams, and Managing global project teams; Managing Project Communication and enhancing team communication; Project Initiation and Planning; Managing Project Scope: Project initiation, How organisations choose projects, Activities, and Developing the project charter; Managing Project Scheduling: Common problems in project scheduling, and Techniques for project scheduling; Managing Project Resources: Types of resources (human, capital, time), and Techniques for managing resources; Project quality and tools to manage project quality; Managing project risk and tools for managing project risk; Managing Project Procurement: Alternatives to systems development, External acquisition, Outsourcing-domestic and offshore, Steps in the procurement process, and Managing the procurement process; Project Execution, Control and Closure: Managing project execution, Monitoring progress and managing change, Documentation and communication, and Common problems in project execution; Managing Project Control and Closure: Obtaining information, Cost control, Change control, Administrative closure, Personnel closure, Contractual closure and Project auditing.

Minimum Academic Standards

Equipment

A Data Science programme should have at least three categories of laboratories: software, hardware laboratories. Best practice requires a staff to students' ratio of 1:20 for laboratory practical. Therefore, multiple small laboratories are preferable to a few large ones. Courses with large enrolments should have the students partitioned into groups to ensure each student has a computer/practice equipment to themselves during practical sessions. Laboratory sessions should be conducted by staff to ensure close monitoring and effective achievement of Learning Outcomes.

Software laboratory

Software laboratories support programming and other courses requiring use of software tools. Requirements for the software laboratory include:

1. Computer systems with capacity to run software systems for all lab-based courses (e.g., Desktop PC with minimum of 1,6 GHz or faster processor with at least 2 GB RAM and 500 GB hard disk space.) A maximum of 3 students to 1 computer system is recommended.
2. Programming environment and tools (e.g., Compilers/interpreters, debuggers, etc. for Java, Python, compiler compilers, e.g., flex, yacc, SableCC, etc,)
3. Operating systems environments and tools (e.g., Windows, LINUX, TempOS, Nachos, Xinu or MiniOS)
4. Tools for systems analysis and design (e.g., Unified Modelling Language (UML))
5. Computer maintenance tools like dust blowers and toolbox
6. Overhead projector
7. Power backup

Hardware laboratory

The hardware laboratory should provide facilities required for hardware-related practicals. Requirements for the hardware laboratory include:

1. NAND, NOR, XOR, AND, OR gates
2. Multiplexers
3. Master-slave flip-flops
4. Digi-Designer Logic Board, etc
5. Dual–trace oscilloscope
6. Digital Proto-Board
7. Computer casing
8. Motherboard
9. ROMs/RAMs
10. Hard drives
11. CD ROMs
12. Display screens
13. Fans
14. Connectors/Jumpers, etc.

Data Science Laboratory

It should have the following:

a) medium- to high-end computing resources for running practicals in data analytics and visualisation.

b) A data bank / repository / warehouse which contains a variety of datasets collated from across various business and industry cases, to be used a testing and training resources for students enrolled to the degree programme.
c) Fully-licensed, multi-client data science tools and applications, including: E-views, Tableau, Hadoop, R Studio, JetBrains PyCharm, Jupiter Python Toolkit, amongst others.
There should be a resident data scientist with industry-recognised certifications in the field of Data Science, to help facilitate and guide laboratory classes and practical sessions for students.

Staffing

Personnel

Academic staff

The guidelines on academic staff/student ratio of 1:20 for Computing Programmes shall apply. To start any programme in Computing, there should be a minimum of six academic staff. There is a 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. The staff structure for the academic staff is expected to be 20: 35: 45 for Professors/Readers: Senior Lecturers: Lecturers 1 and below.

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.

Ratio of junior admin staff to academic staff shall be	1:10
Ratio of senior admin staff to academic staff shall be	1:10

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.

Ratio of Senior Technical Staff to Academic Staff shall be	1:10
Ratio of Junior Technical Staff to Academic Staff shall be	1:5

Library

Universities should leverage available technology to put in place rich databases and other electronic/digital libraries and information resources. In addition, current hard copies of reference and other textual materials should be provided centrally at the level of the Faculty. A well-equipped 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 the students enrolled in each academic programme. The funding of the Library should be in line with NUC guidelines.

Classrooms, Laboratories and Offices

The NUC recommends the following physical space requirement:

		m^2
1. Professor's office	-	18.50
2. Head of department's office	-	18.50
3. Tutorial teaching staff's office	-	13.50
4. Other teaching staff space	-	7.00
5. Technical staff space	-	7.00
6. Secretarial space	-	7.00
7. Seminar space/per student	-	1.85
8. Laboratory space per FTE	-	7.50
9. Conference room	-	37.0

Adequate space should be provided for the Department. Effort must be made to provide the Department with at least:

1. Two (2) large laboratories calculated according to specifications of 7.5 m^2 per FTE. At least two lecture rooms capable of seating at least sixty students at the specification of 1 m^2 per FTE.
2. A departmental conference room.
3. A seminar room.
4. A staff common room.

Minimum Office Equipment

The following equipment should be provided in the offices:

1. Computers
2. Printers
3. Photocopying Machines
4. Functional internet and e-mail facilities

Classroom Space and Examination Theatres

Adequate classrooms should be provided with enough chairs, tables and lecture delivery tools such as projector, whiteboards and smart boards. Examination halls and theatres should be provided to minimise the rate of examination malpractices.

Minimum Classroom Equipment

The following equipment should be provided in the offices:

1. Multimedia projectors
2. Whiteboards or Smartboards
3. Functional internet and e-mail facilities

B.Sc. Information and Communication Technology

Overview

Globally, there is a growing demand for Information and Communication Technology specialists to power and drive processes in business organisations and non-business organisations. Information and Communication Technology have tremendous potential to boost operations efficiency, increase productivity and operate uninterruptedly with no downtime.

The degree programme aims at producing Information and Communication Technology graduates with sufficient professional knowledge and skills to manage organisations' computing infrastructure and provide adequate support for computer users in order to enhance productivity and increase business value.

Philosophy

The guiding principles of the programme is to equip Information and Communication Technology students with adequate skills and knowledge to provide seamless organisations' ICT integration for effective productivity and to support organisations' computer system users through best practices and professional standards.

Objectives

The objectives of the programme are to:

1. provide students with a broad knowledge and practical skills in Information and Communication Technology;
2. empower students to be problem-solvers through Information and Communication Technologies tools; and
3. equip students with the capacity for professional practice in the Information and Communication Technology sector.

Unique Features of The Programme

1. The programme has additional hands-on practical components in a number of courses to emphasise students' engagement in the learning process for better learning and development of soft skills.
2. The programme is intended to produce specialists in digital technology in web application multimedia, document processing, mobile computing and internet communications.

Employability Skills

The skills include communication, teamwork and collaboration, negotiation and persuasion, problem-solving, leadership, organisation, perseverance, motivation, confidence, and the ability to work under pressure. Graduates of the programme should be adequately prepared to pursue careers in one of two main areas: ICT Commercialisation, to use ICT as an enabling tool to drive economic growth; and Technology Management, using ICT to provide a stable operating environment.

21st Century Skills

Among the 21st Century skills for the programme are:

1. critical thinking;
2. creativity;
3. media literacy;
4. flexibility;
5. social skills;
6. Critical thinking;
7. Creativity;
8. Problem solving;
9. Information literacy;
10. Global awareness; and
11. Social skills.

Admission and Graduation Requirements

Admission requirements

4 Year Degree Programme

In addition to appropriate UTME-Score, a candidate must possess five Senior Secondary Certificate (SSC)-credits passes including English Language, Mathematics, Physics and any other relevant Science subjects in not more than two sittings.

3 Year Degree Programme:

Direct Entry

A minimum of a credit at the University/National Diploma or NCE with other five Senior Secondary Certificate (SSC) credit passes in relevant Science subjects three of which must be in English Language, Mathematics, Physics.

Minimum duration

The minimum duration of the Information and Communication Technology degree programme is four academic sessions for UTME. However, it is three academic sessions for candidates admitted to the 200 Level.

Graduation requirements

To be eligible for the award of the Bachelor degree in Information and Communication Technology, a student must have:

1. passed all the core courses, university and faculty/school required courses and electives;
2. accumulated a minimum of 120 course units for students admitted through UTME and 90 course units for students admitted to 200 level; and
3. attain a minimum CGPA of 1.00.

To graduate, a student must be found worthy in character throughout the period of his/her studentship and must accumulate the total units prescribed for the programme from Core, Faculty, General Studies courses, SIWES, Seminar, and Final Year project.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	0
MTH 101	Elementary Mathematics I	2	C	30	0
MTH102	Elementary Mathematics II	2	C	30	0
PHY 101	General Physics I	2	C	30	0
PHY 102	General Physics II	2	C	30	0
PHY 107	General Practical Physics I	1	C	0	45
PHY 108	General Practical Physics II	1	C	0	45
STA 111	Descriptive Statistics	3	C	45	0
COS 101	Introduction to Computing Sciences	3	C	30	45
COS 102	Problem Solving	3	C	30	45
	TOTAL	**23**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic And Human Existence	2	C	30	0
ENT 211	Entrepreneurship and Innovation	2	C	30	0
MTH 201	Mathematical Methods	2	C	30	0
MTH 202	Elementary Differential Equations	2	C	30	0
COS 201	Computer Programming I	3	C	30	45
COS 202	Computer Programming II	3	C	30	45
ICT 201	Introduction to Information and Communication Technology	2	C	30	0
ICT 298	SIWES 1	3	C	0	135
CSC 203	Discrete Structures	2	C	30	0
INS 202	Human-Computer Interface	2	C	30	0
IFT 203	Introduction to Web Technologies	2	C	30	45
	TOTAL	**25**			

300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	0
ENT 312	Venture Creation	2	C	15	45
ICT 301	Satellite Communication	2	C	15	45
ICT 305	Data Communication System &	2	C	15	45

	Network				
ICT 309	Mobile Communication and Network	3	C	30	45
ICT 322	ICT Innovation and Entrepreneurship	2	C	15	45
ICT 398	SIWES II	3	C	0	135
CYB 301	Cryptography Techniques, Algorithms and Applications	2	C	15	45
CSC 308	Operating Systems	3	C	30	45
	TOTAL	**21**			

400 Level

Course Code	**Course Title**	**Unit(s)**	**Status**	**LH**	**PH**
COS 409	Research Methodology and Technical Report Writing	3	C	45	0
CSC 432	Distributed Computing Systems	3	C	45	0
ICT 497	Final Project I	3	C	0	135
ICT 498	Final Project II	3	C	0	135
ICT 418	Design & Installation of Electrical & ICT Services	3	C	30	45
INS 401	Project Management	2	C	30	0
IFT 442	Wireless Communications and Networking	3	C	30	45
	TOTAL	**20**			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 30; PH 45)

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

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

8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

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

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

Learning Outcomes

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

1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents

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

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

the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

COS 102: Problem Solving (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. explain problem solving processes;
2. demonstrate problem solving skills;
3. describe the concept of algorithms development and properties of algorithms;
4. discuss the solution techniques of solving problem;
5. solve computer problems using algorithms, flowcharts, pseudocode; etc.; and
6. solve problems using programming language using C, PYTHON, etc.

Course Contents

Introduction to the core concepts of computing. Problems and problem-solving. The identification of problems and types of problems (routine problems and non-routine problems). Method of solving computing problems (introduction to algorithms and heuristics). Solvable and unsolvable problems. Solution techniques of solving problems (abstraction, analogy, brainstorming, trial and error, hypothesis testing, reduction, literal thinking, means-end analysis, method of focal object, morphological analysis, research, root cause analysis, proof, divide and conquer). General Problem-solving process. Solution formulation and design: flowchart, pseudocode, decision table, decision tree. Implementation, evaluation and refinement. Programming in C, Python etc.

Lab Work: Use of simple tools for algorithms and flowcharts; writing pseudocode; writing assignment statements, input-output statements and condition statements; demonstrating simple programs using any programming language (Visual Basic, Python, C).

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

Learning Outcomes

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

1. understand basic definition of Set, Subset, Union, Intersection, Complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. understand various types of numbers; and
5. solve some problems using the Binomial theorem.

Course Contents

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

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

Learning Outcomes

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

1. carry out differentiation and Integration according to the rules thereof;
2. understand the meaning of the function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents

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

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

Learning Outcomes

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

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

Course Contents

Space and time. units and dimensions. Vectors and Scalars. Differentiation of vectors: displacement, velocity and acceleration. kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). Relative motion. Application of Newtonian mechanics. Equations of motion. Conservation principles in physics. Conservative forces. conservation of linear momentum. Kinetic energy and work. Potential energy. System of particles. Centre of mass. Rotational motion. Torque. vector product. moment. rotation of coordinate axes and angular momentum. Polar coordinates. conservation of angular momentum. Circular motion. Moments of inertia. gyroscopes and precession. Gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General physics II (Electricity & magnetism) (2 Units C: LH 30)

Learning Outcomes

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

1. describe the electric field and potential, and related concepts, for stationary charges;

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

Course Contents

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

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

Learning Outcomes

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

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents

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

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

Learning Outcomes

On completion, the student should be able to:

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;

5. draw conclusions from numerical and graphical analysis of data; and
6. prepare and present practical reports.

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

STA 111: Descriptive statistics: (3 Units; C) (LH 45)

Learning Outcomes

At the end of the course, students should be able to:
1. explain the basic concepts of descriptive statistics.
2. present data in graphs and charts.
3. differentiate between measures of location, dispersion and partition.
4. describe the basic concepts of Skewness and Kurtosis as well as their utility function in a given data set.
5. differentiate rates from ratio and how they are use.
6. compute the different types of index number from a given data set and interpret the output.

Course content
Statistical data. Types, sources and methods of collection. Presentation of data. Tables chart and graph. Errors and approximations. Frequency and cumulative distributions. Measures of location, partition, dispersion, skewness and Kurtosis. Rates, ratios and index numbers.

200 Level
GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)
Learning Outcomes
At the end of this course, students should be able to
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy& the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid

arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 30; PH 45)

Learning Outcomes

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

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

Course Contents

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

COS 201: Computer Programming I (3 Units C: LH 45; PH 45)

Learning Outcomes

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

1. identify different programming paradigms and their approach to programming;
2. write programmes using basic data types and strings;
3. design and implement programming problems using selection;
4. design and implement programming problems using loops;

5. use and implement classes as data abstractions in an object-oriented approach;
6. implement simple exception handling in programmes;
7. develop programmes with input/output from text files; and
8. design and implement programming problems involving arrays.

Course Contents

Introduction to computer programming. Functional programming. Declarative programming. Logic programming. Scripting languages. Introduction to object-orientation as a technique for modelling computation. structured and functional programming principles. Introduction of a typical object-oriented language such as Java. Basic data types, variables, expressions, assignment statements, and operators. Basic object-oriented concepts: abstraction, objects, classes, methods, parameter passing, and encapsulation. Class hierarchies and programme organisation using packages/namespaces. Use of API – use of iterators/enumerators. List, Stack, Queue from API. Searching. sorting. Recursive algorithms. Event-driven programming. event-handling methods. event propagation. exception handling. Introduction to Strings and string processing. Simple I/O. Control structures. Arrays. Simple recursive algorithms. inheritance. polymorphism.

Lab work: Programming assignments. design and implementation of simple algorithms e.g. average, standard deviation, searching and sorting. Developing and tracing simple recursive algorithms. Inheritance and polymorphism.

COS 202: Computer Programming II (3 Units C: LH 45; PH 45)

Learning Outcome

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

1. demonstrate the principles of good programming and structured programming concepts;
2. demonstrate string processing, internal searching, sorting, and recursion;
3. demonstrate the basic use of OOP concepts: classes, objects, inheritance, polymorphism, data abstraction;
4. apply the tools for developing, compiling, interpreting and debugging programmes; and
5. demonstrate the use of syntax and data objects, operators. Central flow constructs, objects and classes programming, Arrays, methods, Exceptions, Applets and the Abstract, OLE, Persistence, Window Toolkit.

Course Contents

Review and coverage of advanced object-oriented programming - polymorphism, abstract classes and interfaces. Class hierarchies and programme organisation using packages/namespaces. Use of API – use of iterators/enumerators, List, Stack, Queue from API. Searching, and sorting. Recursive algorithms. Event-driven programming: event-handling methods, event propagation, exception handling. Applications in Graphical User Interface (GUI) programming.

Lab work: Programming assignments leading to extensive practice in problem-solving and programme development with emphasis on object-orientation. Solving basic problems using

static and dynamic data structures. Solving various searching and sorting algorithms using iterative and recursive approaches. GUI programming.

ICT 201: Introduction to Information and Communication Technology (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. identify components of the computer and know-how the components communicate;
2. know the concept of data transfer and memory types and management;
3. be comfortable with graphics processing;
4. identify and be able to use different communication ports;
5. know the software types;
6. state different computer network topologies and their sizes; and
7. be able to use office applications and the internet.

Course Contents

Basic principle of computers. Computer "backbone". Data transmission. Random Access Memory. Permanent Memory. Graphic processing. Communication Ports. Input and Output Devices. Software types. Accessibility options. Computer types. Portable digital devices. Network Types. Internet. Instant messaging. Voice over Internet Protocol. Really Simple Syndication. Network communication. Internet data transfer. Data rate units. Internet access. Virtual (online) communities. Computer in the workplace. Office Applications (word processing, spreadsheets, presentation, etc.). Other well-known applications. Telecommuting (telework).

MTH 201: Mathematical Methods (2 Units; C) (LH 30)

Learning Outcomes

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

1. Understand the Real-valued functions of a real variable;
2. Solve some problems using the Mean value Theorem and Taylor Series expansion; and
3. Evaluate Line Integral, Surface Integral, and Volume Integrals.

Course Contents

Real-valued functions of a real variable. Review of differentiation and integration and their applications. Mean value theorem. Taylor series. Real-valued functions of two and three variables. Partial derivatives chain rule, extrema, lagrangian multipliers. Increments, differentials and linear approximations. Evaluation of line, integrals. Multiple integrals.

MTH 202: Elementary Differential Equations (2 Units C: LH 30)

Learning Outcomes

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

1. define the following: order and degree of a differential equation;
2. describe some techniques for solving first and second-order linear and non-linear equations; and
3. solve some problems related to geometry and physics.

Course Contents

Derivation of differential equations from primitive, geometry, physics, etc. order and degree of a 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.

ICT 298: Students Industrial Work Experience Scheme (3 Units C: PH 135)

Students are attached to private and public organisations for a period of three months with a view to making them acquire practical experience and to the extent possible, develop skills in all areas of ICT. Students are supervised during the training period and shall be expected to keep records designed for the purpose of monitoring their performance. They are also expected to submit a report on the experience gained and defend their reports.

CSC 203: Discrete Structures (3 Units C: LH 45)

Learning Outcomes

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

1. convert logical statements from informal language to propositional and predicate logic expressions;
2. describe the strengths and limitations of propositional and predicate logic;
3. outline the basic structure of each proof technique (direct proof, proof by contradiction, and induction) described in this unit;
4. apply each of the proof techniques (direct proof, proof by contradiction, and induction) correctly in the construction of a sound argument;
5. apply the pigeonhole principle in the context of formal proof;
6. compute permutations and combinations of a set and interpret the meaning in the context of the particular application;
7. map real-world applications to appropriate counting formalisms, such as determining the number of ways to arrange people around a table, subject to constraints on the seating arrangement, or the number of ways to determine certain hands in cards (e.g., a full house); and
8. solve a variety of basic recurrence relations.

Course Contents

Propositional Logic. Predicate Logic. Sets. Functions. Sequences and Summation. Proof Techniques. Mathematical induction. Inclusion-exclusion and Pigeonhole principles.

Permutations and Combinations (with and without repetitions). The Binomial Theorem. Discrete Probability. Recurrence Relations.

INS 202 Human-Computer Interface (HCI) (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. discuss the foundations and concept of the human-computer interface;
2. explain Understanding of principles of human-computer interface;
3. explain the design and development of the human-computer interface; and
4. explain the importance of user feedback.

Course Contents

Foundations of HCI. The concept underlying the design of HCI. Principles of GUI. GUI toolkits. System design methods. User conceptual models and interface metaphors. Human cognitive and physical ergonomics. Human-centred software evaluation and development. GUI design and programming.

Lab Work: Illustration of the principles of HCI design. Practice on GUI design and programming. Demonstration of some GUI toolkits. Practical evaluation of GUIs

IFT 203: Introduction to Web Technologies (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. state the origin of the internet and the world wide web;
2. create simple web content using HTML, CSS, and JavaScript;
3. use simple application frameworks to develop web content; and
4. appraise the impact of the world wide web on people's lives over time.

Course Contents

Introduction to the internet, the World Wide Web (WWW), and web development. WWW as a platform for interactive applications, content publishing, and social services. The role of HTTP and HTTPS in the context of web applications. Roles and operations of web browsers and the webserver. Interacting with web applications through forms, and using style sheets to separate document structure and document formatting. Web development tools and frameworks. Build a simple website that: organises information effectively, uses valid HTML and CSS, and applies appropriate web standards from standards bodies such as W3C. HTTP communication protocol, the mark-up languages HTML, XHTML, and XML, the CSS and XSLT standards for formatting and transforming web content.Interactive graphics and multimedia content on the web, client-side programming using JavaScript. Impact of the world wide web on people's lives over time.

Lab Work: Using simple form-based web applications; developing simple websites using web development tools and frameworks; using the mark-up languages HTML, XHTML and XML; using JavaScript.

300 Level

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

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;

6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/market research, Unutilised resources, Social and climate conditions, and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (venture capital, equity finance, microfinance, personal savings, small business investment organisations, and business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first mover advantage, e-commerce business models and successful e-commerce companies,). Small business management/family business: Leadership & Management, basic bookkeeping, nature of family business and family business growth model. Negotiation and business communication (Strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological solutions (the concept of market/customer solution, customer solution, and emerging technologies, business applications of new technologies- Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoT), Blockchain, Cloud Computing, renewable energy, etc. digital business and e-commerce strategies).

ICT 301: Satellite Communication (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. describe the various Satellite communication Technologies;
2. explain various access techniques in Satellite Communications;
3. list the advantages and disadvantages of Multi-beam satellite;
4. implement network configuration; and
5. manage satellite communication equipment.

Course Contents

Satellite frequency bands. services, transmission and multiplexing schemes. trans-multiplexing. multiple access schemes. Satellite orbit. Satellite motion. Paths. Geostationary satellites. Non-geostationary constellations. Satellite subsystems. Satellite launching. Antennas: types, gain, pointing loss, G/T, EIRP. High power amplifiers. Low noise amplifiers. BUC/LNB: conversion process, polarisation hopping, redundancy configurations. earth station monitoring and control. Basic link analysis. attenuation. sources of interference. carrier to noise and interference ratio. System availability. Frequency reuse. Link budget. Link design. Multiple access techniques: companded FDM-FM-FDMA, SSB-AM-FDMA, amplitude, and phase nonlinearities. Optimised carrier to noise and intermodulation ratio. TDMA: frame structure, burst structure, frame efficiency, super-frame structure, frame acquisition and synchronisation, satellite position determination. TDMA equipment. advanced TDMA satellite

systems. CDMA: direct sequence CDMA (DS-CDMA), sequence synchronous and sequence asynchronous DS-CDMA. random access DS-CDMA. link analysis. FH-SS systems. FH-CDMA. acquisition and synchronisation. Demand assignment multiple access (DAMA). types of demand assignments. DAMA characteristics. real time frame reconfiguration. DAMA interfaces. SCPC DAMA. SPADE. digital speech interpolation. Message transmission by FDMA. M/G/1 queue. message transmission by TDMA. pure ALOHA- satellite packet switching. slotted ALOHA. packet reservation. tree algorithm. Advantages and disadvantages of multi-beam satellites, interconnection by transponder hopping, interconnection by on-board switching (SS/TDMA). interconnection by beam scanning, ISL: GEO-LEO, GEO-GEO, LEO-LEO, RF, and optical links. VSAT networks. VSAT technologies. network configurations. multi-access and networking. network error control. polling VSAT networks.

Lab Work: Illustration of Basics of Satellite Communication. Demonstration of antennas, high power amplifiers and low noise amplifiers. Illustration of FDMA techniques. Demonstration of TDMA structure and equipment. Illustration of CDMA equipment and techniques. Illustration of DAMA techniques. Demonstration of VSAT networks.

ICT 305: Data Communication Systems and Network (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. define various terminologies relating to Data communication;
2. explain the Seven Layer ISO-OSI standard protocols and network architecture;
3. describe different error-detection methods;
4. describe Internet Technologies and Protocols; and
5. list the features and benefits of Network Operating System.

Course Contents

Types and sources of data. simple communications network. transmission definitions. one-way transmission. half-duplex transmission. transmission codes. transmission modes. parallel transmission. serial transmission. bit synchronisation. character synchronisation. character synchronisation. synchronous transmission. asynchronous transmission. the efficiency of transmission. Protocols: Introduction to network protocol. Seven Layer ISO-OSI standard protocols and network architecture. Transport protocols, session services protocols, and other protocols. Institute of Electrical and Electronics Engineering 802 standards. Error control and Data Compression. Forward Error Control. error detection methods. parity checking. linear block codes. cyclic redundancy checking. feedback error control. data compression. Huffman coding and dynamic Huffman coding. Local Area Networks. medium access control techniques – Ethernet, token bus, and token ring. LAN standards. fibre distributed data interface. metropolitan area network. Peer-to-peer. Client-Server. Client-Server Requirements. GUI design standards. interface independence. platform independence. transaction processing. connectivity. reliability. backup. recovery mechanisms. Information Network Software: features and benefits of major Network Operating Systems. Network OS. TCP/IP and Network OS.

Lab Work: Demonstration of simple communications networks. Illustration of applications at the various levels of the OSI model. Demonstration of different types of Local Area Networks

(LANs). Illustration of Metropolitan Area Networks. Illustration of Error Detection and Error Correction techniques. Demonstration of Network Operating Systems.

ICT 309: Mobile Communication& Network (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. describe mobile communication systems and their protocols;
2. explain the difference between analogue and digital cellular systems;
3. discuss GSM technology and its generational standards; and
4. describe wired and wireless networking, routing protocols, and optimisation.

Course Contents

Evolution of mobile radio communications. Examples of mobile radio systems: radio paging, cordless telephones, cellular radio. Trends in cellular radio and personal communications. A basic cellular system, Frequency reuse, Roaming, Hand-off strategies, Co-channel interference, Traffic and Grade of service, System capacity, Improving capacity of cellular system. Propagation path loss, multi-path propagation problem, Rayleigh fading, Rician distribution. Doppler effect. Field strength prediction models, co-channel interference and reduction, adjacent channel interference, near-far problem. Standards and overview of analogue and digital cellular systems: AMPS, TACS, GSM, CT2, PCN, DECT, PHS. Frequency management and channel assignment, speech coding, channel coding, bandwidth consideration, equalisation, modulation techniques, multiple access techniques. GSM: Architecture, elements, and standard interfaces; FDMA/TDMA structure; Speech and channel coding; time slots and bursts; signalling; hand-offs; DCS 1800; GPRS; data services over GSM. Third Generation Wireless Standard: convergence; UMTS; IMT-2000; CDMA2000; WCDMA; UWC-136; Network layer standards. Paging services and technologies; Short Message Services. Call Processing: Signalling; Roaming and mobility management; Route optimisation; Wireless Intelligent Networking; Databases; Protocols; Security and billing issues. Global Positioning System: principles, and applications.

Lab Work: Demonstration of different types of mobile radio systems. Illustration of basic features of a cellular system. Working with different analog and digital cellular systems. Demonstration of features of a GSM system. Demonstration of the features of SMS. Illustration of GPS applications.

ICT 322: ICT Innovation and Entrepreneurship (2 Units C: LH 30)

Learning Outcomes

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

1. explain business models;
2. explain emerging trends in entrepreneurship;
3. describe business plan and business startup process;
4. explain business feasibility and strategy;
5. explain marketing strategies; and
6. discuss business ethics.

Course Contents

Business leadership. Digital marketing. Emerging trends in entrepreneurship. Business ethics. New venture creation process. Business feasibility planning. Market research. Business strategy. Business models and business plans. Technical presentations.

ICT 399: Students Industrial Work Experience Scheme (SIWES) (3 Units C: PH 135)

Learning Outcomes

Upon the completion of the training, the students should be able to:

1. interact with experts, thus making them gain extra knowledge outside the school environment;
2. compare classwork with real-life working experience in their various areas of specialisation;
3. determine their level of competence;
4. acquire the more practical knowledge and skills;
5. provide a detailed written report on their industrial experience; and
6. defend their project to a panel of examiners.

Course Contents

Students are attached to private and public organisations for a period of three months with a view to making them acquire practical experience and to the extent possible, develop skills in all areas of ICT. Students are supervised during the training period and shall be expected to keep records designed for the purpose of monitoring their performance. They are also expected to document their experiences, produce & submit a report of the documentation, present and defend the reports.

CSC 308: Operating Systems (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. recognise operating system types and structures;
2. describe OS support for processes and threads;
3. recognise CPU scheduling, synchronisation, and deadlock;
4. resolve OS issues related to synchronisation and failure for distributed systems;
5. explain OS support for virtual memory, disk scheduling, I/O, and file systems;
6. identify security and protection issues in computer systems; and
7. use C and Unix commands, examine behaviour and performance of Linux, and develop various system programmes under Linux to make use of OS concepts related to process synchronisation, shared memory, mailboxes, file systems, etc.

Course Contents

Overview of O/S: Role & Purpose, Functionality Mechanisms to Support Client-server models, hand-held devices, Design Issues influences of Security, networking, multimedia, Windows. Process management: processes, threads, CPU scheduling, process synchronisation. Memory management and virtual memory. File systems. I/O systems. Security and protection. Distributed systems. O/S Principles: Structuring methods Abstraction, processes and of recourses, Concept of APIS Device organization interrupts.

Lab work: Practical hands-on engagement to facilitate understanding of the material taught in the course. All the process, memory, file and directory management issues will be

demonstrated under the LINUX operating system. Also, UNIX commands will be briefly discussed. Alternatively, hands-on exposure may be through the use of operating systems developed for teaching, like TempOS, Nachos, Xinu, or MiniOS. Another possibility is through programming exercises that implement and simulate algorithms taught. Simulation of CPU scheduling algorithms, producer-consumer problem, memory allocation algorithms, file organisation techniques, deadlock algorithms, and disk scheduling algorithms.

CYB 301: Cryptography Techniques, Algorithms and Applications (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. define cryptography means, simple cryptosystems, symmetric and asymmetric cryptography, symmetric cryptosystems and asymmetric cryptosystems;
2. differentiate key management and encryption algorithms, types of cryptography and cryptographic techniques;
3. practice cryptanalysis of cipher and how to use protocols, hashing, digital signatures, and certificates;
4. examine the certificate authorities, policies, procedures, and methods for the proper use of cryptography in secure systems;
5. identify public-key cryptography and discrete algorithms, cryptography and its mathematical background, and understand hash functions, data integrity, authentication, algorithmic number theory, primality testing and true primality testing; and
6. discuss factoring integers, RSA, security of RSA encryption, security of RSA key generation, discrete logarithm cryptographic schemes.

Course Contents

Introduction to cryptography, symmetric and asymmetric cryptography, key management, and encryption algorithms. Introduction to simple cryptosystems. Cryptanalysis. Stream ciphers, Block ciphers and Feistel ciphers. Multiple encryption. Hash functions. Data integrity, authentication, and perfect secrecy. Public-key cryptography and discrete algorithms-ELGamal cryptography. Algorithms for the discrete logarithm problem. Algorithmic number theory. Probabilistic primality testing. Security of ELGamal and RSA Encryption, and RSA Key Generation. Discrete logarithm cryptographic schemes. Conventional and public-key cryptography. Selected cryptosystems, including Data Encryption Standard (DES) and Rivest-Shamir-Adleman (RSA) algorithm. AES encryption algorithm, a symmetric 128-bit block data encryption technique. PKI, SSL, and VPN. Digital signatures, pseudo-random number generation, cryptographic protocols and cryptanalytic techniques. Use of protocols, hashing and certificates and certificate authorities. Policies, procedures, and methods for the proper use of cryptography in secure systems. Applications of cryptography to signal.

Lab work: Practical exercise on writing cryptography algorithms. Work on cryptographic techniques. Practice cryptanalysis of cipher and how to use protocols. Understand hash functions and learn how to hash, produce secured digital signatures and certificates. Learn the procedures and methods for the proper use of cryptography in secure systems. Practice

primality testing. Practical assignments on ELGamal, DES and RSA encryption security, generation of RSA key and discrete logarithm cryptographic schemes.

400 Level

COS 409: Research Methodology and Technical Report Writing (3 Units C: LH 45)

Learning Outcomes

At the end of the course, students should have learned to:

1. distinguish qualitative and quantitative research methodologies and their applications;
2. identify and define a research problem in a given area;
3. identify different methods of data collection and select the methods appropriate to a given situation;
4. design and conduct simple research including analysis and interpretation of research results;
5. document research problems, methodology all the way to research report writing;
6. defend the written research report; and
7. be familiar with ethical issues in the conduct of research.

Course Contents

Foundations of Research. Types of Research. Research Approaches. Significance of Research. Research Methods versus Methodology. Research Process. Criteria and Strategy for Good Research. Problems Encountered by Researchers in Nigeria. Principles of Scientific Research. Scientific investigation. Problem formulation. Definition and technique of the Research Problem. Selection of Appropriate Method for Data Collection- Primary Data and Secondary Data. Guidelines for Constructing Questionnaire/Schedule. Guidelines for Successful Interviewing. Difference between Survey and Experiment. Eloping Research Proposal and Research Plan. Formulation of working hypothesis and Testing. Literature review. Procedure for reviewing related relevant studies and referencing cited works. Types of Reports. Technical Report Writing. Layout and Mechanics of Writing a Research Report. Standard Techniques for Research Documentation. Sampling Design. Different Types of Sample Designs. Steps in Sampling Design. Criteria of Selecting a Sampling Procedure. Methods of analysi**s.** Processing and Analysis of Data Elements/Types of Analysis. Interpretation and Presentation of results. How to prepare References and Bibliography.

ICT 418: Design and Installation of Electrical & ICT Equipment (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. Describe Health and safety standards in electrical installations;
2. Explain NCC and FCC codes of practice and standards in Nigeria;
3. Implement Telecommunication design and installation;
4. Configure computer networks; and
5. Design and install Telephony equipment.

Course Contents

Electrical Installation. Introduction to Health and safety at Work Act in Nigeria. Electrical safety. First aid. Electricity supply regulations. Lighting and Illumination: Luminous intensity and flux. Maintenance factor. Coefficient of utilisation. Types of light sources. Calculation of lighting requirements. Glare. Stroboscopic effect. Installation Materials, cables, junction box, terminations, joints. Conduits and conduiting. Trunks and trunking. Electrical Installation design in domestic, commercial, and industry. Alarm and emergency systems. Earthling and Protection. Purposes of earthing. Faraday cage. Rod electrodes. Earth electrode resistance. Earthing system. Earth fault loop impedance. ICT services: NCC and FCC codes of practice and standards. Telecommunication design and installation: Satellite, VSAT, etc. Telephone design and installation. Computer networking design and installation. Wireless LAN design and installation. Preparation of Bill of Engineering Measurement Evaluation. Contract bidding. Consultancy.

Lab Work: Demonstration of simple electrical installations using electrical materials including conduits and trunks. Illustration of ICT installations including wired and wireless computer networks. Demonstration of telecommunications installations

ICT 497: Final Year Project I (3 Units C: PH 135)

Learning Outcomes

Upon completion of the project, students should be able to:

1. identify researchable project topics in information and communication technology'
2. search and review literature pertinent to identified problem statements;
3. acknowledge and reference sources of information used in this research report;
4. conceptualise and design a research methodology to address an identified problem;
5. determine tools for analysing data collected based on research objectives;
6. write a coherent report on research conducted; and
7. work independently to accomplish a research project with the guidance of the research supervisor.

Course Contents

An independent or group investigation development of an information system to address a business problem under the supervision of a lecturer. Before registering, the student must submit a written proposal to the supervisor to review. The proposal should give a brief outline of the project, estimated schedule of completion, and computer resources needed. A formal written report is essential and an oral presentation may also be required. At the end of the semester, the introduction, literature review, and methodology employed should be submitted for grading.

ICT 498: Final Year Project II (3 Units C: PH 135)

Learning Outcomes

Upon completion of the project, students should be able to:

1. demonstrate technical skills in Information and Communication Technology;
2. demonstrate generic transferable skills such as communication and teamwork;
3. produce a technical report in the chosen project;
4. defend the written project report; and
5. appreciate the art of carrying out full-fledged research.

Course Contents

This is a continuation of ICT 497. This contains the implementation and the evaluation of the project. A formal written report chapters 4 - 5 has to be approved by the supervisor. A final report comprising chapters 1 - 5 will be submitted to the department for final grading. An oral presentation is required.

IFT 442: Wireless Communications and Networking (3 Units C: LH 45; PH 45)

Learning Outcomes

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

1. describe the principles underlying wireless data communications;
2. design and implement wireless network environment for any application using the latest wireless protocols and standards;
3. diagnose and troubleshoot faulty PCs and wireless devices;
4. install, configure and upgrade wireless communications system; and
5. develop hands-on experience installing, configuring, and upgrading wireless communications components and software.

Course Contents

Fundamental principles underlying wireless data communications. Wireless transmission basics. radio propagation issues. antennas. digital modulation. spread spectrum techniques and their applications. Popular standards: Wi-Fi, WiMAX and Bluetooth. Also presents practical knowledge to enable the design, testing, deployment, debugging and commissioning of Wi-Fi, WiMAX networks, and point-to-point microwave systems. Discussions on cellular network technologies are also included.

Lab Work: Basics on wireless transmission. Design of simple Wi-Fi and Wi-Max networks. Demonstration of GSM networks. Deployment and testing of wireless networks. Working with LTE. Demonstration of IPv6. Illustration of Wireless Personal Area Networks (PANS)

CSC 432: Distributed Computing Systems (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should have learned to:

1. summarise and describe general properties, challenges, and characteristics of distributed systems;
2. describe generally distributed algorithms for synchronisation and concurrency, coordination, transactions, and replication;
3. exemplify practical issues that need to be considered when designing, implementing, and debugging distributed systems;
4. compare replication schemes with respect to performance, availability, and consistency concerns; and
5. design, implement, and debug distributed systems.

Course Contents

Communication Mechanisms. Communication Protocols. RPC. RMI. Stream Oriented Communication. Synchronisation. Global State. Election. Distributed Mutual Exclusion. Distributed Transactions. Naming: Generic Schemes, DNS, Naming and Localisation. Replication and Coherence. Consistency Models And Protocols. Fault Tolerance: Group Communication, Two- And Three-Phase Commit, Checkpointing; Security: Access Control. Key Management. Cryptography. Distributed File Systems: NFS, Coda, etc. Application: e-commerce, global business strategies, online network business in a secure environment.

INS 401: Project Management (2 Units C: LH 30)

Learning Outcomes

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

1. describe project management planning;
2. describe project scheduling;
3. explain the management of project resources;
4. discuss project procurement, monitoring and execution; and
5. explain project communication and time management.

Course Contents

Introduction to Project Management. The Project Management Lifecycle. Project Execution, Control and Closure. Project management and systems development or acquisition. The project management context, technology and techniques. Project management processes. Managing Project Teams: Project team planning, Leadership in project management. Power and conflict in project teams. Communication among project stakeholders. Scope management. Managing Project Scheduling: Common problems in project scheduling. Resource management. Project quality management. Managing project risk and tools for managing project risk. Managing Project Procurement: Alternatives to systems development, External acquisition, Outsourcing-domestic and offshore, Steps in the procurement process. Project auditing.

Minimum Academic Standards

Laboratory Infrastructure

The Information and Communication Technology programme should have at least three categories of laboratories: Software, Digital logic, and Network laboratories. Best practice requires staff to student's ratio of about 1 to 25 for laboratory practicals. Therefore, multiple small laboratories are desirable to few large ones. Courses with large enrolments of students should have the students divided into groups to ensure each student has computer/practice equipment to themselves during practical sessions. Laboratory sessions should be conducted by qualified personnel to ensure close monitoring and effective achievement of Learning Outcomes.

Software laboratory

There should be a software laboratory that can support the best practice staff to student ratio for all lab-based courses in the programme. Software laboratory support programming courses

and other courses requiring the use of software tools. Requirements for the software laboratory include:

1. Computer systems with the capacity to run software systems for all lab-based courses (e.g., Intel-based desktop PC with a minimum of 166MHz or faster processor with at least 64 MB RAM and 100 MB free disk space)
2. Programming environment and tools (e.g., Compilers/interpreters, debuggers, etc. for Java, Python, compiler compilers, e.g., flex, yacc, SableCC, etc.)
3. Operating systems environments and tools (e.g., Windows, LINUX, TempOS, Nachos, Xinu or MiniOS)
4. Tools for systems analysis and design, e.g., Unified Modelling Language (UML)
5. Computer maintenance tools like dust blowers
6. Overhead projector
7. Power backup

Digital logic laboratory

The digital logic or hardware laboratory should provide facilities required for hardware-related practicals. Requirements for the digital logic laboratory include:

1. NAND, NOR, XOR, AND, OR gates
2. Multiplexers, Demultiplexers, Decoders, Counters
3. Master-slave flip-flops
4. Digi-Designer Logic Board, etc.
5. Dual–trace oscilloscope
6. Digital Proto-Board
7. Microprocessor Demonstration System
8. ROMs, RAMs

Network laboratory

A separate network laboratory is required to expose students to practice on net-centric courses.

Requirements for the network laboratory are not limited to the following:

1. Laptop (CORE i7, 1TB, 8GB RAM)
2. Mikrotik Cloud Switch Router
3. Mikrotik RB2011uais Router
4. Cloud core Router (12GB port, 4SFP)
5. Cisco Switches at least 12
6. Gigabit Switch (24 port)
7. Workstation (1TB, 8GB RAM)
8. Wireless Router
9. Crimping tool
10. LAN Cable Tester
11. CAT6b Cable
12. GNS3
13. Cisco Packet Tracer
14. Putty
15. Secure CRT
16. Microsoft Visio
17. PRTG Network Monitor
18. WIRESHARK
19. EVE-NG
20. Network Simulator -NS3

21. SNMP Agent Simulator
22. VIRL Network Emulator
23. Oracle Virtual Box
24. Clouds
25. BOINC
26. Cable Crimpers
27. PHP/HTML, XML
28. MATLAB
29. Air Blowers
30. Workstations
31. Severs
32. VSAT Installation devices:
    - Low Noise Block (LNB) which is a down converter and receiver
    - Block Up Converter (BUC) this is the up converter and transmitter
    - Ortho-Mode Transducer (OMT) the Tx and Rx waveguide joint
33. Licensed Software

Staffing

Personnel

Academic staff

The guidelines on academic staff/student ratio of 1:20 for Computing Programmes shall apply. To start any programme in Computing, there should be a minimum of six academic staff. There is a 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. The staff structure forthe academic staff is expected to be 20: 35: 45 for Professors/Readers: Senior Lecturers: Lecturers 1 and below.

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.

Ratio of junior admin staff to academic staff shall be	1:10
Ratio of senior admin staff to academic staff shall be	1:10

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.

Ratio of Senior Technical Staff to Academic Staff shall be	1:10
Ratio of Junior Technical Staff to Academic Staff shall be	1:5

Library

Universities should leverage available technology to put in place rich databases and other electronic/digital libraries and information resources. In addition, current hard copies of reference and other textual materials should be provided centrally at the level of the Faculty.

A well-equipped 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 the students enrolled in each academic programme. The funding of the library should be in line with NUC guidelines.

Classrooms, Laboratories and Offices

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
Seminar space/per student	-	1.85
Laboratory space per FTE	-	7.50
Conference room	-	37.0

Adequate space should be provided for the Department. Effort must be made to provide the Department with at least:

1. Two (2) large laboratories calculated according to specifications of 7.5 m2 per FTE. At least two lecture rooms capable of seating at least sixty students at the specification of 1 m2 per FTE.
2. A departmental conference room.
3. A seminar room.
4. A staff common room.

Office Equipment

The following equipment should be provided in the offices:

1. Computers
2. Printers
3. Photocopying machines
4. Functional internet and e-mail facilities

Classroom Space and Examination Theatres

Adequate classrooms should be provided with enough chairs, tables and lecture delivery tools such as projector, whiteboards and smart boards. Examination halls and theatres should be provided to minimise the rate of examination malpractices.

Classroom Equipment

The following equipment should be provided in the offices:

1. Multimedia projectors
2. Whiteboards or Smartboards
3. Functional internet and e-mail facilities

B.Sc. Information Systems

Overview

Information is a critical resource in driving all aspects of human endeavours. for optimal productivity and continuity for survival in a dynamic business environment. Information systems is the key enabler for running and managing processes in organisations today in a global economy. In the world today, entire sectors of economy relied heavily on information systems to thrive. Rational decision-making could only be made about business activities through a well-developed information system. The information system synopses are aimed at producing information system specialists with adequate professional knowledge and skills to support organisation information needs to drive its core operations through adequate course work, practical and applied project experience.

Philosophy

The philosophy of the programme is to equip Information Systems graduates with sufficient knowledge and skills to collect, process, store, distribute information and to use information systems to support decision making, control and coordination in an organisation for increased productivity through best practices and professional standards.

Objectives

The general objectives of this programme is to:

1. create the consciousness of the relevance of information systems as a primary driver in all economic sectors;
2. equip students with appropriate skills and knowledge to develop and manage information system resources in an organisation;
3. empower students with problem-solving skills;
4. develop students with the ability to use information systems to improve business operations;
5. develop students with capacity to manage various information systems in an organisation to best serve the people (manager, staff and customers).
6. equip students with demonstrable business knowledge and applications of software proficiency;
7. equip students with capacity for professional practice in information systems and communication.

Unique Features Of The Programme

The curriculum provides students with managerial and business skills as well as computing knowledge for effective management of information systems infrastructure and technologies to create business value in an enterprise organisation.

Employability Skills

Management of information systems resources and provision of complete information for effective decision making when required is important to all stakeholders in an organisation. Graduates of information systems will possess the following skills among others, information organisation and retrieval, data analysis, business strategy, system security analysis, communication and presentation skills.

21st Century Skills
Among the 21st Century skills for the programme are:

1. creativity;
2. information literacy;
3. flexibility;
4. social skills;
5. Problem solving;
6. Collaboration;
7. Global awareness;
8. Innovation skills; and
9. Critical thinking skills.

Admission and Graduation Requirements
Admission requirements
4 Year Degree Programme
In addition to appropriate UTME-Score, a candidate must possess five Senior Secondary Certificate (SSC)-credits passes including English Language, Mathematics, Physics and any other relevant Science subjects in not more than two sittings.

3 Year Degree Programme:
Direct Entry
A minimum of a credit at the University/National Diploma or NCE with other five Senior Secondary Certificate (SSC) credit passes in relevant Science subjects three of which must be in English Language, Mathematics, Physics.

Minimum duration
The minimum duration of the Information Systems degree programme is four academic sessions for UTME. However, it is three academic sessions for candidates admitted to the 200 Level.

Graduation requirements
To be eligible for the award of the Bachelor degree in Information Systems, a student must have:

1. Passed all the core courses, university and faculty/school required courses and electives.
2. Accumulated a minimum of 120 course units for students admitted through UTME and 90 course units for students admitted to 200 level.
3. Attain a minimum CGPA of 1.00.

To graduate, a student must be found worthy in character throughout the period of his/her studentship and must accumulate the total units prescribed for the programme from Core, Faculty, General Studies courses, SIWES, Seminar, and Final Year project.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	0
MTH 101	Elementary Mathematics I	2	C	30	0
MTH 102	Elementary Mathematics II	2	C	30	0
PHY 101	General Physics I	2	C	30	0
PHY 102	General Physics II	2	C	30	0
PHY 107	General Practical Physics I	1	C	0	45
PHY 108	General Practical Physics II	1	C	0	45
STA 111	Descriptive Statistics	3	C	45	0
COS 101	Introduction to Computing Sciences	3	C	30	45
COS 102	Problem Solving	3	C	30	45
	Total	**23**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	0
ENT 211	Entrepreneurship and Innovation	2	C	30	0
STA 121	Statistical Inference 1	3	C	45	0
BUA102	Introduction to Business II	2	C	30	0
COS 201	Computer Programming I	3	C	30	45
COS 202	Computer Programming II	3	C	30	45
INS 202	Human-Computer Interaction	2	C	15	45
INS 204	Systems Analysis and Design	3	C	30	45
INS 207	Introduction to Information Systems	2	C	30	0
INS 299	SIWES I	3	C	0	135
	Total	**25**			

SIWES (INS 299) now holds during the Long vacation of 200L

300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	0
ENT 312	Venture Creation	2	C	15	45
DTS 304	Data Management I	2	C	15	45

CYB 305	Digital Forensics and Investigation Methods	2	C	15	45
ICT 305	Data Communications System and Networking	3	C	30	45
INS 301	Business Process Management	2	C	30	0
INS 305	Management Theory	2	C	30	0
INS 311	E-Business Systems Development	2	C	15	45
INS 322	Information Systems Innovation and New Technologies	2	C	30	0
INS 399	SIWES II	3	C	0	135
CSC 308	Operating Systems	3	C	30	45
	Total	**25**			

SIWES II (INS 399) now holds during the Long vacation of 300L

400 Level

Course Code	**Course Title**	**Unit(s)**	**Status**	**LH**	**PH**
COS 409	Research Methodology and Technical Report Writing	3	C	45	0
DTS 404	Data Management II	2	C	15	45
INS 401	Project Management	2	C	30	0
INS 403	Business Process Re-engineering	2	C	30	0
INS 497	Final Year Project I	3	C	0	45
INS 498	Final Year Project II	3	C	0	45
	Total	**15**			

Course Contents and Learning Outcomes

100 Level

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

Learning Outcomes

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

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

Course Contents

Sound patterns in English Language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages,

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

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

Learning Outcomes

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

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

Course Contents

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

MTH 101: Elementary Mathematics I (Algebra and Trigonometry) (3 Units C: LH:45)

Learning Outcomes

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

1. understand basic definition of Set, Subset, Union, Intersection, Complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. understand various types of numbers; and
5. solve some problems using Binomial theorem.

Course Contents

Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers, integers, rational and irrational numbers. Mathematical induction, real sequences and series, theory of Quadratic equations, Binomial theorem, complex numbers, algebra of complex numbers, the Argand diagram. De-Moiré's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (3 Units C: LH 45)

Learning Outcomes

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

1. understand types of rules in Differentiation and Integration;
2. understand the meaning of Function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents

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

PHY 101: General Physics I (3 Units C: LH 45)

Learning Outcomes

On completion, the student should be able to;

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

8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents

Space and time; units and dimension, Vectors and Scalars, Differentiation of vectors: displacement, velocity and acceleration; kinematics; Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation); Relative motion; Application of Newtonian mechanics; Equations of motion; Conservation principles in physics, Conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass; Rotational motion; Torque, vector product, moment, rotation of coordinate axes and angular momentum. Polar coordinates; conservation of angular momentum; Circular motion; Moments of inertia, gyroscopes and precession; Gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General physics II (Electricity & magnetism) (2 Units C: LH 30)

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents

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

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

Learning Outcomes

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

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

Course Contents

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

STA 111: Descriptive Statistics: (3 Units C: LH 45)

Learning Outcomes

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

1. explain the basic concepts of descriptive statistics.
2. present data in graphs and charts.
3. differentiate between measures of location, dispersion and partition.
4. describe the basic concepts of Skewness and Kurtosis as well as their utility function in a given data set.
5. differentiate rates from ratio and how they are use.
6. compute the different types of index number from a given data set and interpret the output.

Course content
Statistical data. Types, sources and methods of collection. Presentation of data. Tables chart and graph. Errors and approximations. Frequency and cumulative distributions. Measures of location, partition, dispersion, skewness and Kurtosis. Rates, ratios and index numbers.

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

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

Course Contents
Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.
Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

COS 102: Problem Solving (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. explain problem solving processes;
2. demonstrate problem solving skills;
3. describe the concept of algorithms development and properties of algorithms;
4. discuss the solution techniques of solving problem;
5. solve computer problems using algorithms, flowcharts, pseudocode; etc.;and
6. solve problems using programming language using C, PYTHON, etc.

Course Contents
Introduction to the core concepts of computing. Problems and problem-solving. The identification of problems and types of problems (routine problems and non-routine

problems). Method of solving computing problems (introduction to algorithms and heuristics). Solvable and unsolvable problems. Solution techniques of solving problems (abstraction, analogy, brainstorming, trial and error, hypothesis testing, reduction, literal thinking, means-end analysis, method of focal object, morphological analysis, research, root cause analysis, proof, divide and conquer). General Problem-solving process. Solution formulation and design: flowchart, pseudocode, decision table, decision tree. Implementation, evaluation and refinement. Programming in C, Python etc.

Lab Work: Use of simple tools for algorithms and flowcharts; writing pseudocode; writing assignment statements, input-output statements and condition statements; demonstrating simple programs using any programming language (Visual Basic, Python, C)

200 Level

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

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;

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

Course Contents

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

BUA 102: Introduction to Business II (2 Units C: LH 30)

Learning Outcomes

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

1. Identify the various functional areas of business and describe their contribution to the organization;
2. Identify the business stakeholders and describe their relationship with the Organization;
3. Recognize some of the most common ethical challenges faced by the organization;
4. Discuss the many aspects of business functions such as management, finance, accounting and marketing.

Course Content

Basic principles of management. The functional areas of business. Marketing, production, finance and accounting functions. Sources of business finance. Government and business. The Social responsibility of business. International business. Business risks and uncertainties. Problems of Nigerian business enterprises. Ethics in business.

STA 121: Statistical Inference I (3 Units C: LH 45)

Learning Outcomes

Upon the completion of these courses, the students should be able to:
1. be able to differentiate population from sample as well as point from interval estimate;
2. be able to test for hypothesis concerning population mean and proportions for large and small samples;
3. be able to compute regression and obtain the fitted line. Likewise, the computation for correlation coefficient is well understood; and
4. be familiar with the fundamentals of time series analysis.

Course Contents

Population and samples. Random sampling distributions, estimation (Point and interval) and Tests of hypotheses concerning population mean and proportion (one and two large sample cases). Regression and correlation. Elementary time series analysis.

COS 201: Computer Programming I (3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of this course, students should be able to:
1. explain the principles of good programming and structured programming concepts;
2. explain the programming constructs, syntax and semantics of a higher-level language;
3. describe the chosen programming language variables, types, expressions, statements and assignment; simple input and output;
4. describe the programme control structures, functions and parameter passing, and structured decomposition; and
5. develop simple programmes in the taught programming language as well as debug and test them.

Course Contents

Introduction to computer programming. Functional programming; Declarative programming; Logic programming; Scripting languages. Introduction to object-orientation as a technique for modelling computation. structured, and even some level of functional programming principles; Introduction of a typical object-oriented language, such as Java; Basic data types, variables, expressions, assignment statements and operators; Basic object-oriented concepts: abstraction; objects; classes; methods; parameter passing; encapsulation. Class hierarchies and programme organisation using packages/namespaces; Use of API – use of iterators/enumerators, List, Stack, Queue from API; Searching; sorting; Recursive algorithms; Event-driven programming: event-handling methods; event propagation; exception handling. Introduction to Strings and string processing; Simple I/O; control structures; Arrays; Simple recursive algorithms; inheritance; polymorphism.

Lab work: Programming assignments; design and implementation of simple algorithms, e.g., average, standard deviation, searching and sorting; Developing and tracing simple recursive algorithms. Inheritance and polymorphism.

COS 202 Computer Programming II (3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of this course, students should be able to:
1. demonstrate the principles of good programming and structured programming concepts;

2. demonstrate string processing, internal searching, sorting, and recursion;
3. demonstrate the basic use of OOP concepts: classes, objects, inheritance, polymorphism, data abstraction;
4. apply the tools for developing, compiling, interpreting and debugging programmes; and
5. demonstrate the use of syntax and data objects, operators. Central flow constructs, objects and classes programming, Arrays, methods, Exceptions, Applets and the Abstract, OLE, Persistence, Window Toolkit.

Course Contents

Review and coverage of advanced object-oriented programming - polymorphism, abstract classes and interfaces. Class hierarchies and programme organisation using packages/namespaces. Use of API – use of iterators/enumerators, List, Stack, Queue from API. Searching, and sorting. Recursive algorithms. Event-driven programming: event-handling methods, event propagation, exception handling. Applications in Graphical User Interface (GUI) programming.

Lab work: Programming assignments leading to extensive practice in problem-solving and programme development with emphasis on object-orientation. Solving basic problems using static and dynamic data structures. Solving various searching and sorting algorithms using iterative and recursive approaches. GUI programming.

INS 202: Human-Computer Interface (HCI) (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. discuss the foundations and concept of human-computer interface;
2. explain the principles of human-computer interface;
3. explain the design and development of the human-computer interface; and
4. explain the importance of user feedback.

Course Contents

Foundations of HCI. Concept underlying the design of HCI. Principles of GUI. GUI toolkits. System design methods. User conceptual models and interface metaphors. Human cognitive and physical ergonomics. Human-centred software evaluation and development. GUI design and programming.

Lab Work: Illustration of the principles of HCI design. Practice on GUI design and programming. Demonstration of some GUI toolkits. Practical evaluation of GUIs

INS 204: Systems Analysis and Design (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. describe system requirements gathering techniques;
2. explain data modelling technique (entity relationship modelling);
3. explain process modelling technique (data flow diagram);
4. describe system architectural design;
5. describe process and database design; and
6. explain user interface design.

Course Contents

Structured approach to analysis and design of information systems for businesses. Software development life cycle. Structured top-down and bottom-up design. Dataflow diagramming. Entity relationship modelling. Computer aided software engineering. Input and output, prototyping design and validation. File and database design. Design of user interfaces. Comparison of structured and object-oriented design.

Lab work: Practical exercises on software development life cycle (SDLC) activities with different case studies. Use of different information systems case studies to apply the knowledge of structured top-down and bottom –up design, dataflow diagram and entity relationship models.

INS 207: Introduction to Information Systems (2 Units C: LH 30)

Learning Outcomes

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

1. explain system concepts and organisational processes;
2. explain information systems principles and application in modern organisation;
3. describe information technology security and related ethical issues; and
4. explain database management and system development life cycle.

Course Contents

Roles and relevance of information systems in organisations to conduct business and solve problems. Information systems principles in modern organisations. Systems concepts; organisational processes; technological aspects of information systems. The internet. Information technology security. Ethical issues. Database management. Systems development life cycle.

INS 299: Students Industrial Work Experience Scheme (SIWES) (3Units C: LH 145)

Students are attached to private and public organisations for a period of three months with a view to making them acquire practical experience and to the extent possible, develop skills in all areas of computing. Students are supervised during the training period and shall be expected to keep records designed for the purpose of monitoring their performance. They are also expected to submit a report on the experience gained and defend their reports.

300 Level

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

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

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

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/market research, Unutilised resources, Social and climate conditions, and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (venture capital, equity finance, microfinance, personal savings, small business investment organisations, and business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first mover advantage, e-commerce business models and successful e-commerce companies,). Small business management/family business: Leadership & Management, basic bookkeeping,

nature of family business and family business growth model. Negotiation and business communication (Strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological solutions (the concept of market/customer solution, customer solution, and emerging technologies, business applications of new technologies- Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoT), Blockchain, Cloud Computing, renewable energy, etc. digital business and e-commerce strategies).

DTS 304 Data Management I (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. describe database systems concepts and design;
2. explain database models and construction;
3. explain database implementation with SQL; and
4. describe database management and security.

Course Contents

Database concepts. File versus database systems, data models, ANSI/SPARC 3-level view of a database, and the relational database model and its advantages over older and even emerging models. Design concepts and implementation: entity relationship modelling. Normalisation of database tables, structured query language. Database design and implementation. Introduction to transaction management and concurrency control, distributed database management systems. Database privacy, security, failure and recovery. Some emerging topics in databases such as semi-structured (XML or NoSQL) databases and object-oriented database systems.

Lab work: Practical exercise on information representation, capture, storage and retrieval. Learn how to analyse data and index for easy searching and indexing. Practical on creating database files and models. How to create and use various database designs. How to query the created database. Methods of concurrency and recovery in database. Learn how to secure the database.

CYB 305: Digital Forensics and Investigation Methods (2 Units C: LH 15; PH 45)

Learning Outcome

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

1. explain basic knowledge on digital forensic and digital evidence;
2. establish awareness of digital evidence challenges aspects of digital evidence;
3. learn the cyber trail, challenging aspects of the cyber trail, and brief history of computer crime investigation;
4. trace the evolution of investigative tools and try to understand the language of computer crime investigation;
5. survey the role of computers in crime, technology and law: jurisdiction, pornography and obscenity, child pornography, privacy, copyrights and the "theft" of digital intellectual property, the investigative process, investigative reconstruction, with digital evidence;

6. examine techniques and tools used by computer forensics investigations such as acquisition, preservation, recovery, and analysis of evidence obtained from portable and stationary computer storage devices, personal digital assistants (PDAs), and cell phones;
7. acquire best practices in securing, processing, acquiring, examining and reporting on digital evidence; and
8. exposed to current technologies and methods as well as leading edge techniques with practical based projects and research opportunities.

Course Contents

Introduction to digital forensics, digital evidence, increasing awareness of digital evidence, challenging aspects of digital evidence. best practices in securing, processing, acquiring, examining and reporting on digital evidence. cyber trail, challenging aspects of the cyber trail, brief history of computer crime and cybercrime investigation, evolution of investigative tools, language of computer crime investigation, the role of computers in crime, technology and law: jurisdiction, pornography and obscenity, child pornography, privacy, copyrights and the "theft" of digital intellectual property, the investigative process, investigative reconstruction, with digital evidence. Examine techniques and tools used by computer forensics investigations such as acquisition, preservation, recovery, and analysis of evidence obtained from portable and stationary computer storage devices, personal digital assistants (PDAs), and cell phones. Students will be exposed to current technologies and methods as well as leading edge techniques with practical based projects and research opportunities.

Lab work: Practical exercises on how to make use of various techniques and tools for computer forensics investigations and cyber trail during cybercrime investigations. Practice cyber auditing skills. Work on applying the best practices in securing, processing, acquiring, examining and reporting on digital evidence with current technologies and methods in forensics investigation.

ICT 305: Data Communication System and Networking (2Units C: LH 15; PH 45)

Learning Outcomes

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

1. define various terminologies relating to Data communication;
2. explain the Seven Layer ISO-OSI standard protocols and network architecture;
3. describe different error-detection methods;
4. describe Internet Technologies and Protocols; and
5. list the features and benefits of Network Operating System.

Course Contents

Types and sources of data. simple communications network. transmission definitions. one-way transmission. half-duplex transmission. transmission codes. transmission modes. parallel transmission. serial transmission. bit synchronisation. character synchronisation. character synchronisation. synchronous transmission. asynchronous transmission. the efficiency of transmission. Protocols: Introduction to network protocol. Seven Layer ISO-OSI standard protocols and network architecture. Transport protocols, session services protocols, and other protocols. Institute of Electrical and Electronics Engineering 802 standards. Error control and Data Compression. Forward Error Control. error detection methods. parity checking. linear block codes. cyclic redundancy checking. feedback

error control. data compression. Huffman coding and dynamic Huffman coding. Local Area Networks. medium access control techniques – Ethernet, token bus, and token ring. LAN standards. fibre distributed data interface. metropolitan area network. Peer-to-peer. Client-Server. Client-Server Requirements. GUI design standards. interface independence. platform independence. transaction processing. connectivity. reliability. backup. recovery mechanisms. Information Network Software: features and benefits of major Network Operating Systems. Network OS. TCP/IP and Network OS.

Lab Work: Demonstration of simple communications networks. Illustration of applications at the various levels of the OSI model. Demonstration of different types of Local Area Networks (LANs). Illustration of Metropolitan Area Networks. Illustration of Error Detection and Error Correction techniques. Demonstration of Network Operating Systems.

INS 301: Business Process Management (2 Units C: LH 30)

Learning Outcomes

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

1. explain the concepts of operation management in an organisation;
2. explain continuous process improvement of products and services in an organisation; and
3. describe the interactions between human behaviour and process design.

Course Contents

Integration of core concepts from Management Information System (MIS) with those of Operations Management (OM). Introduction of process-oriented view of the flows of materials, information, products and services through and across organisational functions. All organisations must carefully analyse and document their business processes and must continuously assess the efficiency and effectiveness of these processes to minimise cost and maximise value creation. Identification information-bearing events, assess and improve process efficiency, learn to model and analyse business processes, and understand the interactions between human behaviour and process design.

INS 305: Management Theory (2 Units C: LH 30)

Learning Outcomes

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

1. explain the concepts, principles and techniques of management;
2. explain the evolution of management theories; and
3. demonstrate the application of the concepts, principles and techniques in the solution to management problems.

Course Contents

Definition of management; needs for theory and technique of management. Managerial transformation process, evolution of management theory. Theories of management. Management functions. Management by objective. Securing productivity at work. Criteria for locating bad management and group conflicts in organisation.

INS 311 E-Business System Development (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. explain e-business application design and development;
2. explain security challenges of e-business applications; and
3. describe ethical issues and social impact of web application solutions.

Course Contents

Developing e-business applications and web sites using currently popular software packages, web authoring and development tools. The business processes enabled by integrating information systems, telecommunications and internet-based technologies. e-security challenges. Ethical and social impact of web application solutions.

Lab work: Practical exercises on how to creating websites and develop electronic business applications. Practise on how to secure the developed electronic business application.

INS 322: Information Systems Innovation and Entrepreneurship (2 Units C: LH 30)

Learning Outcomes

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

1. explain business models;
2. identify some entrepreneurial opportunities available in IT;
3. describe business plan and business startup process;
4. explain business feasibility and strategy;
5. explain marketing strategies; and
6. discuss business ethics and legal issues.

Course Contents

Fundamental concepts of innovation and business ideas in general. Product development. Business leadership. Digital marketing. Entrepreneurial opportunities in IT. Legal issues and Business ethics. New venture creation process. Business feasibility planning. Market research. Business strategy. Business models and Business plans. Technical presentations. Report on a successful entrepreneurial outfit.

INS 399: Students Industrial Work Experience Scheme (SIWES) (3 Units C: PH 135)

Students are attached to private and public organisations for a period of three months with a view to making them acquire practical experience and to the extent possible, develop skills in all areas of computing. Students are supervised during the training period and shall be expected to keep records designed for the purpose of monitoring their performance. They are also expected to submit a report on the experience gained and defend their reports.

CSC 308: Operating System (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. recognise operating system types and structures;
2. describe OS support for processes and threads;
3. recognise CPU scheduling, synchronisation, and deadlock;
4. resolve OS issues related to synchronisation and failure for distributed systems;
5. explain OS support for virtual memory, disk scheduling, I/O, and file systems;
6. identify security and protection issues in computer systems; and
7. use C and Unix commands, examine behaviour and performance of Linux, and develop various system programmes under Linux to make use of OS concepts related to process synchronisation, shared memory, mailboxes, file systems, etc.

Course Contents

Fundamentals of operating systems design and implementation. History and evolution of operating systems. Types of operating systems. Operating system structures. Process management: processes, threads, CPU scheduling, process synchronisation. Memory management and virtual memory. File systems; I/O systems; Security and protection; Distributed systems; Case studies.

Lab work: Practical hands-on engagement to facilitate understanding of the material taught in the course. All the process, memory, file and directory management issues will be demonstrated under the LINUX operating system. Also UNIX commands will be briefly discussed. Alternatively, hands-on exposure may be through the use of operating systems developed for teaching, like TempOS, Nachos, Xinu or MiniOS. Another possibility is through programming exercises that implement and simulate algorithms taught. Simulation of CPU scheduling algorithms, producer-consumer problem, memory allocation algorithms, file organisation techniques, deadlock algorithms and disk scheduling algorithms.

400 Level

COS 409: Research Methodology and Technical Report Writing (3 Units C: LH 45)

Learning Outcomes

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

1. describe research, types, approaches, significance of research, research methods, research process, criteria and strategy for good research;
2. discuss the principles of scientific research, scientific investigation, problem formulation, and technique of the research problem;
3. describe the various elicitation methods;
4. develop appropriate data collection instruments;
5. conduct the literature review process; and
6. prepare briefs as well as technical reports and know how to cite referenced works and prepare references and bibliography.

Course Contents

Foundations of Research. Types of Research. Research Approaches. Significance of Research. Research Methods versus Methodology. Research Process. Criteria and Strategy for Good Research. Principles of Scientific Research. Scientific investigation. Problem Formulation and Its Techniques. Developing Research Proposal and Research Plan. Formulation of Research Questions and Hypothesis Testing. Developing Research Proposal and Research Plan. Literature Review. Procedure for Reviewing Related Relevant Studies. Methods for Collection of Primary and Secondary Data. Elicitation Techniques - Questionnaires, Interviewing, Ethnography, etc. Guidelines for Constructing Data Instruments. Methods of AnalysingData in Computing and Related Disciplines. System Design: Architectural design, input design, process design, output design. Use case analysis, sequence diagram, activity diagram, deployment diagram, etc.Types of Reports. Technical Report Writing. Layout and Mechanics of Writing a Research Report. Standard Techniques for Research Documentation. Interpretation and Presentation of Results. How to Cite Referenced Works and Prepare References and Bibliography.

DTS 404: Data Management II (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. explain the principles and best practices of managing data with efficiency and effectiveness;
2. demonstrate knowledge of SQL and NoSQL;
3. explain data warehouse concepts, methodologies and tools; and
4. explain data mining architecture and applications.

Course Contents

Rational Databases: Mapping conceptual schema to relational schema; Database Query Languages (SQL) and NoSQL, Concept of functional dependencies & multi-valued dependencies. Transaction processing; distributed databases, XML and semantic Web. Data warehousing. Introduction to data science. Introduction to Data Warehouse, OLTP Systems; Differences between OLTP Systems and Data Warehouse: Characteristics of Data Warehouse; Functionality of Data Warehouse: Advantages and Applications of Data Warehouse. Advantages, Applications: Top- Down and Bottom-Up Development Methodology: Tools for Data warehouse development: Data Warehouse Types. Introduction: Scope of Data Mining: What is Data Mining. How Data Mining Works, Predictive Modelling: Data Mining and Data Warehousing: Architecture for Data Mining: Profitable Applications: Data Mining Tools.

Lab work: Practical exercises on basic R commands and data structures for manipulating data; how to read data from multiple formats in and out of R, using loops, conditional statements, and functions to automate common data management tasks. Exercises on how to clean and manage multiple complex datasets, manipulate textual data, basic web scraping techniques, for both standard web pages and the Twitter API. Work on techniques and hardware necessary to manage large datasets efficiently. Practical exercise on managing multiple data sets by example; working with text data; converting long- and wide-format data; and dealing with messy data. R Programming Fundamentals for data I/O and packages, looping and conditional statements, and functions.

INS 401: Project Management (2 Units C: LH 30)

Learning Outcomes

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

1. describe project management planning;
2. describe project scheduling;
3. explain management of project resources;
4. discuss project procurement, monitoring and execution;
5. explain project communication and time management;

Course Contents

Introduction to Project Management. The Project Management Lifecycle. Project Execution, Control and Closure. Project management and systems development or acquisition. The project management context, technology and techniques. Project management processes. Managing Project Teams: Project team planning, Leadership in project management. Power and conflict in project teams. Communication among project stakeholders. Scope management. Managing Project Scheduling: Common problems in project scheduling. Resource management. Project quality management. Managing project risk and tools for managing project risk. Managing Project Procurement: Alternatives to systems development, External acquisition, Outsourcing-domestic and offshore, Steps in the procurement process. Project auditing.

INS 403: Business Process Re-engineering (2 Units C: LH 30)

Learning Outcomes

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

1. explain the concept of business process re-engineering;
2. describe how to improve organisational structure for efficiency and effectiveness to maximise productivity; and
3. explain business strategies to drive improvement of processes.

Course Contents

Business Process Re-engineering (BPR) involves changes in structures and in processes within the business environment. The entire technological, human, and organisational dimensions may be changed in BPR. Information technology plays a major role in Business Process Re-engineering as it provides office automation, it allows the business to be conducted in different locations, provides flexibility in manufacturing, permits quicker delivery to customers and supports rapid and paperless transactions. In general, it allows an efficient and effective change in the manner in which work is performed. Students learn to leverage business strategy to drive improvement, develop tools, identify problem areas, measure performance, validate change, and create models of current and future processes in order to maximise efficiency and productivity.

INS 497: Final Year Project I (3 Units C: PH 135)

Learning Outcomes

Upon completion of the project, students should be able to:

1. identify researchable project topics in information systems;
2. search and review literature pertinent to identified problem statements;
3. acknowledge and reference sources of information used in this research report;
4. conceptualise and design a research methodology to address an identified problem;
5. determine tools for analysing data collected based on research objectives;
6. write a coherent report on research conducted; and
7. work independently to accomplish a research project with the guidance of the research supervisor.

Course Contents

An independent or group investigation development of an information system to address a business problem under the supervision of a lecturer. Before registering, the student must submit a written proposal to the supervisor to review. The proposal should give a brief outline of the project, estimated schedule of completion, and computer resources needed. A formal written report is essential and an oral presentation may also be required. At the end of the semester, the introduction, literature review and methodology employed should be submitted for grading.

INS 498: Final Year Project II (3 Units C: PH 135)

Learning Outcomes

Upon completion of the project, students should be able to:

1. demonstrate technical skills in Information Systems
2. demonstrate generic transferable skills such as communication and team work
3. produce a technical report in the chosen project
4. defend the written project report
5. appreciate the art of carrying out a full-fledged research

Course Contents

This is a continuation of INS 497. This contains the implementation and the evaluation of the project. A formal written report, chapters 4 - 5 has to be approved by the supervisor. A final report comprising chapters 1 - 5 will be submitted to the department for final grading. An oral presentation is required.

Minimum Academic Standards

Equipment

The Information Systems programme should have at least three categories of laboratories: software, network and hardware laboratories. Best practice requires a staff to students' ratio of 1:20 for laboratory practical. Therefore, multiple small laboratories are preferable to a few large ones. Courses with large enrolments should have the students partitioned into groups to ensure each student has a computer/practice equipment to themselves during practical sessions. Laboratory sessions should be conducted by staff to ensure close monitoring and effective achievement of Learning Outcomes.

Software laboratory

Software laboratory support programming and other courses requiring use of software tools. Requirements for the software laboratory include:

1. Computer systems with capacity to run software systems for all lab-based courses (e.g., Desktop PC with minimum of 1,6 GHz or faster processor with at least 2 GB RAM and 500 GB hard disk space.) A maximum of 3 students to 1 computer system is recommended.
2. Programming environment and tools (e.g., Compilers/interpreters, debuggers, etc. for Java, Python, compiler compilers, e.g., flex, yacc, SableCC, etc,)
3. Operating systems environments and tools (e.g., Windows, LINUX, TempOS, Nachos, Xinu or MiniOS)
4. Tools for systems analysis and design (e.g., Unified Modelling Language (UML))
5. Computer maintenance tools like dust blowers and toolbox
6. Overhead projector
7. Power backup

Network laboratory

A separate network laboratory is required to expose students to practice on net-centric courses. Requirements for the network laboratory include:

1. Computer systems (hosts running LINUX or Windows). A maximum of 3 students to 1 computer system is recommended.
2. Routers, Switches, Radio modems, etc.
3. Dialup modems and PABXs
4. Patch panels
5. Simulation software like Packet tracer, NS Simulator or others
6. LAN testers, crimping tools, etc.
7. Practical consumables (RJ-45 connectors, twisted pair cable, etc.)

Hardware laboratory

The hardware laboratory should provide facilities required for hardware-related practicals. Requirements for the hardware laboratory include:

1. NAND, NOR, XOR, AND, OR gates
2. Multiplexers
3. Master-slave flip-flops
4. Digi-Designer Logic Board, etc
5. Dual–trace oscilloscope
6. Digital Proto-Board
7. Computer casing
8. Motherboard
9. ROMs/RAMs
10. Hard drives
11. CD ROMs
12. Display screens
13. Fans
14. Connectors/Jumpers, etc.

Staffing

Personnel

Academic staff

The guidelines on academic staff/student ratio of 1:20 for Computing Programmes shall apply. To start any programme in Computing, there should be a minimum of six academic staff. There is a 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. The staff structure for the academic staff is expected to be 20: 35: 45 for Professors/Readers: Senior Lecturers: Lecturers 1 and below.

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.

Ratio of junior admin staff to academic staff shall be 1:10
Ratio of senior admin staff to academic staff shall be 1:10

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.

Ratio of Senior Technical Staff to Academic Staff shall be 1:10
Ratio of Junior Technical Staff to Academic Staff shall be 1:5

Library

Universities should leverage available technology to put in place rich databases and other electronic/digital libraries and information resources. In addition, current hard copies of reference and other textual materials should be provided centrally at the level of the Faculty. A well-equipped 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 the students enrolled in each academic programme. The funding of the Library should be in line with NUC guidelines.

Classrooms, Laboratories and Offices

The NUC recommends the following physical space requirement:

			m^2
1.	Professor's office	-	18.50
2.	Head of department's office	-	18.50
3.	Tutorial teaching staff's office	-	13.50
4.	Other teaching staff space	-	7.00
5.	Technical staff space	-	7.00
6.	Secretarial space	-	7.00
7.	Seminar space/per student	-	1.85
8.	Laboratory space per FTE	-	7.50
9.	Conference room	-	37.0

Adequate space should be provided for the department. Effort must be made to provide the department with at least:

1. Two (2) large laboratories calculated according to specifications of 7.5 m^2 per FTE. At least two lecture rooms capable of seating at least sixty students at the specification of 1 m^2 per FTE.
2. A departmental conference room.
3. A seminar room.
4. A staff common room.

Office Equipment

The following equipment should be provided in the offices:

1. Computers
2. Printers
3. Photocopying Machines
4. Functional internet and e-mail facilities

Classroom Space and Examination Theatres

Adequate classrooms should be provided with enough chairs, tables and lecture delivery tools such as projector, whiteboards and smart boards. Examination halls and theatres should be provided to minimise the rate of examination malpractices.

Classroom Equipment

The following equipment should be provided in the offices:

1. Multimedia projectors
2. Whiteboards or Smartboards
3. Functional internet and e-mail facilities

B.Sc. Information Technology

Overview

Information Technology (IT) is a rapidly growing field that today, organisations of every kind are dependent on IT. This underscores the need to have appropriate systems in place that work properly and are secured.

The B.Sc. Information Technology programme is geared towards producing graduates who possess the right combination of knowledge and practical hands-on expertise to take care of both the organisation's Information Technology infrastructure and the end user. IT specialists assume responsibility for selecting hardware and software products appropriate for an organisation, and integrating these products with organisational needs and infrastructure as well as installing, customising, and maintaining these applications.

Philosophy

The philosophy of the programme is to produce Information Technology graduates who are well grounded in theory and practice on the analysis, design, implementation and management of Information Technology solutions and resources, and also recognise the impact of this technology on individuals, organisations and society at large.

Objectives

The objectives of the Bachelor of Science in Information Technology Programme are to:

i. provide students with a broad and balanced foundation of Information Technology knowledge and practical skills;
ii. equip students with the necessary professional skills to practice as successful IT professionals and compete effectively in a world of rapid technological change;
iii. develop in students a range of transferable skills of Information Technology in all aspects of human endeavour;
iv. develop students for the purpose of self-employment and job placement in the government and industries serving the needs of the local and global community; and
v. develop skills for career development and life-long learning.

Unique Features of The Programme

The curriculum features an inclusive emphasis on hands-on laboratory practical and relevant skills in the areas of web technologies, network servers and infrastructures, mobile and pervasive computing, and mobile and web application development. The acquired skills among others will equip the students to face the dynamics of computing in the 21st century.

Employability Skills

The dynamic nature of computing coupled with the advances in Information Technology has necessitated the need for Information Technology graduates to have all the necessary employability skills required in today's competitive world. The skills include communication, teamwork and collaboration, negotiation and persuasion, problem-solving, leadership, organisation, perseverance, motivation, confidence, and the ability to work under pressure.

21st Century Skills

Among the 21st Century skills for the programme are:

1. creativity;
2. information literacy;

3. flexibility;
4. social skills;
5. Problem solving;
6. Innovation skills; and
7. Critical thinking.

Admission and Graduation Requirements
Admission requirements
Candidates can be admitted into the Information Technology degree programme by one of the following ways:

1. The Indirect/Preliminary Mode (4 years Degree Programme)
2. Direct Entry

4 Year Degree Programme
In addition to appropriate UTME-Score, a candidate must possess five Senior Secondary Certificate (SSC)-credits passes including English Language, Mathematics, Physics and any other relevant Science subjects in not more than two sittings.

3 Year Degree Programme:
Direct Entry
A minimum of a credit at the University/National Diploma or NCE with other five Senior Secondary Certificate (SSC) credit passes in relevant Science subjects three of which must be in English Language, Mathematics, Physics.

Minimum duration
The minimum duration of the Information Technology degree programme is four academic sessions for UTME. However, it is three academic sessions for candidates admitted to the 200 Level.

Graduation requirements
To be eligible for the award of the Bachelor degree in Information Technology, a student must have:

1. passed all the core courses, university and faculty/school required courses and electives.
2. accumulated a minimum of 120 course units for students admitted through UTME and 90 course units for students admitted to 200 level.
3. attained a minimum CGPA of 1.00.

To graduate, a student must be found worthy in character throughout the period of his/her studentship and must accumulate the total units prescribed for the programme from Core, Faculty and General Studies courses, SIWES, Seminar and Final Year Project..

Global Course Structure
100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	0
MTH 101	Elementary Mathematics I	2	C	30	0
MTH 102	Elementary Mathematics II	2	C	30	0
PHY 101	General Physics I	2	C	30	0
PHY 102	General Physics II	2	C	30	0
PHY 107	General Practical Physics I	1	C	0	45
PHY 108	General Practical Physics II	1	C	0	45
STA 111	Descriptive Statistics	3	C	45	0
COS 101	Introduction to Computing Sciences	3	C	30	45
COS 102	Problem Solving	3	C	30	45
	Total Units	**23**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic, and Human Existence	2	C	30	0
ENT 211	Entrepreneurship and Innovation	2	C	30	0
COS 201	Computer ProgrammingI	3	C	30	45
COS 202	Computer Programming II	3	C	30	45
IFT 203	Introduction to Web Technologies	2	C	15	45
IFT 205	Introduction to Information Technology	2	C	30	0
IFT 211	Digital Logic Design	2	C	15	45
IFT 212	Computer Architecture and Organisation	2	C	15	45
IFT 299	SIWES I	3	C	0	135
INS 202	Human-Computer Interface	2	C	30	0
	Total Units	**23**			

SIWES I takes place during the long vacation of 200 level

300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	0
ENT 312	Venture Creation	2	C	15	45
IFT 302	Web Application Development	2	C	15	45
IFT 304	Web Development using Content Management Systems	2	C	15	45

IFT 308	Ethics and Legal Issues in IT	2	C	30	0
IFT 310	Mobile Application Development	2	C	15	45
IFT 322	IT Innovation and Entrepreneurship	2	C	15	45
IFT 342	Network Servers and Infrastructures	2	C	15	45
IFT 399	SIWES II	3	C	0	135
CSC 308	Operating Systems	3	C	30	45
ICT 305	Data Communications Systems and Network	3	C	30	45
	Total Units	**25**			

SIWES II takes place during the long vacation of 300 level

400 Level

Course Code	**Course Title**	**Unit(s)**	**Status**	**LH**	**PH**
COS 409	Research Methodology and Technical Report Writing	3	C	45	0
IFT 403	Mobile and Pervasive Computing	2	C	15	45
IFT 410	System Integration and Architecture	2	C	30	0
IFT 442	Wireless Communications and Networking	2	C	15	45
IFT 497	Final Year Student's Project I	3	C	0	135
IFT 498	Final Year Student's Project II	3	C	0	135
INS 401	Project Management	2	C	30	0
	Total Units	**17**			

Course Contents and Learning Outcomes

100 Level

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

Learning Outcomes

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

1. identify possible sound patterns in the English language;
2. list notable language skills;
3. classify word-formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents

Sound patterns in English language (vowels and consonants, phonetics, and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). A sentence in English (types: structural and functional, simple and complex).

Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and Deductive Argument and Reasoning Methods, Analogy, Generalisation, and Explanations). Ethical considerations, Copyright Rules, and Infringements. Writing Activities: (Pre-writing, Writing, Post Writing, Editing, and Proofreading; Brainstorming, outlining, Paragraphing, Types of writing, Summary, Essays, Letter, Curriculum Vitae, Report writing, Note making, etc. Mechanics of writing). Comprehension Strategies: (Reading and types of Reading, Comprehension Skills, 3RsQ). Information and Communication Technology in modern Language Learning. Language skills for effective communication. Major word-formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

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

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

1. tell the basic definition of Set, Subset, Union, Intersection, Complements, and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. define various types of numbers; and
5. solve some problems using the Binomial Theorem.

Course Contents

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

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

Learning Outcomes

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

1. explain the fundamental concept of Differentiation and Integration;
2. evaluate the Function of a real variable, graphs, limits, and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents

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

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

Learning Outcomes

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

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

Course Contents

Space and time, units and dimension, vectors and scalars, differentiation of vectors. Displacement, velocity, and acceleration; kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). Relative motion. Application of Newtonian mechanics. Equations of motion. Conservation principles in physics. Conservative forces. Conservation of linear momentum. Kinetic energy, and work, Potential energy, System of particles, centre of mass. Rotational motion; Torque, vector product, moment, rotation of coordinate axes and angular momentum. Polar coordinates, conservation of angular momentum. Circular motion. Moments of inertia, gyroscopes, and precession. Gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion, and orbits.

PHY 102: General physics II (Electricity & magnetism) (2 Units C: LH 30)

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

On completion, the student should be able to:

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;

4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

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

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

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

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

STA 111:Descriptive Statistics: (3 Units C: LH 45)

Learning Outcomes

At the end of the course, students should be able to:
1. explain the basic concepts of descriptive statistics.
2. present data in graphs and charts.
3. differentiate between measures of location, dispersion and partition.
4. describe the basic concepts of Skewness and Kurtosis as well as their utility function in a given data set.
5. differentiate rates from ratio and how they are use.
6. compute the different types of index number from a given data set and interpret the output.

Course content
Statistical data. Types, sources and methods of collection. Presentation of data. Tables chart and graph. Errors and approximations. Frequency and cumulative distributions. Measures of location, partition, dispersion, skewness and Kurtosis. Rates, ratios and index numbers.

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

Learning Outcomes

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

1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents

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

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

COS 102: Problem Solving (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. explain problem-solving processes;
2. demonstrate problem-solving skills;
3. describe the concept of algorithms development and properties of algorithms;
4. discuss the solution techniques of solving the problem;
5. solve computer problems using algorithms, flowcharts, pseudocode, etc; and
6. solve problems using a programming language, e.g., C, PYTHON, etc.

Course Contents

Core concepts of computing. Identification of problems. Types of problems (routine problems and non-routine problems). Problem-solving. Methods of solving computing problems. Algorithms and heuristics. Solvable and unsolvable problems. Solution techniques of solving problems; abstraction; analogy; brainstorming; trial and error; hypothesis testing; reduction; literal thinking; means-end analysis. Method of the focal object; morphological analysis; research; root cause analysis; proof; divide and conquer. General Problem-solving process.

Solution formulation and design; flowchart; pseudocode; decision table; decision tree. programming in any language.

Lab Work: Use of simple tools for algorithms and flowcharts; writing pseudocode; writing assignment statements, input-output statements and condition statements; demonstrating simple programs using any programming language (Visual Basic, Python, C)

200 Level

GST 212: PHILOSOPHY, LOGIC AND HUMAN EXISTENCE (2 Units C: LH 30)

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk-taking;
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;

6. describe stages in enterprise formation, partnership, and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa, and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents

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

COS 201: Computer Programming I (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. explain the principles of good programming and structured programming concepts;
2. explain the programming constructs, syntax, and semantics of a higher-level language;
3. describe the chosen programming language variables, types, expressions, statements, and assignment; simple input and output;
4. describe the programme control structures, functions and parameter passing, and structured decomposition; and
5. develop simple programmes in the taught programming language as well as debug and test them.

Course Contents

Essentials of computer programming. Types of programming: Functional programming; Declarative programming; Logic programming, object-oriented programming. Scripting languages, structured programming principles. Basic data types, variables, expressions, assignment statements, and operators. Basic object-oriented concepts: abstraction; objects; classes; methods; parameter passing; encapsulation. Class hierarchies and programme organisation using packages/namespaces. Use of API – use of iterators/enumerators, List, Stack, Queue from API. Searching; sorting; Recursive algorithms. Event-driven programming: event-handling methods; event propagation; exception handling. Introduction to Strings and string processing. Simple I/O; control structures; Arrays. Simple recursive algorithms; inheritance; polymorphism.

Lab work: Programming assignments, design and implementation of simple algorithms, e.g., average, standard deviation, searching and sorting. Developing and tracing simple recursive algorithms. Inheritance and polymorphism.

COS 202: Computer Programming II (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. demonstrate the principles of good programming and structured programming concepts;
2. demonstrate string processing, internal searching, sorting, and recursion;
3. demonstrate the basic use of OOP concepts: classes, objects, inheritance, polymorphism, data abstraction;
4. apply the tools for developing, compiling, interpreting, and debugging programmes; and
5. demonstrate the use of syntax and data objects, operators. Central flow constructs, objects and classes programming, Arrays, methods, Exceptions, Applets, and the Abstract, OLE, Persistence, Window Toolkit.

Course Contents

Review and coverage of advanced object-oriented programming - polymorphism, abstract classes, and interfaces. Class hierarchies and programme organisation using packages/namespaces. Use of API – use of iterators/enumerators, List, Stack, Queue from API. Searching, sorting. Recursive algorithms. Event-driven programming: event-handling methods, event propagation, exception handling. Applications in Graphical User Interface (GUI) programming.

Lab work: Programming assignments leading to extensive practice in problem-solving and programme development with emphasis on object orientation. Solving basic problems using static and dynamic data structures. Solving various searching and sorting algorithms using iterative and recursive approaches. GUI programming.

IFT 203: Introduction to Web Technologies (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. state the origin of the internet and the world wide web;
2. create simple web content using HTML, CSS, and JavaScript;
3. use simple application frameworks to develop web content; and
4. appraise the impact of the world wide web on people's lives over time.

Course Contents

Introduction to the internet, the world wide web (WWW), and web development. WW as a platform for interactive applications, content publishing, and social services. The role of HTTP and HTTPS in the context of web applications. Roles and operations of web browsers and the webserver. Interacting with web applications through forms, and using style sheets to separate document structure and document formatting. Web development tools and frameworks. Build a simple website that: organises information effectively, uses valid HTML

and CSS, and applies appropriate web standards from standards bodies such as W3C. HTTP communication protocol, the mark-up languages HTML, XHTML, and XML, the CSS and XSLT standards for formatting and transforming web content.Interactive graphics and multimedia content on the web, client-side programming using JavaScript. Impact of the world wide web on people's lives over time.

Lab Work: Using simple form-based web applications; developing simple websites using web development tools and frameworks; using the mark-up languages HTML, XHTML and XML; using JavaScript**.** Illustration of the use of interactive graphics and multimedia content.

IFT 205: Introduction to Information Technology (2 Units C: LH 30)

Learning Outcomes

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

1. explain the history and development of information technologies;
2. describe information technology application domains;
3. identify information technology and its related disciplines;
4. analyse security, privacy, policy, and other social issues inherent in information technology; and
5. compare the fundamental structures of computer networks and the internet.

Course Contents

Introduction to computer software, hardware, and networking technologies. Information technology systems model. A brief introduction to information technologies – human-computer interaction, information management; networking, platform technologies, programming, and web systems and technologies. Data versus information. History of information technology and the internet. Information technology application domains. Security, privacy, policy, and other social issues inherent in Information technology development and use. Future trends in information technology, problems on mining, visualisation, natural language processing, and Blockchain.

IFT 211: Digital Logic Design (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. explain why everything is data, including instructions, in computers;
2. describe how negative integers, fixed-length numbers, and non-numeric data are represented;
3. convert numerical data from one format to another;
4. describe computations as a system characterised by a known set of configurations with transitions from one unique configuration (state) to another (state);
5. describe the distinction between systems whose output is only a function of their input (combinational) and those with memory/history (sequential);
6. describe a computer as a state machine that interprets machine instructions;
7. articulate that there are many equivalent representations of computer functionality, including logical expressions and gates, and be able to use mathematical expressions to describe the functions of simple combinational and sequential circuits; and

8. design the basic building blocks of a computer: arithmetic-logic unit (gate-level), registers (gate-level), central processing unit (register transfer-level), and memory (register transfer-level).

Course Contents

Introduction to information representation and number systems. Boolean algebra and switching theory. Manipulation and minimisation of completely and incompletely specified Boolean functions. Physical properties of gates: fan-in, fan-out, propagation delay, timing diagrams and tri-state drivers. Combinational circuits design using multiplexers, decoders, comparators and adders. Sequential circuit analysis and design, basic flip-flops, clocking and timing diagrams. Registers, counters, RAMs, ROMs, PLAs, PLDs, and FPGAs.

Lab Work: Simple combinational gates (AND, OR, NOT, NAND, NOR); Combinational circuits design using multiplexers, decoders, comparators and adders. Sequential circuit analysis and design using basic flip-flops (S-R, J-K, D, T flip-flops); Demonstration of registers, counters, RAMs, ROMs, PLAs, PLDs, and FPGAs.

IFT 212: Computer Architecture and Organisation (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. explain the organisation of the classical von Neumann machine and its major functional units;
2. construct simple assembly language programme segments;
3. describe how fundamental high-level programming constructs are implemented at the machine-language level;
4. discuss the concept of control points and the generation of control signals using hardwired or microprogrammed implementations;
5. describe how the use of memory hierarchy (cache, virtual memory) is used to reduce the effective memory latency; and
6. explain the concept of interrupts and describe how they are used to implement I/O control and data transfers.

Course Contents

Principles of computer hardware and instruction set architecture. Internal CPU organisation and implementation. Instruction format and types, memory, and I/O instructions. Dataflow, arithmetic, and flow control instructions, addressing modes, stack operations, and interrupts. Data path and control unit design. RTL, microprogramming and hardwired control. The practice of assembly language programming. Memory hierarchy. Cache memory, Virtual memory. Cache performance. Compiler support for cache performance. I/O organisations.

Lab work: Practical demonstration of the architecture of a typical computer. Illustration of different types of instructions and how they are executed. Simple Assembly Language programming. Demonstration of interrupts. Programming assignments to practice MS-DOS batch programming, Assembly Process, Debugging, Procedures, Keyboard input, Video Output, File and Disk I/O, and Data Structure. Demonstration of Reduced Instruction Set Computers. Illustration of parallel architectures and interconnection networks.

IFT 299: SIWES I (3 Units C: PH 135)

Learning Outcomes

Upon the completion of the training, the students should be able to:

1. demonstrate competence by interacting with experts outside the school environment;
2. compare classwork with real-life working experience in their various areas of specialisation;
3. prepare a detailed written report on their industrial experience; and
4. defend their project successfully to a panel of examiners.

Course Contents

Students are attached to private and public organisations for three months at first instance to enable them acquire practical experience and to the extent possible, develop skills in all areas of computing. Students are supervised during the training period and shall be expected to keep records designed to monitor their performance. They are also expected to submit a report on the experience gained and defend their reports.

INS 202 Human-Computer Interface (HCI) (2 Units C: LH 15; PH 45)

Learning outcomes

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

1. discuss the foundations and concept of the human-computer interface;
2. explain the principles of the human-computer interface;
3. explain the design and development of the human-computer interface; and
4. explain the importance of user feedback.

Course Contents

Foundations of HCI. The concept underlying the design of HCI. Principles of GUI. GUI toolkits. System design methods. User conceptual models and interface metaphors. Human cognitive and physical ergonomics. Human-centred software evaluation and development. GUI design and programming.

Lab Work: Illustration of the principles of HCI design. Practice on GUI design and programming. Demonstration of some GUI toolkits. Practical evaluation of GUIs

300 Level

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

Learning Outcomes

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

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

Course Contents

Concepts of Peace, Conflict, and Security in a multi-ethnic nation. Types and Theories of Conflicts: Ethnic, Religious, Economic, Geo-political Conflicts; Structural Conflict Theory, Realist Theory of Conflict, Frustration-Aggression Conflict Theory. Root causes of Conflict and Violence in Africa: Indigene and settlers Phenomenon; Boundaries/border disputes; Political disputes; Ethnic disputes and rivalries; Economic Inequalities; Social disputes; Nationalist Movements and Agitations; Selected Conflict Case Studies – Tiv-Jukun; Zango Kataf, Chieftaincy, and Land disputes, etc. Peace Building, Management of Conflicts and Security: Peace & Human Development. Approaches to Peace & Conflict Management --- (Religious, Government, Community Leaders, etc.). Elements of Peace Studies and Conflict Resolution: Conflict dynamics assessment Scales: Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice; The Nigeria Legal System. Insurgency and Terrorism. Peace Mediation and Peace Keeping. Peace & Security Council (International, National, and Local levels) Agents of Conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution, ADR. a) Dialogue b). Arbitration, c). Negotiation d). Collaboration, etc.

Roles of International Organisations in Conflict Resolution. (a). The United Nations, UN, and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping. Media and Traditional Institutions in Peace Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis

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

Learning Outcomes

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

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

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/market research, Unutilised resources, Social and climate conditions, and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (venture capital, equity finance, microfinance, personal savings, small business investment organisations, and business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first

mover advantage, e-commerce business models and successful e-commerce companies,). Small business management/family business: Leadership & Management, basic bookkeeping, nature of family business and family business growth model. Negotiation and business communication (Strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological solutions (the concept of market/customer solution, customer solution, and emerging technologies, business applications of new technologies- Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoT), Blockchain, Cloud Computing, renewable energy, etc. digital business and e-commerce strategies).

IFT 302: Web Application Development (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. design and implement simple client-side and server-side web applications;
2. demonstrate hands-on skills in PHP and Python programming uses open-source software;
3. compare and contrast web programming with general-purpose programming; and
4. develop a fully functioning website and deploy it on a web server.

Course Contents

Introduction to framework-based web development using a contemporary language like PHP and ASP.net. Principles of web pages (dynamic and static) and website design. The tool used in web development. Client-side and server-side languages. Creation of interactive, dynamic websites using a common web architecture and object-based database access. Design, implementation, and testing of web-based applications including related software, databases, interfaces, and digital media. Standard object models, and the use of server-side programmes for database and file access; testing, software quality assurance; and the process of publishing Web sites. Hands-on PHP and Python programme using open-source software (Apache, PHP, Python, JavaScript, and MySQL). Programming for web development includes control structures, objects, functions, and the use of composite data types. Deploying dynamic content using JavaScript. Designing and developing dynamic web pages and creating, validating, transforming, and formatting data using PHP.

Lab Work: Simple PHP programming. Design of simple web pages. Creation of dynamic websites. Design of client-side and server-side programmes. Demonstration of web-based applications with database access. Use of JavaScript to develop dynamic content. Use of Python to develop dynamic web pages.

IFT 304: Web Development using Content Management Systems (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. develop a basic knowledge of web technology;
2. acquire skills necessary to develop and manage websites;
3. analyse Web content management techniques;

4. appraise the role of dynamic sites as the future of web design; and
5. convert a static design into a dynamic CMS-powered site.

Course Contents

Web development techniques using content management systems (CMS) (e.g., Joomla, MS SharePoint 2013). Design and creation of websites using specialised CMS tools. Review and evaluation of CMS tools and technologies in terms of client requirements.Development of Web sites using front-end (client-side) and back-end (server-side). Use of a CMS to set up, deploy, and maintain websites. Programming while considering issues of interface and user experience design, accessibility, and Web standards. Methods, languages, tools related to developing web-based content management systems. Development of plugins or extensions that integrate with existing systems to extend their functionality. Audit content for a website. Choose an appropriate CMS, and convert a static design into a dynamic CMS-powered site.

Lab Work: Basic features of Content Management Systems. Developing websites using CMS. Developing front-ends and back-ends. Using various tools in CMS. Developing plugins and extensions. Converting static designs to dynamic websites.

IFT 308: Ethics and Legal Issues in IT (2 Units C: LH 30)

Learning Outcomes

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

1. describe laws and regulations related to ethics;
2. recall relevant codes of ethics for computing practice;
3. interpret consequences of violating ethical provisions;
4. explain the ethical issues associated with intellectual property; and
5. develop a strategy for resolving conflict in the workplace.

Course Contents

Social, ethical, legal, and managerial issues in the application of information technology in government, organisations, and industry. Foundations of intellectual property. Ownership of information. Plagiarism, Software piracy. Fairness in the workplace. Digital millennium copyright act. Patents. Trademarks and trade secrets. Legal issues in computing. Organisational context; professional and ethical issues and responsibilities. Relationships with professional societies. Codes of professional conduct. Ethics and history of ethics. Whistle-blowing. Workplace issues (harassment, discrimination). Identify theft. Ethical hacking. Privacy and civil liberties organisations.

IFT 310: Mobile Application Development (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. identify the basic knowledge on mobile application environment and technology;
2. explain the concepts and processes of mobile application development;
3. discuss design and development issues specific to mobile applications;
4. design and develop mobile applications, using development tools and environments;
5. evaluate the performance of a mobile application and give its result; and
6. appreciate perspectives of mobile applications and their impact.

Course Contents

Introduction to developing mobile applications. Mobile operating systems capabilities, application architecture, and major components, such as activities, services, broadcast receivers, etc. Development of interactive applications using widget libraries, web-based services. Basic concepts of 2D graphics and animation. An SQL database engine, and multithreading. Multiplatform mobile application development. Mobile application basics and features; Android application basics, UI design. Data storage; networking application design. Advanced application design (sensors, camera, GPS, Audio, etc.), graphics and games, web-based hybrid application design. Design and implement a simple mobile application for a given mobile platform. Metrics and methods to evaluate the performance of mobile applications. Mobile application perspectives and impact.

Lab Work: Demonstration of a Simple Mobile Application. Design and Development of interactive mobile applications. Demonstration of multiplatform mobile application development. Development of Android applications including UI design and data storage design. Demonstration of advanced mobile application design. Illustration of metrics for measuring the performance of mobile applications.

IFT 322: IT Innovation and Entrepreneurship (2 Units C: LH 15, PH 45)

Learning Outcomes

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

1. explain business models;
2. identify some entrepreneurial opportunities available in IT;
3. describe business plan and business start-ups process;
4. explain business feasibility and strategy;
5. explain marketing strategies; and
6. discuss business ethics and legal issues.

Course Contents

Fundamental concepts of innovation and business ideas in general. Product development. business leadership. Digital marketing. Entrepreneurial opportunities in IT. Legal issues and business ethics. New venture creation process. Business feasibility planning. Market research. Business strategy. Business models and business plans. Technical presentations. Report on a successful entrepreneurial outfit.

IFT 342: Network Servers and Infrastructures (2 Units C: LH 15;PH 45)

Learning Outcomes

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

1. analyse IPv6 networking concepts and practices for communications over VPNs;
2. explain the fundamental concept of Virtual Computing, Cloud Computing, VoIP;
3. demonstrate through practical examples how protocols are used to enable communication between computing devices connected;
4. list the opportunities of virtual computing service provision models, such as cloud computing for organisations; and
5. identify, connect and install applications on virtual servers.

Course Contents

IP networking concepts and practices for IPv6 addressing. DHCP and DNS in IPv.6 networks. Secure communication over VPNs, VoIP architecture. Concept of Virtual Computing, Cloud Computing, VoIP. Traffic monitoring and network connectivity between operating systems. Overview of latest technologies of IP networks and understand application-level services used in the internet. Multi-Protocol Label Switching (MPLS). VPN Secure Network Connectivity. VoIP Architecture. Network Neutrality.

Lab Work: Demonstration of IPv6 networks including DHCP and DNS configuration.Basics of VPNs. Simple applications of VPNs. Installation of applications on virtual servers. Monitoring traffic on virtual servers. Working with Multiple Servers. Balancing traffic on servers. Testing the security of VPNs. Illustration of VOIP architecture.

IFT 399: SIWES II (3 Units C: PH 135)

Learning Outcomes

Upon the completion of the training, the students should be able to:

1. interact with experts, thus making them gain extra knowledge outside the school environment;
2. compare classwork with real-life working experience in their various areas of specialisation;
3. determine their level of competence;
4. acquire the more practical knowledge and skills;
5. provide a detailed written report on their industrial experience; and
6. defend their project to a panel of examiners.

Course Contents

Students are attached to private and public organisations for three months to make them acquire practical experience and to the extent possible, develop skills in all areas of computing. Students are supervised during the training period and shall be expected to keep records designed to monitor their performance. They are also expected to submit a report on the experience gained and defend their reports.

CSC 308: Operating Systems (3 Units C: LH 30, PH 45)

Learning Outcomes

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

1. recognise operating system types and structure;
2. describe OS support for processes and threads;
3. recognise CPU scheduling, synchronisation, and deadlock;
4. resolve OS issues related to synchronisation and failure for distributed systems;
5. explain OS support for virtual memory, disk scheduling, I/O, and file systems;
6. identify security and protection issues in computer systems; and
7. use C and Unix commands, examine behaviour and performance of Linux, and develop various system programmes under Linux to make use of OS concepts related to process synchronisation, shared memory, mailboxes, file systems, etc.

Course Contents

Fundamentals of operating systems design and implementation. History and evolution of operating systems. Types of operating systems. Operating system structures. Process

management: processes, threads. CPU scheduling, process synchronisation. Memory management and virtual memory. File systems; I/O systems. Security and protection. Distributed systems. Case studies.

Lab work: Practical hands-on engagement to facilitate understanding of the material taught in the course. All the process, memory, file, and directory management issues will be demonstrated under the LINUX operating system. Also, UNIX commands will be briefly discussed. Alternatively, hands-on exposure may be through the use of operating systems developed for teaching, like TempOS, Nachos, Xinu, or MiniOS. Another possibility is through programming exercises that implement and simulate algorithms taught. Simulation of CPU scheduling algorithms, producer-consumer problem, memory allocation algorithms, file organisation techniques, deadlock algorithms, and disk scheduling algorithms.

ICT 305: Data Communications Systems and Network (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. identify various network services, characteristics, elements, standards, and technologies;
2. describe the layered architecture of computer networks and the operation of main protocols in the TCP/IP model;
3. identify, compare and contrast different techniques and design issues of core functions such as addressing, routing, internetworking, switching, multiplexing, error and flow control, medium access, and coding;
4. implement simple client-server applications using socket programming;
5. demonstrate the ability to set up a small network and properly configure network components including switches, routers, and services (such as RAS, FTP, DNS, Web, DHCP, POP3); and
6. explain potential threats to network resources and various security mechanisms.

Course Contents

Types and sources of data, simple communications network, transmission definitions, one-way transmission, half-duplex transmission, transmission codes, transmission modes, parallel transmission, serial transmission, bit synchronisation, character synchronisation, character synchronisation, synchronous transmission, asynchronous transmission, the efficiency of transmission, error detection methods and data compression. Protocols: Introduction to the network protocol. Seven Layer ISO-OSI standard protocols and network architecture. Transport protocols, session services protocols, and other protocols. Institute of Electrical and Electronics Engineering 802 standards. Error control and Data Compression: Forward Error Control; error detection methods; parity checking; linear block codes, cyclic redundancy checking; feedback error control, data compression, Huffman coding, and dynamic Huffman coding. Local Area Networks: medium access control techniques – Ethernet, token bus and token ring; LAN standards; fibre-distributed data interface, metropolitan area network. Peer-to-peer, Client-Server. Client-Server Requirements: GUI design standards, interface independence, platform independence, transaction processing, and connectivity, reliability, backup, and recovery mechanisms. Information Network Software; Features and benefits of major recovery mechanisms. Information Network Software: features and benefits of major Network Operating Systems. Network OS: (e.g., Novell NetWare, UNIX/LINUX, and OS/2 &

Windows NT). TCP/IP and Network OS. INTERNET: Definition, architecture, services, internet addressing. Internet protocol, IPv4, IPv6. Internet programming, Intranet. System administration, and security issues.

Lab Work: Demonstration of simple communications networks. Illustration of applications at the various levels of the OSI model. Demonstration of different types of Local Area Networks (LANs). Illustration of Metropolitan Area Networks. Illustration of Error Detection and Error Correction techniques. Demonstration of Network Operating Systems.

400 Level

COS 409: Research Methodology and Technical Report Writing (3 Units C: LH 45)

Learning Outcomes

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

1. describe research, types, and approaches, the significance of the research, research methods, research process, criteria, and strategy for good research;
2. discuss the principles of scientific research, scientific investigation, problem formulation, and technique of the research problem;
3. describe the various elicitation methods;
4. develop appropriate data collection instruments;
5. conduct the literature review process; and
6. prepare briefs as well as technical reports and know how to cite referenced works and prepare references and bibliography.

Course Contents

Foundations of Research. Types of Research. Research Approaches. Significance of Research. Research Methods versus Methodology. Research Process. Criteria and Strategy for Good Research. Principles of Scientific Research. Scientific investigation. Problem Formulation and Its Techniques. Developing Research Proposal and Research Plan. Formulation of Research Questions and Hypothesis Testing. Developing Research Proposal and Research Plan. Literature Review. Procedure for Reviewing Related Relevant Studies. Methods for Collection of Primary and Secondary Data (Elicitation Techniques) - Questionnaires, Interviewing, Ethnography, etc. Guidelines for Constructing Data Instruments. Methods of AnalysingData in Computing and Related Disciplines.System Design: Architectural design, input design, process design, output design. Use case analysis, sequence diagram, activity diagram, deployment diagram, etc.Types of Reports. Technical Report Writing. Layout and Mechanics of Writing a Research Report. Standard Techniques for Research Documentation. Interpretation and Presentation of Results. How to Cite Referenced Works and Prepare References and Bibliography.

IFT 403: Mobile and Pervasive Computing (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. describe the concepts of programming mobile devices and pervasive computing;
2. define open protocols and context-aware sensor networks;
3. evaluate techniques, needs, and requirements for pervasive systems; and
4. describe security protocols for sensor networks.

Course Contents

Definitions and motivations: mobile, pervasive and ubiquitous computing. Physical interaction. Theoretical foundations of pervasive computing. Context-aware interaction, resource and device constraints. Implementing pervasive systems: sensor, actuators, and embedded systems. Applications, programming languages, and approaches, device types, and choices. Capturing needs and requirements for pervasive systems: techniques and challenges. Multisensory communication using pervasive computing. Sensor Networks.Security Protocols for Sensor Networks. Introduction to cloud computing technologies and its services.

Lab Work: Developing simple mobile applications. Design of simple pervasive computer systems. Design of context-aware sensor networks. Testing the security of mobile and pervasive computer systems. Using security protocols for sensor networks.

IFT 410: System Integration and Architecture (2 Units C: LH 30)

Learning Outcomes

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

1. discuss systems integration activities as a part of the development lifecycle;
2. explain and apply key systems integration architecture, methodologies, and technologies;
3. apply integration technologies to implement system integration solutions; and
4. describe Interplay between IT applications roll-out and related organisational processes.

Course Contents

System architecture, testing, evaluation, and benchmarking. Contracts, RFPs, and quality. System integration and deployment. System release. Pilot and acceptance testing and defect repair. System support strategies and user support plans, and enterprise integration approaches, standards, and best practices. Testing and quality assurance. Role of systems architecture in systems integration, performance, and effectiveness. Principles and concepts of DevOps. The interplay between IT applications roll-out and related organisational processes. The concept of Enterprise Architecture. Developing an Enterprise Architecture.

IFT 442: Wireless Communications and Networking (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. describe the principles underlying wireless data communications;
2. design and implement wireless network environment for any application using the latest wireless protocols and standards;
3. develop skills in diagnosing and troubleshooting PCs and wireless devices' problems;
4. develop hands-on experience installing, configuring, and upgrading wireless communications components and software;
5. describe the concepts of Packet switching cellular systems; and
6. describe the concept of mobility management and WPAN.

Course Contents

Fundamental principles underlying wireless data communications. Wireless transmission basics. Radio propagation issues, antennas, digital modulation. Spread spectrum techniques, and their applications, and popular standards. Wi-Fi, WiMAX, and Bluetooth. Practical

knowledge in the design, testing, deployment, debugging, and commissioning of Wi-Fi, WiMAX networks, and point-to-point microwave systems. Cellular Concept and Spatial Reuse (Interference-Limited and Coverage-Limited Systems). Frequency Reuse (Cellular vs. WIFI - GSM: Architecture). Voice Support, UMTS: Basics of CDMA, Architecture and Key Channels. Introduction to LTE: History, Architecture. Uplink and Downlink Communication in LTE. Mobility in Cellular Systems: The Gateway Concept. Measurement Reports. Mobility Procedures. Mobile IP: Basic Components, Tunnelling, Enhancements for Mobile Ipv6 - Wireless Personal Area Networks (PANS). Discussions on emerging cellular network technologies.

Lab Work: Basics on wireless transmission. Design of simple Wi-Fi and Wi-Max networks. Demonstration of GSM networks. Deployment and testing of wireless networks. Working with LTE. Demonstration of IPv6. Illustration of Wireless Personal Area Networks (PANS)

IFT 497 Final Year Project I (3 Units C: PH 135)

Learning Outcomes

Upon completion of the project, students should be able to:

1. identify researchable project topics in information technology;
2. search and review literature pertinent to identified problem statements;
3. acknowledge and reference sources of information used in this research report;
4. conceptualise and design a research methodology to address an identified problem;
5. determine tools for analysing data collected based on research objectives;
6. write a coherent report on research conducted; and
7. work independently to accomplish a research project with the guidance of the research supervisor.

Course Contents

An independent or group investigation development of an information technology related problem under the supervision of a lecturer. Before registering, the student must submit a written proposal to the supervisor to review. The proposal should give a brief outline of the project, estimated schedule of completion, and computer resources needed. A formal written report is essential and an oral presentation may also be required. At the end of the semester, the introduction, literature review and methodology employed should be submitted for grading.

IFT 498 Final Year Project II (3 Units C: PH 135)

Learning Outcomes

Upon completion of the project, students should be able to:

1. demonstrate technical skills in Information Technology;
2. demonstrate generic transferable skills such as communication and team work.
3. produce a technical report in the chosen project;
4. defend the written project report; and
5. appreciate the art of carrying out full-fledged research.

Course Contents

This is a continuation of IFT 497. This contains the implementation and the evaluation of the project. A formal written report, chapters 4 - 5 has to be approved by the supervisor. A final

report comprising chapters 1 - 5 will be submitted to the department for final grading. An oral presentation is required.

INS 401: Project Management (2 Units C: LH 30)

Learning Outcomes

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

1. describe project management planning;
2. describe project scheduling;
3. explain the management of project resources;
4. discuss project procurement, monitoring, and execution; and
5. explain project communication and time management.

Course Contents

Introduction to Project Management. The Project Management Lifecycle: Project management and systems development or acquisition, The project management context, Technology and techniques to support the project management lifecycle, and Project management processes. Managing Project Teams: Project team planning, Motivating team members, Leadership, power and conflict in project teams, and managing global project teams; Managing Project Communication and enhancing team communication; Project Initiation and Planning. Managing Project Scope: Project initiation, How organisations choose projects, Activities, and Developing the project charter; Managing Project Scheduling: Common problems in project scheduling, and Techniques for project scheduling; Managing Project Resources: Types of resources (human, capital, time), and Techniques for managing resources. Project quality and tools to manage project quality. Managing project risk and tools for managing project risk. Managing Project Procurement: Alternatives to systems development, External acquisition, Outsourcing-domestic and offshore, Steps in the procurement process, and managing the procurement process. Project Execution, Control, and Closure: Managing project execution, monitoring progress, and managing change, Documentation, and communication, and common problems in project execution; Managing Project Control and Closure: Obtaining information, Cost control, Change control, Administrative closure, Personnel closure, Contractual closure, and Project auditing.

Minimum Academic Standards

Equipment

The Information Technology programme should have at least three categories of laboratories: Software, Digital logic, and Network laboratories. Best practice requires staff to student's ratio of about 1 to 25 for laboratory practicals. Therefore, multiple small laboratories are desirable to few large ones. Courses with large enrolments of students should have the students divided into groups to ensure each student has computer/practice equipment to themselves during practical sessions. Laboratory sessions should be conducted by qualified personnel to ensure close monitoring and effective achievement of Learning Outcomes.

Software laboratory

There should be a software laboratory that can support the best practice staff to student ratio for all lab-based courses in the programme. Software laboratory support programming courses

and other courses requiring the use of software tools. Requirements for the software laboratory include:

1. Computer systems with the capacity to run software systems for all lab-based courses (e.g., Intel-based desktop PC with a minimum of 166MHz or faster processor with at least 64 MB RAM and 100 MB free disk space)
2. Programming environment and tools (e.g., Compilers/interpreters, debuggers, etc. for Java, Python, compiler compilers, e.g., flex, yacc, SableCC, etc.)
3. Operating systems environments and tools (e.g., Windows, LINUX, TempOS, Nachos, Xinu or MiniOS)
4. Tools for systems analysis and design, e.g., Unified Modelling Language (UML)
5. Computer maintenance tools like dust blowers
6. Overhead projector
7. Power backup

Digital logic laboratory

The digital logic or hardware laboratory should provide facilities required for hardware-related practicals. Requirements for the digital logic laboratory include:

1. NAND, NOR, XOR, AND, OR gates
2. Multiplexers, Demultiplexers, Decoders, Counters
3. Master-slave flip-flops
4. Digi-Designer Logic Board, etc.
5. Dual–trace oscilloscope
6. Digital Proto-Board
7. Microprocessor Demonstration System
8. ROMs, RAMs

Network laboratory

A separate network laboratory is required to expose students to practice on net-centric courses.

Requirements for the network laboratory are not limited to the following:

1. Laptop (CORE i7, 1TB, 8GB RAM)
2. Mikrotik Cloud Switch Router
3. Mikrotik RB2011uais Router
4. Cloud core Router (12GB port, 4SFP)
5. Cisco Switches at least 12
6. Gigabit Switch (24 port)
7. Workstation (1TB, 8GB RAM)
8. Wireless Router
9. Crimping tool
10. LAN Cable Tester
11. CAT6b Cable
12. GNS3
13. Cisco Packet Tracer
14. Putty
15. Secure CRT
16. Microsoft Visio
17. PRTG Network Monitor
18. WIRESHARK
19. EVE-NG
20. Network Simulator -NS3

21. SNMP Agent Simulator
22. VIRL Network Emulator
23. Oracle Virtual Box
24. Clouds
25. BOINC
26. Cable Crimpers
27. PHP/HTML, XML
28. MATLAB
29. Air Blowers
30. Workstations
31. Severs
32. Licensed Software

Staffing

Personnel

Academic staff

The guidelines on academic staff/student ratio of 1:20 for Computing Programmes shall apply. To start any programme in Computing, there should be a minimum of six academic staff. There is a 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. The staff structure for the academic staff is expected to be 20: 35: 45 for Professors/Readers: Senior Lecturers: Lecturers 1 and below.

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.

Ratio of junior admin staff to academic staff shall be	1:10
Ratio of senior admin staff to academic staff shall be	1:10

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.

Ratio of Senior Technical Staff to Academic Staff shall be	1:10
Ratio of Junior Technical Staff to Academic Staff shall be	1:5

Library

Universities should leverage available technology to put in place rich databases and other electronic/digital libraries and information resources. In addition, current hard copies of reference and other textual materials should be provided centrally at the level of the faculty. A well-equipped network digital library should serve the entire university community. Availability of wireless facilities (Wi-Fi) with adequate bandwidth should enhance access to these electronic resources.

In any case, there should be internet-ready workstations available in the library for the students enrolled in each academic programme. The funding of the library should be in line with NUC guidelines.

Classrooms, Laboratories and Offices

The NUC recommends the following physical space requirement:

		m^2
1. Professor's office	-	18.50
2. Head of department's office	-	18.50
3. Tutorial teaching staff's office	-	13.50
4. Other teaching staff space	-	7.00
5. Technical staff space	-	7.00
6. Secretarial space	-	7.00
7. Seminar space/per student	-	1.85
8. Laboratory space per FTE	-	7.50
9. Conference room	-	37.0

Adequate space should be provided for the department. Effort must be made to provide the department with at least:

1. Two (2) large laboratories calculated according to specifications of 7.5 m^2 per FTE. At least two lecture rooms capable of seating at least sixty students at the specification of 1 m^2 per FTE.
2. A departmental conference room
3. A seminar room
4. A staff common room

Office Equipment

The following equipment should be provided in the offices:

1. Computers
2. Printers
3. Photocopying machines
4. Functional internet and e-mail facilities

Classroom Space and Examination Theatres

Adequate classrooms should be provided with enough chairs, tables and lecture delivery tools such as projector, whiteboards and smart boards. Examination halls and theatres should be provided to minimise the rate of examination malpractices.

Classroom Equipment

The following equipment should be provided in the offices:

1. Multimedia projectors
2. Whiteboards or Smartboards
3. Functional internet and e-mail facilities

B.Sc. Software Engineering

Overview

The software development industry presents huge opportunities within the context of an expanding global economy that is increasingly becoming digital. With the enormous potentials of this sector of the economy and the ever increasing need for large and complex software systems, there is great promise to grow a large crop of software engineers as a force for sustainable socio-economic development. In addition to its core Computer Science foundation, Software Engineering also involves human and technical processes, and therefore borrows and adapts from the field of project management as well as from traditional engineering practice.

Philosophy

The philosophy of Software Engineering focuses on producing graduates who have the required knowledge and skills to develop and maintain quality software systems of scale for governments, organisations and businesses that adequately fulfil the functional and non-functional requirements of the systems within time and budget constraints.

Objectives

The specific objectives of the Software Engineering programme for students are to:

1. provide them a solid foundation in computing in such areas as problem solving, algorithm design, data structures and programming basics;
2. demonstrate practical skills in requirements analysis, system design, software architecture, software metrics, verification and validation, and the software engineering process in general for the production of high quality software-based systems;
3. demonstrate expertise in programming in a number of different languages with emphasis on the production of robust, reliable, cost-effective and secure systems that are based on sound design and development principles;
4. train them to be able to effectively and efficiently manage the development of large, complex and critical software; and
5. enable them to have the requisite knowledge and skill base as well as adequate practical exposure and high ethical standards for the limitless professional career opportunities (including self-employment) in the software industry.

Unique Features of The Programme

Special efforts have been made to tailor the programme to the rapidly evolving software industry in Nigeria in particular and Africa in general especially in the following areas:

1. Development of skilled software engineers in mobile applications and web development
2. Rigorous training on how to effectively manage software projects in highly challenging circumstances
3. Grooming of software engineers with specialised skills in Software Engineering but very broad knowledge on the entire computing discipline.

Employability Skills

The critical importance and increasing proliferation of software systems in every aspect of human endeavour make it mandatory for today's software engineers to have all the necessary employability skills they require in today's competitive world. They include communication, teamwork and collaboration, negotiation and persuasion, problem solving, leadership, organisation, perseverance, motivation, confidence and the ability to work under pressure.

21st Century Skills
Among the 21st Century skills for the programme are:

1. Creative thinking;
2. information literacy;
3. media literacy;
4. flexibility;
5. social skills;
6. Problem solving,
7. Social skills; and
8. Innovation skills.

Admission and Graduation Requirements
The admission and graduation requirements are the same as for the other programmes in the computing discipline. They are as stated below:

Admission requirements
Candidates can be admitted into the Software Engineering degree programme by one of the following ways:

1. The Indirect/Preliminary Mode (4 years Degree Programme)
2. Direct Entry

4 Year Degree Programme
In addition to appropriate UTME-Score, a candidate must possess five Senior Secondary Certificate (SSC)-credits passes including English Language, Mathematics, Physics and any other relevant Science subjects in not more than two sittings.

3 Year Degree Programme:
Direct Entry
A minimum of a credit at the University/National Diploma or NCE with other five Senior Secondary Certificate (SSC) credit passes in relevant Science subjects three of which must be in English Language, Mathematics, Physics.

Minimum duration
The minimum duration of the Software Engineering degree programme is four academic sessions for UTME. The minimum duration will be three academic sessions for candidates admitted to the 200 Level

Graduation requirements
To be eligible for the award of the Bachelor degree in Software Engineering, a student must have:

1. passed all the core courses, university and faculty/school required courses and electives;
2. accumulated a minimum of 120 course units for students admitted through UTME and 90 course units for students admitted to 200 level.
3. completed successfully students' industrial training (SIWES), seminar and research project.
4. attain a minimum CGPA of 1.00.

To graduate, a student must be found worthy in character throughout the period of his/her studentship and must accumulate the total units prescribed for the programme from core, faculty, General Studies, SIWES, seminar and Final year project.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST111	Communication in English	2	C	15	45
GST112	Nigerian Peoples & Culture	2	C	30	0
MTH101	Elementary Mathematics I	2	C	30	0
MTH102	Elementary Mathematics II	2	C	30	0
PHY101	General Physics I	2	C	30	0
PHY102	General Physics II	2	C	30	0
PHY107	General Practical Physics I	1	C	0	45
PHY108	General Practical Physics II	1	C	0	45
STA 111	Descriptive Statistics	3	C	45	0
COS101	Introduction to Computing Sciences	3	C	30	45
COS102	Introduction to Problem Solving	3	C	30	45
TOTAL		**23**			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic And Human Existence	2	C	30	0
ENT212	Entrepreneurship and Innovation	2	C	30	0
MTH 201	Mathematical Methods I	2	C	30	0
MTH 202	Mathematical Methods II	2	C	30	0
COS201	Computer Programming I	3	C	30	45
COS202	Computer Programming II	3	C	30	45
SEN201	Introduction to Software Engineering	2	C	30	0
SEN299	SIWES I	3	C	0	135
CSC203	Discrete Structures	2	C	30	0
INS204	System Analysis and Design	3	C	30	45
IFT 211	Digital Logic Design	2	C	15	45
IFT 212	Computer Architecture and Organisation	2	C	15	45
TOTAL		**28**			

NOTE: ***SIWES will take place during long vacations of 200 Level and 300 Level.

300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	0

ENT312	Venture Creation	2	C	15	45
SEN301	Object-Oriented Analysis and Design	2	C	15	45
SEN304	Software Testing and Quality Assurance	2	C	15	45
SEN306	Software Construction	2	C	15	45
SEN322	Software Engineering Innovation and New Technology	2	C	15	45
SEN399	SIWES II	3	C	0	135
CSC301	Data Structures	3	C	15	45
CSC308	Operating Systems	3	C	30	45
TOTAL		**21**			

400 Level

Course Code	**Course Title**	**Unit(s)**	**Status**	**LH**	**PH**
COS409	Research Methodology and Technical Report Writing	3	C	30	0
SEN401	Software Configuration Management and Maintenance	2	C	15	45
SEN410	Software Architecture and Design	2	C	15	45
SEN497	Final Year Student's Project I	3	C	0	135
SEN498	Final Year Student's Project II	3	C	0	135
INS 401	Project Management	2	C	30	0
	TOTAL	**15**			

Course Contents and Learning Outcomes

100 Level

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

Learning Outcomes

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

1. identify possible sound patterns in English language;
2. list notable Language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents

Sound patterns in English Language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday

life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and Deductive Argument and Reasoning Methods, Analogy, Generalisation and Explanations). Ethical considerations, Copyright Rules and Infringements. Writing Activities: (Pre-writing, Writing, Post writing, Editing and Proofreading; Brainstorming, outlining, Paragraphing, Types of writing, Summary, Essays, Letter, Curriculum Vitae, Report writing, Note making etc. Mechanics of writing). Comprehension Strategies: (Reading and types of Reading, Comprehension Skills, 3RsQ). Information and Communication Technology in modern Language Learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

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

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

1. understand the basic definition of Set, Subset, Union, Intersection, Complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. understand various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents

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

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

Learning Outcomes

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

1. understand types of rules in Differentiation and Integration;
2. understand the meaning of Function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents

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

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

Learning Outcomes

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

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

8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents

Space and time; units and dimension, Vectors and Scalars, Differentiation of vectors: displacement, velocity and acceleration; kinematics; Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation); Relative motion; Application of Newtonian mechanics; Equations of motion; Conservation principles in physics, Conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass; Rotational motion; Torque, vector product, moment, rotation of coordinate axes and angular momentum. Polar coordinates; conservation of angular momentum; Circular motion; Moments of inertia, gyroscopes and precession; Gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General physics II (Electricity & magnetism) (2 Units C: LH 30)

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;

3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

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

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

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

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

STA 111: Descriptive statistics: (3 Units C: LH 45)

Learning Outcomes
At the end of the course, students should be able to:
1. explain the basic concepts of descriptive statistics.
2. present data in graphs and charts.
3. differentiate between measures of location, dispersion and partition.
4. describe the basic concepts of Skewness and Kurtosis as well as their utility function in a given data set.
5. differentiate rates from ratio and how they are use.
6. compute the different types of index number from a given data set and interpret the output.

Course content
Statistical data. Types, sources and methods of collection. Presentation of data. Tables chart and graph. Errors and approximations. Frequency and cumulative distributions. Measures of location, partition, dispersion, skewness and Kurtosis. Rates, ratios and index numbers.

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

Learning Outcomes

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

1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents

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

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

COS 102: Problem Solving (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. explain problem solving processes;
2. demonstrate problem solving skills;
3. describe the concept of algorithms development and properties of algorithms;
4. discuss the solution techniques of solving problem;
5. solve computer problems using algorithms, flowcharts, pseudocode, etc.; and
6. solve problems using programming language using C, PYTHON etc.

Course Contents

Core concepts of computing. Identification of problems. Types of problems (routine problems and non-routine problems). Problem-solving. Methods of solving computing problems. Algorithms and heuristics. Solvable and unsolvable problems. Solution techniques of solving problems; abstraction; analogy; brainstorming; trial and error; hypothesis testing; reduction; literal thinking; means-end analysis. Method of the focal object; morphological analysis; research; root cause analysis; proof; divide and conquer. General Problem-solving process. Solution formulation and design; flowchart; pseudocode; decision table; decision tree. Programming in any language.

Lab Work: Use of simple tools for algorithms and flowcharts; writing pseudocode; writing assignment statements, input-output statements and condition statements; demonstrating simple programs using any programming language (Visual Basic, Python, C)

200 Level

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

Learning Outcomes

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

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

Course Contents

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

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 30)

Learning Outcomes

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

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

Course Contents

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

MTH 201: Mathematical Methods 1 (2 Units C: LH 30)

Learning Outcomes

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

1. understand Real-valued functions of a real variable;
2. solve some problems using Mean value Theorem and Taylor Series expansion; and
3. evaluate Line Integral, Surface Integral and Volume Integrals.

Course Contents

Real-valued functions of a real variable. Review of differentiation and integration and their applications. Mean value theorem. Taylor series. Real-valued functions of two and three variables. Partial derivatives chain rule, extrema, lagrangian multipliers. Increments, differentials, and linear approximations. Evaluation of line, integrals. Multiple integrals.

MTH 202: Mathematical Methods II (2 Units C: LH 30)

Learning Outcomes

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

1. define the following: order and degree of a differential equation;
2. describe some techniques for solving first and second order linear and non-linear equations; and
3. solve some problems related to geometry and physics.

Course Contents

Derivation of differential equations from primitive, geometry, physics etc. order and degree of differential equation. Techniques for solving first and second order linear and non-linear equations. Solutions of systems of first order linear equations. Finite linear difference equations. Application to geometry and physics.

COS 201: Computer Programming I (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. explain the principles of good programming and structured programming concepts;
2. explain the programming constructs, syntax and semantics of a higher-level language;
3. describe the chosen programming language variables, types, expressions, statements and assignment; simple input and output;
4. describe the programme control structures, functions and parameter passing, and structured decomposition; and
5. develop simple programs in the taught programming language as well as debug and test them.

Course Contents

Essentials of computer programming. Types of programming: Functional programming, Declarative programming, Logic programming, object-oriented programming. Scripting languages, structured programming principles. Basic data types, variables, expressions, assignment statements, and operators. Basic object-oriented concepts: abstraction, objects, classes, methods; parameter passing; encapsulation. Class hierarchies and programme organisation using packages/namespaces. Use of API – use of iterators/enumerators, List, Stack, Queue from API. Searching; sorting; Recursive algorithms. Event-driven programming: event-handling methods; event propagation; exception handling. Introduction to Strings and string processing. Simple I/O; control structures; Arrays. Simple recursive algorithms, inheritance, polymorphism.

Lab work: Programming assignments; design and implementation of simple algorithms e.g. average, standard deviation, searching and sorting. Developing and tracing simple recursive algorithms. Inheritance and polymorphism.

COS 202: Computer Programming II (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. demonstrate the principles of good programming and structured programming concepts;
2. demonstrate string processing, internal searching, sorting, and recursion;
3. demonstrate the basic use of OOP concepts: classes, objects, inheritance, polymorphism, data abstraction;
4. apply the tools for developing, compiling, interpreting and debugging programs; and
5. demonstrate the use of syntax and data objects, operators. Central flow constructs, objects and classes programming, Arrays, methods, Exceptions, Applets and the Abstract, OLE, Persistence, Window Toolkit.

Course Contents

Review and coverage of advanced object-oriented programming - polymorphism, abstract classes and interfaces; Class hierarchies and program organisation using packages/namespaces; Use of API – use of iterators/enumerators, List, Stack, Queue from API; Searching; sorting; Recursive algorithms; Event-driven programming: event-handling methods; event propagation; exception handling. Applications in Graphical User Interface (GUI) programming.

Lab work: Programming assignments leading to extensive practice in problem solving and program development with emphasis on object-orientation. Solving basic problems using static and dynamic data structures. Solving various searching and sorting algorithms using iterative and recursive approaches. GUI programming.

SEN201: Introduction to Software Engineering (2 units C: LH 30)

Learning Outcomes

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

1. describe the concept of the software life cycle;
2. explain the phases of requirements analysis, design, development, testing and maintenance in a typical software life cycle;
3. differentiate amongst the various software development models;
4. utilise UML for object oriented analysis and design;
5. describe different design architectures;
6. explain the various tasks involved in software project management; and
7. describe the basic legal issues related to Software Engineering.

Course Contents

Software Engineering concepts and principles. Design, development and testing of software systems. Software processes: software lifecycle and process models. Process assessment models. Software process metrics. Life cycle of software system. Software requirements and specifications. Software design. Software architecture. Software metrics. Software quality and testing. Software architecture. Software validation. Software evolution: software maintenance; characteristics of maintainable software; re-engineering; legacy systems; software reuse. Software Engineering and its place as a computing discipline. Software project management: team management; project scheduling; software measurement and estimation techniques; risk analysis; software quality assurance; software configuration management. Software Engineering and law.

CSC 203: Discrete Structures (3 Units C: LH 45)

Learning Outcomes

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

1. convert logical statements from informal language to propositional and predicate logic expressions;
2. describe the strengths and limitations of propositional and predicate logic;
3. outline the basic structure of each proof technique (direct proof, proof by contradiction, and induction) described in this unit;
4. apply each of the proof techniques (direct proof, proof by contradiction, and induction) correctly in the construction of a sound argument;
5. apply the pigeonhole principle in the context of a formal proof.;
6. compute permutations and combinations of a set, and interpret the meaning in the context of the particular application;
7. map real-world applications to appropriate counting formalisms, such as determining the number of ways to arrange people around a table, subject to constraints on the seating arrangement, or the number of ways to determine certain hands in cards (e.g., a full house); and
8. solve a variety of basic recurrence relations.

Course Contents

Propositional Logic, Predicate Logic, Sets, Functions, Sequences and Summation, Proof Techniques, Mathematical induction, Inclusion-exclusion and Pigeonhole principles, Permutations and Combinations (with and without repetitions), The Binomial Theorem, Discrete Probability, Recurrence Relations.

INS 204: Systems Analysis and Design (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. describe system requirements gathering techniques;
2. explain data modelling technique (entity relationship modelling);
3. explain process modelling technique (data flow diagram);
4. describe system architectural design;
5. describe process and database design; and
6. explain user interface design.

Course Contents

Structured approach to analysis and design of information systems for businesses. Software development life cycle. Structured top-down and bottom-up design. Dataflow diagramming. Entity relationship modelling. Computer aided software engineering. Input and output, prototyping design and validation. File and database design. Design of user interfaces. Comparison of structured and object-oriented design

Lab Work: system requirements gathering techniques;data modelling techniques (entity relationship modelling);process modelling techniques (data flow diagram); use of UML diagrams; system architectural design; user interface design.

IFT 211: Digital Logic Design (3 Units C: LH 15; PH 45)

Learning Outcomes

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

1. explain why everything is data, including instructions, in computers;
2. describe how negative integers, fixed-length numbers and non-numeric data are represented;
3. convert numerical data from one format to another;
4. describe computations as a system characterised by a known set of configurations with transitions from one unique configuration (state) to another (state);
5. describe the distinction between systems whose output is only a function of their input (Combinational) and those with memory/history (Sequential);
6. describe a computer as a state machine that interprets machine instructions;
7. articulate that there are many equivalent representations of computer functionality, including logical expressions and gates, and be able to use mathematical expressions to describe the functions of simple combinational and sequential circuits; and
8. design the basic building blocks of a computer: arithmetic-logic unit (gate-level), registers (gate-level), central processing unit (register transfer-level), memory (register transfer-level).

Course Contents

Introduction to information representation and number systems. Boolean algebra and switching theory. Manipulation and minimisation of completely and incompletely specified Boolean functions. Physical properties of gates: fan-in, fan-out, propagation delay, timing diagrams and tri-state drivers. Combinational circuits design using multiplexers, decoders, comparators and adders. Sequential circuit analysis and design, basic flip-flops, clocking and timing diagrams. Registers, counters, RAMs, ROMs, PLAs, PLDs, and FPGAs.

Lab Work: Simple combinational gates (AND, OR, NOT, NAND, NOR); Combinational circuits design using multiplexers, decoders, comparators and adders. Sequential circuit analysis and design using basic flip-flops (S-R, J-K, D, T flip-flops); Demonstration of registers, counters, RAMs, ROMs, PLAs, PLDs, and FPGAs.

IFT 212: Computer Architecture and Organisation (3 Units C: LH 30; PH 45)

Learning Outcomes:

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

1. explain different instruction formats, such as addresses per instruction and variable length vs. fixed length formats;
2. describe the organisation of the classical von Neumann machine and its major functional units;
3. explain how subroutine calls are handled at the assembly level;
4. describe the basic concepts of interrupts and I/O operations;
5. write simple assembly language program segments;
6. show how fundamental high-level programming constructs are implemented at the machine-language level;
7. compare alternative implementation of data paths;
8. discuss the concept of control points and the generation of control signals using hardwired or micro-programmed implementations;

Course Contents

Instruction format and types, memory and I/O instructions, dataflow, arithmetic, and flow control instructions, addressing modes, stack operations, and interrupts. Data path and control unit design. RTL, microprogramming, and hardwired control. Practice of assembly language programming. Memory hierarchy, cache memory, virtual memory. I/O fundamentals. Interrupt structures.

Lab work: Programming assignments to practice MS-DOS batch programming, Assembly Process, Debugging, Procedures, Keyboard input, Video Output, File and Disk I/O and Data Structure. Instruction and arithmetic pipelining, superscalar architecture. Reduced Instruction Set Computers. Parallel architectures and interconnection networks.

SEN 299: Students Industrial Work Experience Scheme I (3 Units C: PH 135)

Learning Outcomes

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

1. explain how a typical software engineering firm operates;

2. describe the various assignments carried out and the skills acquired during the SIWES period; and
3. submit a comprehensive report on the knowledge acquired and the experience gained during the exercise.

Course Contents

Students are attached to private and public organisations for a period of three months during the second year session long break with a view to making them acquire practical experience and to the extent possible, develop skills in all areas of Software Engineering. Students are supervised during the training period and shall be expected to keep records designed for the purpose of monitoring their performance. They are also expected to submit a report on the experience gained and defend their reports.

300 Level

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

Learning Outcomes

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

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

Course Contents

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

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

Learning Outcomes

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

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

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/market research, Unutilised resources, Social and climate conditions, and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (venture capital, equity finance, microfinance, personal savings, small business investment organisations, and business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first mover advantage, e-commerce business models and successful e-commerce companies,). Small business management/family business: Leadership & Management, basic bookkeeping, nature of family business and family business growth model. Negotiation and business communication (Strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological solutions (the concept of market/customer solution, customer solution, and emerging technologies, business applications of new technologies- Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoT), Blockchain, Cloud Computing, renewable energy, etc. digital business and e-commerce strategies).

SEN 301: Object-Oriented Analysis and Design (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. explain the concept of the object-oriented approach to modelling;
2. describe the conceptual model of the UML-based software development life cycle;
3. demonstrate how to use the major UML diagrams for object-oriented analysis and design;
4. demonstrate the use of UML-based CASE tools.

Course Contents

Object-oriented approach to information system development, particularly in reference to the earlier stages of analysis and design. Importance of modelling, principles of modelling, object-

oriented modelling, conceptual model of the Unified Modelling Language (UML), architecture, software development life cycle. The principles and basic concepts of object orientation and the different aspects of object-oriented modelling as represented by the UML technique. Case study of a typical UML-based CASE tool.

Lab Work: Practical exercises on different requirements specification and design activities; developing problem statements, SRS documents and Use Case Diagrams; designing UML Activity diagrams, UML Class diagrams and State Chart diagrams; drawing partial layered, logical architecture diagram with UML package diagram notation; Designing Component and Deployment diagrams.

SEN 304: Software Testing & Quality Assurance (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. state the critical importance of software testing in ensuring software quality;
2. explain the difference between validation and verification and their different techniques;
3. describe the concept of quality assurance and differentiate between process assurance and product assurance;
4. describe the different statistical approaches to quality control.

Course Contents

The importance of Software Testing. Understanding Verification and Validation. How to assure it and verify it, and the need for a culture of quality. Avoidance of errors and other quality problems. Inspections and reviews. Testing, verification and validation techniques. Process assurance vs. Product assurance. Quality process standards. Product and process assurance. Problem analysis and reporting. Statistical approaches to quality control

Lab WorK: Debugging tools; unit testing – black box and white testing techniques; integration and system testing tools; other testing tools – performance testing, load testing, stress testing, regression testing, security testing; manual testing vs automated testing.

SEN 306: Software Construction (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. explain the importance of Software Construction and the key construction decisions;
2. describe the key issues in design including key design concepts, levels of design and Abstract Data Types (ADTs);
3. discuss best practices in dealing with routines, fundamental data types and different types of statements; and
4. describe how to ensure software quality through developer testing, debugging and software craftsmanship.

Course Contents

Definition of Software Construction; Its importance; Key construction decisions – choice of programming language, selection of major construction decisions. Design in construction – Key design concepts, levels of design, design heuristics. Abstract Data Types (ADTs). Working Classes. High Quality Routines. The Pseudo Code Programming Process. Fundamental Data

Types – Numbers, Characters and Strings, Boolean Variables, Arrays, Tables. Types of Statements – Straight Line Code, Loops, Control Structures; Developer Testing and Debugging. Software Craftsmanship – Layout and Style, Documentation, Personal Character. **Lab Work:** Practicals on the most common tools to ensure good software construction. The features include static code analysers to check that code follows coding conventions, special code searching and editing, collaboration support to allow multiple programmers working simultaneously, support for proper code documentation. Practice with IDEs (such as Visual Study Code, NetBeans and Eclipse) on debugging, compilation, running of code, auto completion and version control.

SEN 322: Software Engineering Innovation and New Technology (2 Units C: LH 15)

Learning Outcomes

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

1. explain business models;
2. identify some entrepreneurial opportunities available in Software Engineering;
3. describe business plan and business startup process;
4. explain business feasibility and strategy;
5. explain marketing strategies; and
6. discuss business ethics and legal issues.

Course Contents

Software entrepreneurial process. Principles of software business ownership. Identifying software market opportunities. Entrepreneurial software marketing. Software business communication and negotiation techniques. Feasibility analysis. Entrepreneurial financing. Legal issues. Software business plan development. Risk management.

SEN 399: Students Industrial Work Experience Scheme II (3 Units C: PH 135)

Learning Outcomes

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

1. explain how a typical software engineering firm operates;
2. describe the various assignments carried out and the skills acquired during the SIWES period; and
3. submit a comprehensive report on the knowledge acquired and the experience gained during the exercise.

Course Contents

Students are attached to private and public organisations for a period of three months during the third year session long break with a view to making them acquire additional practical experience in all areas of Software Engineering over and above what is gained in SEN 299. Students are supervised during the training period and shall be expected to keep records designed for the purpose of monitoring their performance. They are also expected to submit a report on the experience gained and defend their reports.

CSC 301: Data Structures (3 Units C: LH 30, PH 45)

Learning Outcomes

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

1. discuss the appropriate use of built-in data structures;
2. apply object-oriented concepts (inheritance, polymorphism, design patterns, etc.) in software design;
3. implement various data structures and their algorithms, and apply them in implementing simple applications;
4. choose the appropriate data structure for modelling a given problem;
5. analyse simple algorithms and determine their efficiency using big-O notation; and
6. apply the knowledge of data structures to other application domains like data compression and memory management.

Course Contents

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.

Lab work: Writing C^{+}/C^{++} functions to perform practical exercises and implement using the algorithms on arrays, records, string processing, queues, trees, pointers and linked structures.

CSC 308: Operating Systems (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. recognise operating system types and structure;
2. describe OS support for processes and threads;
3. recognize CPU scheduling, synchronization, and deadlocks;
4. resolve OS issues related to synchronization and failure for distributed systems;
5. explain OS support for virtual memory, disk scheduling, I/O, and file systems;
6. identify security and protection issues in computer systems; and
7. use C and Unix commands, examine behaviour and performance of Linux, and develop various system programs under Linux to make use of OS concepts related to process synchronization, shared memory, mailboxes, file systems, etc.

Course Contents

Fundamentals of operating systems design and implementation, history and evolution of operating systems, Types of operating systems; Operating system structures; Process management: processes, threads, CPU scheduling, process synchronization; Memory management and virtual memory; File systems; I/O systems; Security and protection; Distributed systems; Case studies.

Lab work: Practical hands-on engagement to facilitate understanding of the material taught in the course. All the process, memory, file and directory management issues will be demonstrated under the LINUX operating system. Also UNIX commands will be briefly discussed. Alternatively, hands-on exposure may be through the use of operating systems developed for teaching, like TempOS, Nachos, Xinu or MiniOS. Another possibility is through programming exercises that implement and simulate algorithms taught. Simulation of CPU

scheduling algorithms, producer-consumer problem, memory allocation algorithms, file organisation techniques, deadlock algorithms and disk scheduling algorithms.

400 Level

COS 409: Research Methodology and Technical Report Writing (3 Units C: LH 45)

Learning Outcomes

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

1. describe research, types, approaches, significance of research, research methods, research process, criteria and strategy for good research;
2. discuss the principles of scientific research, scientific investigation, problem formulation, and technique of the research problem;
3. describe the various elicitation methods;
4. develop appropriate data collection instruments;
5. conduct the literature review process; and
6. prepare briefs as well as technical reports and know how to cite referenced works and prepare references and bibliography.

Course Contents

Foundations of Research. Types of Research. Research Approaches. Significance of Research. Research Methods versus Methodology. Research Process. Criteria and Strategy for Good Research. Principles of Scientific Research. Scientific investigation. Problem Formulation and Its Techniques. Developing Research Proposal and Research Plan. Formulation of Research Questions and Hypothesis Testing. Developing Research Proposal and Research Plan. Literature Review. Procedure for Reviewing Related Relevant Studies. Methods for Collection of Primary and Secondary Data. Elicitation Techniques - Questionnaires, Interviewing, Ethnography, etc. Guidelines for Constructing Data Instruments. Methods of AnalysingData in Computing and Related Disciplines.System Design: Architectural design, input design, process design, output design. Use case analysis, sequence diagram, activity diagram, deployment diagram, etc.Types of Reports. Technical Report Writing. Layout and Mechanics of Writing a Research Report. Standard Techniques for Research Documentation. Interpretation and Presentation of Results. How to Cite Referenced Works and Prepare References and Bibliography.

SEN401: Software Configuration Management & Maintenance (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. state the importance of software configuration management;
2. explain the typical processes in software configuration management; and
3. describe the key issues in software maintenance

Course Contents

Management of the software configuration management process – organisation context for software configuration management, constraints and guidance for software configuration

management process. Planning for software configuration management, software configuration management plan, and surveillance of software configuration management. Software configuration identification and software library. Software configuration control – requesting, evaluating and approving software changes, implementing software changes, and deviations and waivers. Software configuration status accounting – software configuration status information and reporting. Software configuration auditing. Key issues in software maintenance – technical issues, management issues, maintenance cost estimation, and software maintenance measurement. Maintenance process – maintenance processes and activities. Techniques for maintenance – program comprehension, re-engineering, reverse engineering, migration, and retirement.

Lab Work: Practical demonstration of software configuration management processes. Working with software configuration management software. Illustration of software maintenance processes and activities. Working with software maintenance software. Illustration of software re-engineering and reverse engineering techniques.

SEN 410: Software Architecture and Design (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. describe design patterns, frameworks and architectures;
2. explain design of distributed systems and component based design; and
3. describe the techniques of designing for qualities such as reliability, performance, safety, security and reusability.

Course Contents

An in-depth look at software design. Continuation of the study of design patterns, frameworks, and architectures. Survey of current middleware architectures. Design of distributed systems using middleware. Component based design. Measurement theory and appropriate use of metrics in design. Designing for quality attributes such as reliability, performance, safety, security, reusability, etc. Measuring internal qualities and complexity of software. Evaluation and evolution of designs.

Lab Work: Practical demonstration of the use of design patterns, frameworks and architectures. Practical simulation of distributed systems. Illustration of component based design. Working with software design software. Use of software metrics measuring software.

SEN 497: Final Year Project I (3 Units C: PH 135)

Learning Outcomes:

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

1. identify researchable project topics in Software Engineering;
2. search and review literature pertinent to identified problem statements;
3. acknowledge and reference sources of information used in the research report;
4. conceptualise and design a research methodology to address an identified problem;
5. determine tools for analysing data collected based on research objectives;
6. write a coherent report on the research conducted;
7. take instruction to accomplish the set goals for the project with the guidance of the research supervisor; and

8. orally present the written project report.

Course Contents
An independent or group investigation to address a Software Engineering problem under the supervision of a lecturer. Before registering, the student must submit a written proposal to the supervisor for review. The proposal should give a brief outline of the project, estimated schedule of completion, and computer resources needed. A formal written report is essential and an oral presentation may also be required. At the end of the semester, the introduction, literature review and methodology employed should be submitted for grading.

SEN 498: Final Year Project II (3 Units C: PH 135)

Learning Outcomes
Upon completion of the project, students should be able to:
1. demonstrate technical skills in Software Engineering;
2. demonstrate generic transferable skills such as communication and team work;
3. produce a technical report in the chosen project;
4. defend the written project report; and
5. appreciate the art of carrying out a full-fledged research.

Course Contents
This is a continuation of SEN 497. This contains the implementation and the evaluation of the project. A formal written report (chapters 4-5) has to be approved by the supervisor. A final report comprising chapters 1-5 will be submitted to the department for final grading. An oral presentation is required.

INS 401 Project Management (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. describe project management planning;
2. describe project scheduling;
3. explain management of project resources;
4. discuss project procurement, monitoring and execution; and
5. explain project communication and time management;

Course Contents
Introduction to Project Management. The Project Management Lifecycle. Project management and systems development or acquisition. The project management context, technology and techniques to support the project management lifecycle, and Project management processes. Managing Project Teams: Project team planning, Motivating team members, Leadership, power and conflict in project teams, and Managing global project teams. Managing Project Communication and enhancing team communication. Managing Project Scope: Project initiation, how organisations choose projects, activities, and developing the project charter. Managing Project Scheduling: Common problems in project scheduling, and Techniques for project scheduling. Managing Project Resources: Types of resources (human, capital, time), and techniques for managing resources. Project quality and tools to manage project quality.

Managing project risk and tools for managing project risk. Managing Project Procurement: Alternatives to systems development, External acquisition, Outsourcing-domestic and offshore, Steps in the procurement process, and Managing the procurement process. Project Execution, Control and Closure: Managing project execution, monitoring progress and managing change, Documentation and communication, and Common problems in project execution; Managing Project Control and Closure: Obtaining information, Cost control, Change control, Administrative closure, Personnel closure, Contractual closure and Project auditing

Minimum Academic Standards
Equipment
The following laboratories together with their software requirements are required for the B.Sc. Software Engineering programme.

Software Engineering Laboratory
The hardware requirements for this laboratory are as follows:
1. PCs with CPU with minimum of 4 GB of main memory, 1 TB HDD (ideally there should be a minimum of one PC per every three students);
2. Multifunctional laser printers (minimum of two) to be networked with the PCs; and
3. External Hard Disk, 500GB (minimum of two).

(Maximum of three students per computer system)

The minimum software requirements are as follows:
Software requirements tools:
1. Requirements gathering tools;
2. UML modelling tools; and
3. Requirements management tools.

Software design tools:
1. UML-based Design tools;
2. Object-oriented Design tools;
3. Design Analysis tools;
4. CASE tools;
5. Process Modelling tools;
6. Project Management tools; and

Software testing tools:
1. Automation Testing tools;
2. Black-box and White-box Testing tools;
3. Unit testing, Integration Testing and System Testing tools;
4. Regression Testing tools;
5. Test Generation tools; and
6. Test Management tools.

Software Construction and Development Laboratory

The hardware requirements the laboratory are as follows:
1. PCs with CPU with minimum of 4 GB of main memory, 1 TB HDD (ideally there should be a minimum of one PC per every three students)

2. Multifunctional laser printers (minimum of two) to be networked with the PCs
3. External Hard Disk, 500GB (minimum of two)

(Maximum of three students per computer system)
The minimum software requirements are as follows:
1. Integrated Development Environments (IDEs) with support for different programming languages
2. Debuggers, Automated Bug-finders, Programme Differencing tools
3. Static and Dynamic Programme Analysis tools
4. Compilation Managers and Build Scripts
5. Software Construction Collaboration tools
6. Software Development Frameworks
7. Cloud Tools

Digital Logic Laboratory

The digital logic or hardware laboratory should provide facilities required for hardware-related practicals. Requirements for the digital logic laboratory include:
1. NAND, NOR, XOR, AND, OR gates
2. Multiplexers
3. Master-slave flip-flops
4. Digi-Designer Logic Board, etc
5. Dual–trace oscilloscope
6. Digital Proto-Board
7. Computer casing
8. Motherboard
9. Microprocessor Emulator System
10. ROMs/RAMs
11. Hard drives
12. CD ROMs
13. Display screens
14. Fans
15. Connectors/Jumpers, etc.

Staffing
Personnel

Academic Staff
The guidelines on academic staff/student ratio of 1:20 for Computing programmes shall apply. To start any programme in Computing, there should be a minimum of six academic staff. There is a 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. The staff structure for the academic staff is expected to be 20: 35: 45 for Professors/Readers: Senior Lecturers: Lecturers 1 and below.

To start up a Software Engineering programme, a minimum of five (5) Academic staff core to the subject areas are required.
The ratio of Academic staff to students shall be 1:20.

The staff structure for the academic staff is expected to be 20:35:45 for Professors/Readers: Senior Lecturers: Lecturers 1 and below respectively.

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.

Ratio of junior admin staff to academic staff shall be 1:10

Ratio of senior admin staff to academic staff shall be 1:10

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.

Ratio of senior technical staff to academic staff shall be 1:10

Ratio of junior technical staff to academic staff shall be 1:5

Library

Universities should leverage available technology to put in place rich databases and other electronic/digital libraries and information resources. In addition, current hard copies of reference and other textual materials should be provided centrally at the level of the Faculty. A well-equipped 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 the students enrolled in each academic programme. The funding of the library should be in line with NUC guidelines.

Classrooms, Laboratories And Offices

The NUC recommends the following physical space requirement:

		m^2
1. Professor's office	-	18.50
2. Head of department's office	-	18.50
3. Tutorial teaching staff's office	-	13.50
4. Other teaching staff space	-	7.00
5. Technical staff space	-	7.00
6. Secretarial space	-	7.00
7. Seminar space/per student	-	1.85
8. Laboratory space per FTE	-	7.50
9. Conference room	-	37.0

Adequate space should be provided for the department. Effort must be made to provide the department with at least:

1. A high-end functional computing laboratory calculated according to specifications of 7.5 m^2 per FTE.
2. At least two lecture rooms capable of seating at least sixty students at the specification of 1 m^2 per FTE.

3. A departmental conference room.
4. A seminar room.
5. A staff common room.

Office Equipment

The following equipment should be provided in the offices:

1. Computers
2. Printers
3. Photocopying machines
4. Functional internet and e-mail facilities

Classroom Space and Examination Theatres

Adequate classrooms should be provided with enough chairs, tables and lecture delivery tools such as projector, whiteboards and smart boards. Examination halls and theatres should be provided to minimise the rate of examination malpractices.

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

1. A minimum number of identifiable and adequately equipped laboratories which should be in accordance with the recommended space requirements; and
2. At least one software and hardware laboratory, reasonably equipped for teaching and research, along with specialised laboratories.

Classroom Equipment

For effective learning the following equipment should be provided:

1. scientific equipment for specific areas of specialisations
2. computers
3. photocopying machines
4. video cameras
5. tape recorders
6. internet and e-mail facilities
7. multimedia projectors
8. other specialised equipment