# UNIVERSITY OF NIGERIA

## Faculty of Engineering

## Department of Electronic & Computer Engineering

**Revised Five-Year Standard Undergraduate Academic Programme for BEng (Hons) in Electronic & Computer Engineering**

**DECEMBER 2022**

# Revised Five-Year Standard Undergraduate Academic Programme for BEng (Hons) in Electronic & Computer Engineering

## Brief History

The Department of Electronic Engineering was founded in 1981 from the parent Department of Electrical/Electronic Engineering, one of the pioneer departments in the Faculty of Engineering, University of Nigeria, Nsukka. The Department is being renamed to **Electronic and Computer Engineering** to better reflect the undergraduate and graduate courses taught in the Department since the 1990's.

The Department was founded on the national intention to be part of the digital revolution and the University goal to be at the frontiers of knowledge and development in Electronic & Computer Engineering.

In the pursuit of these national and institutional goals, the Department has recorded many significant milestones. These include, among other things: the Department has never lost any academic or professional accreditation by the National Universities Commission (NUC) and the Council for Registration of Engineers in Nigeria (COREN), respectively. It is note worthy to state that the Department came first among the five departments of the Faculty in the latest accreditation exercises by the both national bodies (NUC and COREN) in 2006. Since its inception (1981), the Department has produced the highest number of first class graduates than any other departments in the University. These performances have earned the Department two national designations (honours) as a Centre of Excellence in Electronics and in Information and Communication Technology (ICT) in 1986 and 2001, respectively.

The Department's vigorous strive for academic and professional excellence for both its students and staff, has culminated into a number of teaching and research collaborations with other national and international institutions. At the national level, the Department runs Postgraduate Diploma and Masters (PGD, M.Eng, M.Sc) programmes in Telecommunications Engineering and ICT in collaboration with the Digital Bridge Institute (DBI), Abuja. DBI is an International Centre for Professional Training in Telecommunications and ICT, established in 2004 by the National Communications Commission (NCC).

The international linkage of the Department includes teaching, research and exchange collaborations with the Delft University of Technology (TU Delft) in the Netherlands. The University of Nigeria, Nsukka signed an MOU with Delft University of Technology on behalf of the Department of Electronic & Computer Engineering and other departments (Physics, Computer Science, Electrical Engineering) of the University to establish a Centre of Excellence in Microsystems and Nanoelectronics at UNN.

**Programmes in the Department of Electronic and Computer Engineering**

The Department of Electronic and Computer Engineering mounts the following undergraduate programmes in the Department:

1. Electronic and Computer Engineering
2. Computer Engineering
3. Telecommunication Engineering
4. Information and Computer Engineering
5. Artificial Intelligence and Software Engineering

The students are meant to choose courses in the 400 and 500 levels in accordance to their programme of graduation.

**Philosophy**

The Department is designed to develop and execute a world-class electronic engineering programme intended to provide sound theoretical and practical training for students in the areas of communication, control, measurement, instrumentation, digital electronics and computer. This intention was born out of the national drive to be part of the digital revolution and the information society, as well as an institutional strive to be at the cutting edge of global developmental trends in Information and Communication Technology (ICT).

**Objectives**

The main objective of the five/four/three–year Bachelor of Engineering (B.Eng) programme offered by the Department of Electronic and Computer Engineering is to produce first degree Electronic and Computer Engineering graduates armed with adequate theoretical knowledge and practical experience for successful and fruitful career in the Electronic & Computer Engineering profession. The broad objective is to produce graduates that have the requisite knowledge, skills and emotional disposition needed for a 21st century world that increasingly demands greater, more advanced, efficient, sustainable and client-centric technological solutions.

Specific objectives include:

1. Designing, developing and installing electronic systems
2. applying the knowledge gained from courses in mathematics, science (social and

basic), computing, and algorithmic reasoning to resolve Computer Engineering challenges individually or within multidisciplinary groups/teams;

3. understanding and applying discrete mathematics and computation;
4. defining complex engineering problems, collecting, analysing data and problems as well as developing models and implementing solutions for engineering problems;
2. analysing, designing and optimally managing the hardware/software computer system requirements of organisations with constrained resources;
3. using modern computer engineering models, tools, and information technologies to develop computer hardware;
4. undertaking research, and laboratory and real-life and real-time experiments by using computers and computer-based devices/systems and having the ability to acquire, analyse, and interpret data and to solve engineering and other problems locally and globally;
5. working on interdisciplinary and multidisciplinary concepts with teams as well as individually in developing new computer engineering knowledge, products, and services needed for the seamless functioning and wellbeing of society;
6. appreciating and using life-long learning to improve self-employability as well as adapting to future professional and ethical responsibilities in an efficient, effective, fair, responsible and competitive manner;
7. practising in different roles as engineering managers, project managers, innovators, entrepreneurs, quality controllers, researchers/knowledge creators and managers in the computer engineering field; and
8. having an understanding of contemporary as well as legal and ethical issues impinging on computer engineering solutions deployed in society.

**Programme Learning Outcomes**

Upon the successful completion of the 5-year Electronic and Computer Engineering programme, the student should be capable to:

1. demonstrate knowledge and understanding of the fundamental electrical concepts;
2. analyse and understand the behaviour of any electronic circuit and equipment;
3. design electronic and electrical communication systems;
4. plan and implement applied research activities, evaluate outcomes, and draw reasonable conclusions;
5. demonstrate the need to maintain their technical skills and develop new ones through personal development and life-long learning;
6. convey technical information through their proficiency in written and spoken communication skills; and
7. demonstrate an understanding of professional and ethical responsibilities to their field and to society.

## Scope

In line with the modern trends in curriculum development all over the globe as well as the Nigerian Universities Commission regulations for engineering study in the country, students of Electronic and Computer Engineering are expected to graduate in five years (academic sessions) for UME students, four years for Direct Entry students and three years for students with B.Eng. in related areas.

In the first two years of study, different courses from all facets of learning in different departments/faculties are taught. These courses provide an overview of the broad field of Engineering. In the third year, students are exposed to Electrical, Electronics and Computer courses with different laboratory experiments and technical Writing. The fourth year is a year of pure electronic and computer courses with more laboratory courses and Seminar presentation and 6-month Industrial Training (IT) organized by the Student Industrial Works Experience Scheme (SIWES) in relevant industries.

In the final year, students in addition to taking other final year courses must undertake and complete a bachelor of engineering final year project selected from any area of electronic and computer engineering and with a significant practical content. The project report and design is evaluated on the basis of the continuous assessment of individual performance throughout the year and an oral examination.

**Job Opportunities**

It is imperative to note that the technological advancement of any country lies in the hands of its Engineers. The need for Electronic and Computer Engineers in the society today cannot be over-emphasized. This is because Electronic and Computer Engineering permeate almost every aspect of life and industry. Based on this CCMAS, the Electronic and Computer Engineering programme graduate will acquire requisite skills that will enable them to:

1. apply knowledge of mathematics, science and computer engineering to the solution of local and global engineering problems;
2. identify, formulate, research literature and analyse computer engineering problems and proffer informed, efficient and effective theoretical and practical solutions;
3. design, develop and deploy computer-based systems, devices or processes to meet specified computer engineering needs;
4. apply critical reasoning and logic in resolving engineering problems using research-based knowledge and research methods including the set-up of experiments, analysis and interpretation of data, and distilling of information to create new knowledge, products and services;
5. create, select and apply appropriate techniques, resources and modern engineering and ICT tools, including prediction, modelling and optimisation to developmental and complex engineering activities, with a clear understanding of the theoretical and practical limitations;
6. apply ethical principles at all times in practice as a subject matter expert and professional;
7. function effectively as an individual and as a reliable collaborator, partner, team member or leader;
8. communicate effectively on developmental or complex engineering activities;
9. demonstrate knowledge of the principles of organisation, engineering, management, corporate social responsibility and finance; and
10. exhibit evidence of independent and lifelong learning and community service.

Our graduates are properly equipped to take on challenging jobs such as design, development and production of hardware and software for industries such as Telecommunications, ICT Companies, Computer Networking Firms, Software Companies, Oil Companies etc. There are also numerous job opportunities in Banks, Research Institutes and Academic Institutes.

Along with having an affinity for solving problems and a strong interest in technology for a successful career in electronic and computer engineering, the following essential skills are needed:

1. Strong IT skills along with efficiency in programming. An upcoming electronics engineer should have command of a number of high-level programming languages like C, C++, Python, computer-aided design tools, and circuit simulators to analyse designs;
2. Practical experience of different circuits and electrical systems. Technical thinking requires critical thinking skills to identify common issues and to come up with working solutions;
3. Communications skills;
4. Time management and an ability to prioritise and plan work effectively.

**21st Century Skills**

The B. Eng. Electronic & Computer Engineering CCMAS has the capability of inculcating into the graduate engineer skills essential for the 4th industrial revolution such as:

1. critical thinking and problem solving
2. creativity and innovation
3. collaboration and team work
4. communication and information literacy
5. media literacy
6. computation and data management
7. technology literacy
8. flexibility
9. leadership and ethical responsibility
10. initiative

## Admission and Graduation Requirements

## UTME Entry Requirements

Candidates for admission to the Department must first satisfy the University entry requirements. The University requires that departmental requirements be obtained in not more than two sittings. The Departmental minimum requirement is passes at levels not lower than credit in Senior Secondary School Examination or its equivalent in five subjects including Mathematics, Physics, Chemistry and English Language.

## Admission Requirements

Candidates are admitted into the degree programme in any of the following two ways:

1. Indirect Entry (5 Year Degree Programme)
2. Direct Entry (4 Year Degree Programme)

**Indirect Entry**

For Five year Indirect admission, in addition to acceptable passes in Unified Tertiary Matriculation Examination (UTME), the minimum academic requirement is credit level passes in Senior Secondary Certificate (SSC) in at least five subjects which must includes English Language, Mathematics, Physics, Chemistry and other acceptable science subject at not more than two sittings.

**Direct Entry**

For Four year Direct Entry, in addition to five (5) Senior Secondary Certificate (SSC) credit passes which must includes English Language, two of which must be principal subjects at Advance GCE Level or NCE and its equivalent. Holder of upper credit level at HND are eligible for consideration for admission into 300 levels respectively.

| Stress Areas | Codes |
|---|---|
| Foundational Courses | 0 |
| Circuits and Systems | 1 |
| Physical and Microelectronics | 2 |
| Electromagnetism | 3 |
| Communication | 4 |
| Control | 5 |
| Measurement, Instrumentation & Laboratories | 6 |
| Digital and Computer Systems | 7 |
| Seminars | 8 |
| Projects & Technical writing | 9 |

# 100 Level

**FIRST SEMESTER**

| Course Code | Course Title | Units | Status | LH | PH |
|---|---|---|---|---|---|
| | **REQUIRED ANCILLARY COURSES** | | | | |
| EGR 101 | Introduction to Engineering / Engineer in Society | 2 | C | 15 | 45 |
| MTH 111 | Elementary Mathematics I: Algebra and Trigonometry | 2 | C | 30 | - |
| MTH 121 | Elementary Mathematics III | 2 | C | 30 | - |
| CHM 101 | Basic Principles of Chemistry | 2 | C | 30 | - |
| CHM 107 | Basic Practical Chemistry | 1 | C | - | 45 |
| PHY 101 | Fundamentals of Physics I: Mechanics | 2 | C | 30 | - |
| PHY 107 | Practical Physics | 1 | C | - | 45 |
| | **GENERAL STUDIES COURSES** | | | | |
| GSP 101 | The Use of English I | 2 | C | 30 | - |
| GSP 111 | Use of Library Studies | 2 | C | 30 | - |
| **Total** | | **16** | | | |

**SECOND SEMESTER**

| Course Code | Course Title | Units | Status | LH | PH |
|---|---|---|---|---|---|
| EGR 102 | Applied Mechanics | 3 | | | |
| MTH 102 | Elementary Mathematics II: Calculus | 2 | C | 30 | - |
| CHM 112 | Basic Principles of Chemistry II | 2 | | | |
| PHY 105 | General Physics for Physical Sciences | 2 | C | 30 | - |
| PHY 109 | Fundamentals of Physics III | 3 | C | 30 | |
| GSP 102 | The Use of English II | 2 | | | |
| EGR 102 | Engineering Graphics and Solid Modelling I | 2 | C | 15 | 45 |
| **Total** | | **16** | | | |

# 200 Level

**FIRST SEMESTER**

| Course Code | Course Title | Units | Status | LH | PH |
|---|---|---|---|---|---|
| | **REQUIRED ANCILLARY COURSES** | | | | |
| GET 202 (EGR 201) | Engineering Materials (Materials Science I) | 2 | C | 30 | |
| EGR 203 | Materials Science Laboratory | 1 | C | | 45 |
| GET 201 (EEE 211) | Applied Electricity I (Basic Electrical Engineering) | 3 | C | 30 | 45 |
| GET 203 (MEC 211) | Engineering Graphics and Solid Modeling II (Engineering Drawing I) | 2 | C | 15 | 45 |
| GET 206 (MEC 261) | Fundamentals of Thermodynamics (Engineering Thermodynamics I) | 2 | C | 30 | - |

| | | | | | |
|---|---|---|---|---|---|
| GET 209 (MTH 206) | Engineering Mathematics I (Advanced Mathematics VI) | 3 | C | 45 | - |
| | **GENERAL STUDIES COURSES** | | | | |
| GSP 201 | Basic Concepts & Theories of Peace & Conflicts | 2 | C | 30 | - |
| GST 212 (GSP 207) | Philosophy, Logic and Human Existence (Humanities I) | 2 | C | 30 | - |
| **Total** | | **19** | | | |

**SECOND SEMESTER**

| Course Code | Course Title | Units | Status | LH | PH |
|---|---|---|---|---|---|
| | **MAJOR COURSES** | | | | |
| ECE 272 | Computing and Software Engineering | 3 | C | 30 | 45 |
| | **REQUIRED ANCILLARY COURSES** | | | | |
| EEE 252 | Basic Electrical Engineering Laboratory/Practice | 1 | C | - | 45 |
| MTH 208 | Advanced Mathematics VIII | 2 | C | 30 | - |
| GET 210 (MTH 207) | Engineering Mathematics II (Advanced Mathematics VII) | 2 | C | 30 | - |
| | **GENERAL STUDIES COURSES** | | | | |
| GSP 202 | Issues in Peace & Conflict Resolution Studies | 2 | C | 30 | - |
| GSP 208 | Humanities II | 2 | C | 30 | - |
| ENT 211 (CED 341) | Entrepreneurship and Innovation (Introduction to Entrepreneurship) | 2 | C | 30 | - |
| ENT 212 | Venture Creation | 2 | C | 15 | 45 |
| GET 299 (EGR 298) | SIWES I: Students Work Experience Scheme | 3 | C | 9 Weeks | |
| **Total** | | **19** | | | |

# 300 Level

**FIRST SEMESTER**

| Course Code | Course Title | Units | Status | LH | PH |
|---|---|---|---|---|---|
| | **MAJOR COURSES** | | | | |
| ELE 305 (ECE 311) | Circuit Theory | 3 | E | 45 | - |
| GET 306 (ECE 321) | Renewable Energy Systems and Technologies (Physical Electronics) | 3 | C | 30 | 45 |
| ECE 331 | Electromagnetic Fields & Waves | 2 | C | 30 | - |
| ECE 361 (CPE 302) | Measurements and Instrumentation | 3 | C | 30 | 45 |

| | | | | | |
|---|---|---|---|---|---|
| GET 307 (ECE 371) | Introduction to Artificial Intelligence, Machine Learning and Convergent Technologies | 3 | C | 45 | - |
| ELE 313 (ECE 322) | Analog Electronic circuits (Microelectronics) | 3 | C | 30 | 45 |
| **Total** | | **17** | | | |

**SECOND SEMESTER**

| Course Code | Course Title | Units | Status | LH | PH |
|---|---|---|---|---|---|
| | **MAJOR COURSES** | | | | |
| ECE 312 | Signals and Systems with MATLAB / PYTHON | 3 | C | 30 | 45 |
| ELE 324 (ECE 341) | Communication Principles | 3 | E | 45 | - |
| ECE 372 (ECE471) | Digital Electronics I | 2 | E | 30 | - |
| CPE 301 (ECE 374) | Computer Organisation and Architecture | 2 | C | 30 | - |
| GET 304 (ECE 391 & ECE482) | Engineering Communication, Technical Writing and Presentation (Technical writing & Seminars) | 2 | C | 30 | - |
| | **REQUIRED ANCILLARY COURSES** | | | | |
| GET 301 & 302 (EGR 302) | Engineering Mathematics III & IV (Engineering Analysis) | 4 | C | 45 | - |
| GET 305 (EGR 396) (STA 203) | Engineering Statistics and Data Analytics. (Statistics for Physical Sciences and Engineering) | 2 | C | 30 | - |
| EGR 398 (GET 399) | SIWES II: Students Work Experience Scheme | 4 | C | 12 Weeks | |
| | | | | | |
| **Total** | | **21** | | | |

# 400 Level

**FIRST SEMESTER**

| Course Code | Course Title | Units | Status | LH | PH |
|---|---|---|---|---|---|
| | **MAJOR COURSES** | | | | |
| CPE 403 (ECE 451) | Control Theory | 3 | C | 30 | 30 |
| ECE 473 | Digital Electronics II (Digital Logic Theory) | 2 | C | 30 | - |
| CPE 405 (ECE477) | Fundamentals of Software Engineering | 2 | C | 30 | - |

| | | | | | |
|---|---|---|---|---|---|
| | **REQUIRED ANCILLARY COURSES** | | | | |
| ELE 403 (EGR 401) | Engineering Mathematics IV (Computational Methods) | 3 | C | 45 | |
| ELE 405 | Engineering System Modeling and Simulation | 3 | C | 45 | - |
| | **ELECTIVE COURSES (Select one (1) elective)** | | | | |
| ELE 407 (ECE 443)* | Data Communications and Networking | 3 | E | 45 | 45 |
| ELE 411 (ECE475)* | Advanced Electronic Circuits Design | 3 | E | 45 | 45 |
| TEL 423* | Power Electronics | 3 | E | 45 | - |
| ECE 421* | Applied Electronics II (Microelectronics II) | 3 | E | 45 | 45 |
| ASE 471 | Software Engineering Development | 3 | E | 45 | - |
| **Total** | | **16** | | | |

**SECOND SEMESTER**

| Course Code | Course Title | Units | Status | LH | PH |
|---|---|---|---|---|---|
| CPE 401 | Microprocessor and Embedded Systems | 3 | C | 30 | 45 |
| | **REQUIRED ANCILLARY COURSES** | | | | |
| CPE 413 | Research Methods | 2 | E | 30 | - |
| EGR 498 (GET 499) | SIWES III: Students Work Experience Scheme | 8 | C | 24 Weeks | |
| | **ELECTIVE COURSES (Select one (1) elective)** | | | | |
| CPE 411 | Hardware Design Techniques and Verification | 2 | E | 30 | - |
| ASE 472 | Software Engineering Development using Object Orientation | 2 | E | 30 | 30 |
| **Total** | | **15** | | | |

# 500 Level

**FIRST SEMESTER**

| Course Code | Course Title | Units | Status | LH | PH |
|---|---|---|---|---|---|
| | **COMPULSORY COURSES** | | | | |
| ELE 505 (ECE 577) | Artificial Intelligence and Engineering Applications | 3 | C | 45 | 45 |
| GET 501 | Engineering Project Management | 3 | C | 45 | - |
| | **ELECTIVES (Select 3)** | | | | |
| | ***TELECOMMUNICATIONS*** | | | | |
| TEE 501 | Telecommunications Systems | 3 | C | 45 | |
| TEE 502 | Optical Communication Systems | 3 | C | 45 | |
| TEE 503 | Mobile Communication System | 3 | E | 45 | |
| ECE 549 | Electroacoustics | 3 | E | 45 | - |

| | | | | | |
|---|---|---|---|---|---|
| | ***CONTROL*** | | | | |
| ECE 551 | Control Engineering | 3 | E | 45 | - |
| | ***COMPUTER ENGINEERING*** | | | | |
| CPE 511 | Machine Learning and Applications | 3 | C | 45 | - |
| CPE 514 | Professional Practice and Ethics | 3 | E | 45 | - |
| | ***AI & SOFTWARE ENGR'G*** | | | | |
| ASE 571 | Web Engineering | 3 | E | 45 | 45 |
| ASE 573 | Component-Based Software Development | 3 | E | 45 | 45 |
| ASE 575 | Cyber Security | 3 | E | 45 | - |
| ASE 577 | Computer Vision | 3 | E | 45 | 45 |
| | ***DIGITAL SYSTEMS*** | | | | |
| CPE 505 (ECE 511) | Digital System Design with VHDL (Digital System Design) | 3 | E | 45 | - |
| ELE 513 (ECE571) | Embedded Systems Design and Programming (Microprocessor Systems) | 3 | E | 45 | - |
| | ***ELECTRONICS*** | | | | |
| ECE 521 | Industrial Electronics Design | 3 | C | 45 | - |
| | ***INFORMATION & COMM. ENGR'G*** | | | | |
| ICE 515 | Satellite Communication | 3 | C | 45 | - |
| **Total** | | **15** | | | |

**SECOND SEMESTER**

| Course Code | Course Title | Units | Status | LH | PH |
|---|---|---|---|---|---|
| | **COMPULSORY COURSES** | | | | |
| CPE 501 (ECE 512) | Testing, Reliability and Maintainability (Reliability Engineering) | 2 | C | 30 | - |
| GET 502 | Engineering Law | 2 | C | 30 | - |
| ELE 507 (ECE 574) | Digital Signal Processing and Applications | 3 | C | 45 | 15 |
| ECE 592 | Final Year Project | 6 | C | - | 270 |
| | **ELECTIVES (Select 2)** | | | | |
| | ***COMPUTER ENGR'G & AI*** | | | | |
| CPE 511 | Machine Learning and Applications | 3 | C | 45 | - |
| CPE 514 | Professional Practice and Ethics | 3 | E | 45 | - |
| ECE 578 | Artificial Intelligence and Robotics | 3 | E | 45 | - |
| | ***AI & SOFTWARE ENGR'G*** | | | | |
| ASE 502 | Software Engineering Project Management | 3 | E | 45 | - |
| ASE 572 | Image Processing | 3 | E | 45 | 15 |
| ASE 574 | Biometrics Recognition | 3 | E | 45 | 15 |
| | ***TELECOMMUNICATIONS ENGR'G*** | | | | |
| TEE 502 | Optical Communication Systems | 3 | C | 45 | - |
| ECE 540 | Introduction to Radar and Navigation | 3 | E | 45 | - |
| ECE 546 | Communications Networks | 3 | E | 45 | - |
| ECE 548 | Television and Radio | 3 | E | 45 | - |

| | | | | | |
|---|---|---|---|---|---|
| | ***CONTROL*** | | | | |
| ECE 552 | Advanced Control Engineering | 3 | E | 45 | - |
| ECE 554 | Process Control | 3 | E | 45 | - |
| ECE 556 | Linear Systems Theory | 3 | E | 45 | - |
| | ***DIGITAL AND COMPUTER SYSTEMS*** | | | | |
| ECE 572 | Computer Systems Design | 3 | E | 45 | - |
| ECE 576 | Microprocessor System Design | 3 | E | 45 | - |
| ECE 570 | Database Management Systems | 3 | E | 45 | - |
| | ***ELECTRONICS*** | | | | |
| ECE 524 | Solid State Electronics | | | | |
| | ***OPTO-ELECTRONICS*** | | | | |
| ECE 526 | Optical Engineering | 3 | E | 45 | - |
| ECE 528 | Medical Electronics | 3 | E | 45 | - |
| | ***INSTRUMENTATION*** | | | | |
| ECE 562 | Automation | 3 | E | 45 | - |
| **Total** | | **19** | | | |

# Course Contents and Learning Outcomes

## 200 Level

### ECE 272: Computing and Software Engineering (3 Units C: LH 30; PH 45)

**Learning Outcomes**

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

1. describe and apply computing, software engineering knowledge, best practices, and standards appropriate for complex engineering software systems;
2. develop competence in designing, evaluating, and adapting software processes and software development tools to meet the needs of an advanced development project through practical object-oriented programming exposure taught in concrete terms with a specific modern language – preferable selected from Python, Java or C++;
3. use widely available libraries to prepare them for machine learning, graphics and design simulations;
4. develop skills in eliciting user needs and designing an effective software solution;
5. recognise human, security, social, and entrepreneurial issues and responsibilities relevant to engineering software and the digitalisation of services; and
6. acquire capabilities that can further be developed to make them productively employable by means of short Internet courses in specific areas.

**Course Contents**

Introduction to computers and computing; computer organisation – data processing, memory, registers and addressing schemes; Elements of Boolean algebra and logic design. Algebraic minimization of Boolean expressions. Concept of combinational logic circuits. Basic logic gates – AND, NAND, OR, NOT, NOR, XOR, XNOR; floating-point arithmetic; Review of number systems and conversions (binary, octal, decimal, hexadecimal), logical operations. Representation of non-numeric information; problem-solving and algorithm development; coding (solution design using flowcharts and pseudo codes). Data models and data structures; computer software and operating system; computer operators and operators precedence; components of computer programs; introduction to object oriented, structured and visual programming; use of MATLAB in engineering applications. ICT fundamentals, Internet of Things (IoT). Elements of software engineering.

Compilation of programs; Use of Internet and Web-based applications; Computer Aided Design (CAD) packages/ applications; Introduction to basic Unix operating system

**EGR 298 (GET 299): Students Industrial Work Experience I (3 Units C: 9 weeks)**

**Learning Outcomes**

SIWES I should provide opportunity for the students to:

1. acquire industrial workplace perceptions, ethics, health and safety consciousness, inter-personal skills and technical capabilities needed to give them a sound engineering foundation;
2. learn and practise basic engineering techniques and processes applicable to their specialisations;
3. build machines, devices, structures or facilities relevant to their specific engineering programmes and applications; and
4. acquire competence in technical documentation (log-book) and presentation (report) of their practical experiences.

**Course Contents**

Practical experience in a workshop or industrial production facility, construction site or special centres in the university environment, considered suitable for relevant practical/industrial working experience but not necessarily limited to the student's major. The students are exposed to hands-on activities on workshop safety and ethics, maintenance of tools, equipment and machines, welding, fabrication and foundry equipment, production of simple devices; electrical circuits, wiring and installation, etc. (8-10 weeks during the long vacation following 200 level).

# 300 Level

### ECE 311 (ELE 305): CIRCUIT THEORY (3 Units)

**Learning Outcomes**

On the successful completion of this course students will be able to:

1. write circuit equations for a coupled-inductor system;
2. analyse circuits containing ideal transformers and autotransformers;
3. analyse three-phase wye- and delta-connected balanced circuits;
4. plot Bode diagrams from transfer functions for SISO circuits;
5. write behavioural descriptive equations for series- and parallel-resonant circuits in the time- and frequency domains;
6. use Fourier series techniques to analyse circuit responses to periodic signals; and
7. derive two-port parameters of circuits.

**Course Contents**

Three-phase balanced circuits and power; mutual inductance; Linear transformer, ideal transformer, autotransformer; Frequency response, transfer function, Bode plots; Series and parallel resonance in the frequency domain; Series and parallel resonance in the time domain; Fourier series in circuit analysis; Two-port parameters; Laplace transform circuit analysis. (OLD VERSION: Network Theorems, Network Topology, General network solutions. Network Transformations. Two-port networks. Parametric representation of passive and active two-port networks. Symmetrical two-port networks. Characteristic impedance. Propagation coefficient. Image coefficient. Filters as examples of two-port networks. Active filters. Network Synthesis: Foster and Cauer's methods of synthesis. Two-port network synthesis. Approximation to non-linear characteristic analysis and synthesis of non-linear restive circuits. Harmonic analysis of non-linear dynamic circuits. Application of computers in the analysis of linear and non-linear circuits.)

### ECE 312: SIGNALS AND SYSTEMS WITH MATLAB / PYTHON (3 Units)

Signal Types, Signal Transformations, Domain of Signals, Analytical expressions of signals, Signal properties, Signal domains. Generating continuous impulses; step and ramp sequences and carrying out operations on signals in MATLAB. Time domain analysis. Frequency domain analysis. Fourier series and periodic signals. Application of Fourier series in network analysis. Fourier Transforms. Laplace transforms. Application of Laplace transformation to transient analysis of RLC circuits. Transfer function concepts. Reliability of transfer functions. Systems programming using MATLAB.

**ECE 321 (GET 306): Physical Electronics & Renewable Energy Systems and Technology (3 Units C: LH 30; PH 45)**

**Learning Outcomes**

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

1. identify the types, uses and advantages of renewable energy in relation to climate change;
2. design for use the various renewable energy systems;
3. recognise and analyse the current energy systems in Nigeria, their impacts on development and the global energy demand and supply scenarios;
4. appreciate the environmental impact of energy exploitation and utilisation, and pursue the sustainable development of renewable energy for various applications; and
5. recognise the exploitation, excavation, production, and processing of fossil fuels such as coal, petroleum and natural gas, and discuss the sources, -technology and contribution to future energy demands of renewable energy.

**Course Contents**

Energy bands in conductors, insulators and semiconductors. Bond model – electron and holes. Intrinsic and Extrinsic semiconductors. Generation, recombination and thermal equilibrium; doping, donors, acceptors, compensation. Carrier and Transport Phenomena in Semiconductors (drift velocity, drift current density, diffusion current density, Conductivity and resistivity). Electrostatics: charge density, electric field and potential of a semiconductor. The PN junction Graphical models for Poisson's Equation using the Depletion Approximation and 60mV rule. The PN junction under Bias, PN junction breakdown and depletion capacitance. Diode Characteristics and Equation / Analysis of diodes operating in the breakdown region – Zener diode. PN Junction devices. Overview of Photodevices (photo resistor, photodiode, light emitting diode, solar cell). Bipolar junction transistor (BJT) structure and principle of operation. Bias modes of a BJT, BJT characteristics for CB, CE and CC configurations. BJT Base-width modulation, Recombination in the depletion region, High injection effects, Temperature dependent effects in bipolar transistors, Breakdown mechanisms in BJTs. Field Effect Transistor (FET) types / JFET: transfer characteristics. MOSFET: physical structure, circuit symbol and operation, transfer characteristics. MOSFET under bias and saturation. Complementary MOSFET, (CMOS) characteristics. Overview of Integrated Circuits (IC) and IC fabrication techniques.

Current and potential future energy systems in Nigeria and globally - resources, extraction, concepts in energy conversion systems; parallels and differences in various conversion systems and end-use technologies, with emphasis on meeting 21st-century national, regional and global energy needs in a sustainable manner. Various energy technologies in each fuel cycle stage for fossil (oil, gas, synthetic), nuclear (fission and fusion) and renewable (solar, biomass, wind, hydro, and geothermal). Energy types, storage, transmission and conservation. Analysis of energy mixes within an engineering, economic and social context. Sustainable energy; emphasise sustainability in general and in the overall concept of sustainable development and the link this has with sustainable energy as the fundamental benefit of renewable energy.

**ECE 331: ELECTROMAGNETIC FIELDS AND WAVES (3 Units)**

Review of vector analysis techniques. Electromagnetic laws in integral forms. Gauss' law. Ampere's law. Faraday's laws. Electrostatic fields due to distribution of charge. Magnetic fields in and around current carrying conductors. Time varying magnetic and electric fields. Conduction and displacement current. Maxwell's equation (in rectangular coordinates and vector-calculus notations). Electromagnetic potential and waves. Ponyting vector. Boundary conditions. Wave propagation in good conductors, skin effect. Plane waves in unbounded dielectric media. Transmission lines. Fundamentals of waveguides and antennas. Wave propagation, attenuation, polarization, reflection, refraction and diffraction.

**ECE 341 (ELE 324) : Communication Principles (3 Units E: LH 45)**

**Learning Outcomes**

On the successful completion of this course, students will be able to:

1. analyse communication systems in both the time and frequency domains;
2. describe the principles of amplitude modulated and angle modulated communication systems, and be able to analyse their performance in the presence of noise;
3. explain source coding and its relations to information theory, citing Shannon's theorem;
4. describe the principles of various digital modulation systems and their properties, including bandwidth, channel capacity, transmission over bandlimited channels, inter-symbol interference (ISI), demodulation methods, and error performance in the presence of noise; and
5. explain engineering fundamentals of photogeneration, photodetection and lightwave propagation for optical communications.

**Course Contents**

Models of telecommunication system. The concept of information volume. Characteristics of analogue audio and video signals. Analogue modulation techniques and their implementation: amplitude and angle modulation, Frequency Division Multiplexing. Digitization of analogue signals. Binary system. Arithmetic operations on binary numbers. Modulo 2 arithmetic. Pulse code modulation (PCM), sampling, quantization, coding. Delta and differential pulse code modulation. Synchronous and asynchronous, static and dynamic time division multiplexing. Plesio-synchronous digital hierarchy, primary group, secondary group, groups of higher levels. Synchronous digital hierarchy. Multiplexing PDH signals into SDH STM-1 transport module. Transmission media. Optical fibres: single mode, multimode. Optical cables. Wavelength division multiplexing

(WDM): Dense wavelength division multiplexing (DWDM). Information theory: Entropy and coding. Coding: Primary coding; secondary coding and Line coding. Noise in analogue and digital systems.

## ECE 361 (TEL 304): MEASUREMENTS AND INSTRUMENTATION (3 Units C: LH 30: PH 45)

**Learning Outcomes**

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

1. analyse the performance characteristics of each instrument;
2. illustrate basic metres such as voltmetres and ammetres;
3. explain about different types of signal analyseanalysers;
4. explain the basic features of oscilloscope and different types of oscilloscopes; and

apply the complete knowledge of various electronics instruments/transducers to measure the physical quantities in the field of science, engineering and technology.

**Course Contents**

Introduction: Significance of Measurement and block diagram of Measurement System, Static characteristics- Accuracy, Precision, Sensitivity, Linearity, Repeatability, Reproducibility, Resolution, Threshold, Drift, Stability, Dead zone, hysteresis, Dynamic Characteristics- speed of response, measuring lag, fidelity, dynamic error, Types of Errors – Gross error, systematic errors, Random errors.

Measuring Instruments: PMMC, DC voltmetre and current metres and its Extension ranges, True RMS Responding Voltmeter, Average responding rectifier type voltmetre, electronic voltmetre, block diagram approach for measurement of voltage, current and Resistance using Digital Multi Metre (DMM), Basic Potentiometer Circuit, Q-meter – Series Method.

Bridges and Analyse Analysers: DC Bridge- Wheatstone bridge, Kelvin's Double Bridge, AC Bridge- Maxwell's Bridge, Schering bridge and Wien's Bridge. Signal Analysers: Frequency Selective and Heterodyne Wave Analysers, Harmonic distortion Analysers, Total Harmonic distortion, Spectrum AnalyseAnalysers.

Oscilloscopes: Cathode Ray Tube (CRT), Electrostatic Deflection, Post-deflection and Acceleration of Electron Beam, Screens for CRT's, Block diagram of CRO, Time-based Generator, Delay line, Attenuators, probes, Dual beam oscilloscope, Dual trace oscilloscope, Digital Storage Oscilloscope, Applications of CRO: Measurement of Phase and Frequency using Lissajous Patterns.

Transducers: Transducer and its classification, ideal features of Transducer – Resistive Transducer: Potentiometric type, Strain Gauge type (Gauge factor derivation, SG materials, Bonded and unbounded strain gauges), Capacitive Transducers - Variable gap type, variable area type and variable Dielectric type, Inductive Transducers - LVDT, Thermocouple, Thermistor, Piezo Electric Transducers, Piezoelectric effect, Piezoelectric materials, RTD, photo voltaic cell, LDR.

## ECE 322: ANALOG ELECTRONICS (APPLIED ELECTRONICS I) (3 Units)

**Learning Outcomes**

Students will be able to:

1. classify, describe and discuss the principles of operation and applications of FET and BJT; and
2. calculate amplifier parameters; and design simple amplifiers using BJT and FET with given specifications.

**Course contents**

Single-stage transistor amplifiers using BJT and FET Equivalent circuits and calculation of current gain, voltage gain, power gain, input and output impedance. Operational Amplifiers: Description, parameters and applications. Feedback, broadband and narrowband amplifiers. Power amplifiers. Voltage and current stabilizing circuits. Voltage amplifiers, multi-stage amplifiers using BJTs and FETs.

**OLD (**Classification on Amplifiers, representation of an amplifier circuits as a voltage, current, transresistance and transconductance amplifier. Biasing and stabilization of BJT and FET circuits. Small-signal representation of active devices. Small-signal analysis of single and multi-stage amplifiers at midband. Low frequency and high frequency response of single and multi-stage amplifiers. Bode plots and frequency response of amplifiers. Analysis of broadband and narrowband amplifiers and other communication circuits. Effect of feedback on gain, input and output impedances. Analysis of feedback amplifiers. Stability and compensation techniques. Electronically regulated power supplies, current limiting and feedback current limiting protection.**)**

**ECE 371 (**GET 307)**: INTRODUCTION TO ARTIFICIAL INTELLIGENCE, MACHINE LEARNING DATA ANALYTICS AND CONVERGENT TECHNOLOGIES (3 Units C: LH 45)**

**Learning Outcomes**

At the completion of the course, the students are expected to be able:

1. explain the meaning, purpose, scope, stages, applications and effects of artificial intelligence;
2. explain the fundamental concepts of machine learning, deep learning and convergent technologies;
3. demonstrate the difference between supervised, semi-supervised and unsupervised learning;
4. demonstrate proficiency in machine learning workflow and how to implement the steps effectively;
5. explain natural languages, knowledge representation, expert systems and pattern recognition;

6. describe distributed systems, data and information security and intelligent web technologies;
7. explain the concept of big data analytics, purpose of studying it, issues that can arise with a data set and the importance of properly preparing data prior to a machine learning exercise; and
8. work with data from the point of view of knowledge convergence, machine learning, and intelligence augmentation, which significantly raises their standard for engineering analysis (the approach forces them to learn statistics in an actionable way that helps them to see the holistic importance of data analytics in modern engineering and technology);
9. explain the concepts, characteristics, models and benefits, key security and compliance challenges of cloud computing.

**Course Contents**

Concepts of human and artificial intelligence; artificial/computational intelligence paradigms; search, logic and learning algorithms. Machine learning and nature-inspired algorithms – examples, their variants and applications to solving engineering problems; understanding natural languages; knowledge representation, knowledge elicitation, mathematical and logic foundations of AI; expert systems, automated reasoning and pattern recognition; distributed systems; data and information security; intelligent web technologies; convergent technologies

definition, significance and engineering applications. Neural networks and deep learning. Introduction to python AI libraries.

Computational programming: Introduction to MATLAB

**ECE 372: DIGITAL ELECTRONICS 1 (2 Units: E: 30LH)**

Switching waveforms, waveshaping and transient analysis of switching circuits. Circuit models of diodes, bipolar transistors and FETs for switching circuits. The transistor as a switch. Analysis of stable, monostable and bistable multi-vibrators. Schmitt triggers and time-base generators using transistors. Analysis of DTL, TTL, MOS and CMOS gates. Commercially available IC logic families. Practical considerations in the application of integrated circuits: switching speed, noise margin, fan-in and fan-out considerations. Data sheet specifications and worst case consideration. Concepts of small, medium and large scale integration. Consequences of integration in digital systems design.

## ECE 374: COMPUTER ORGANISATION AND ARCHITECTURE (2 Units)

**Learning Outcomes**

Upon completion of this course, the students will be able to:

1. describe the fundamental organisation of a computer system;
2. explain the functional units of a processor;
3. explain addressing modes, instruction formats and programme control statements;
4. identify the organisation of various parts of a system memory hierarchy;
5. describe basic concept of parallel computing; and
6. describe fundamentals concepts of pipeline and vector processing.

**Course Contents**

Computer fundamentals: development history of computer hardware and software; hard- wired vs stored program concept; Von-Neuman architecture; Harvard architecture: principle of operation, advantages and disadvantages; single address machine; contemporary computers; computer system: block diagram, functions, examples, dataflow and control line; computer arithmetic: integer arithmetic (addition, subtraction, multiplication, division)
floating-point representation (IEEE), floating-point arithmetic, arithmetic and logic unit (ALU). Introduction to CISC and RISC architecture: principle of operation, merits and demerits; storage and input/output systems: computer function (fetch and execute cycles), interrupts, interconnection structures (bus structure and bus types); overview of memory system, memory chip organisation and error correction, cache memory, and memory storage devices; overview of I/O, programmed and interrupt-driven I/Os, DMA, I/O channel and I/O processor; control unit: micro-operations, control of the CPU, hard-wired implementation, control unit operation, micro-instruction sequencing and execution, and micro-programmed control; using INTEL family, and MOTOROLA family as case study of a CISC computer system; instruction set and register: machine instruction characteristics, types of operands and operations,

instruction functions, addressing modes, instruction formats, register organisation, and instruction pipelining; high performance computer systems: techniques to achieve high performance, pipelining, storage hierarchy, and units with function dedicated for I/O; RISC, introduction to superscalar processor, and parallel processor; using popular RISC processor (e.g. i960, Motorola PowerPC) as case study. Operating system: overview of operating system, dimension and type of operating system: overview of operating system, dimension and type of operating system, high level scheduling, short-term scheduling, I/O scheduling, memory management, virtual memory, UNIX/LINUX operating system: architecture, commands, programming; window-based operating systems (MS windows).

**ECE 391 (GET 304): Engineering Communication, Technical Writing and Presentation (3 Units C: LH 45) Learning Outcomes**

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

1. demonstrate the concept of clear writing, common pitfalls and unambiguous language in engineering communication, including technical reporting for different applications and emotional comportment;
2. demonstrate the skills of language flexibility, formatting, logic, data presentation styles, referencing, use of available aids, intellectual property rights, their protection, and problems in engineering communication and presentation; and
3. demonstrate good interpersonal communication skills through hands-on and constant practice on real-life communication issues for engineers in different sociocultural milieu for engineering designs, structural failure scenarios and presentation of reports.

**Course Contents**

A brief review of common pitfalls in writing. Principles of clear writing (punctuations and capitalization). Figures of speech. Units of grammar. Tenses and verb agreement. Active and passive sentences Lexis and structure Fog Index concept. Skills for communication and communication algorithm. Types and goals of communication; Interpersonal communication; features and the Finger Model or A,B,C,D,E of good interpersonal communication (accuracy of technical terms, brevity of expression, clarity of purpose, directness of focus and effectiveness of the report). Language and organisation of reports. Technical report writing skills(steps, problems in writing, distinguishing technical and other reports, significance, format and styles of writing technical reports). Different formats for communication; styles of correspondences – business report and proposal, business letter, memorandum, e-mails, etc. Proposals for projects and research; format, major steps and tips of grant-oriented proposals. Research reports(competency, major steps, components and formats of research reports and publishable communication). Sources and handling of data, tables, figures, equations and references in a report. Presentation skills; overview, tips, organisation, use of visual aids and practising of presentation. Intellectual property rights in research reports. Case studies of major engineering designs, proposals and industrial failures with professional presentation of reports.

**EGR 396 (GET 305): Engineering Statistics and Data Analytics (3 Units**

**C: LH 45) Learning Outcomes**

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

1. work with data from the point of view of knowledge convergence, machine learning, and intelligence augmentation, which significantly raises their standard for engineering analysis (the approach forces them to learn statistics in an actionable way that helps them to see the holistic importance of data analytics in modern engineering and technology);
2. anticipate the future with Artificial Intelligence while fulfilling the basic requirements of conventional engineering statistical programming consistent with their future careers;
3. perform, with proficiency, statistical inference tasks with language or programming toolboxes such as R, Python, Mathematica or MATLAB, and Design Expert to summarise analysis and interpretation of industry engineering data, and make appropriate conclusions based on such experimental and/or real-life industrial data;
4. construct appropriate graphical displays of data and highlight the roles of such displays in data analysis, particularly the use of statistical software packages;
5. plan and execute experimental programmes to determine the performance of programme- relevant industrial engineering systems, and evaluate the accuracy of the measurements undertaken; and
6. demonstrate mastery of data analytics and statistical concepts by communicating the results of experimental and industry-case investigations, critically reasoned scientific and professional analysis through written and oral presentation.

**Course Contents**

Descriptive statistics, frequency distribution, populations and sample, central tendency, variance data sampling, mean, median, mode, mean deviation, percentiles, etc. Probability. Binomial, poison hyper-geometric, normal distributions, etc. Statistical inference intervals, test hypothesis and significance. Regression and correlation. Introduction to big data analytics and cloud computing applications. Introduction to the R language; R as a calculator; Vectors, matrices, factors, data frames and other R collections. Iteration and looping control structures. Conditionals and other controls. Designing, using and extending functions. The Apply Family. Statistical modelling and inference in R.

**Practical Contents**

Simple measurement of solar radiation, bomb calorimeter determination of calorific value of fuels and biomass; measurement of the velocity of wind, waves and the energy that abound in them; laboratory production of biogas and determination of energy available in it; simple conversion of solar energy to electricity; transesterification of edible oil into biodiesel; simulation of geothermal energy; Geiger-Muller or Scintillation Counters' determination of uranium or thorium energy; simple solid or salt storage of energy; hybrid application of renewable energy.

**EGR 302 (**GET 301 & 302**): ENGINEERING ANALYSIS (**Engineering Mathematics III & IV **)(4 Units)**

**GET 301: Engineering Mathematics III (3 Units C: LH 45)**

**Learning Outcomes**

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

1. demonstrate a clear understanding of the course content, that is, possess a breadth of knowledge in the area covered;
2. possess an in-depth knowledge upon which a solid foundation can be built in order to demonstrate a depth of understanding in advanced mathematical topics;
3. develop simple algorithms and use computational proficiency;
4. write simple proofs for theorems and their applications;; and
5. communicate the acquired mathematical knowledge effectively in speech, writing and collaborative groups..

Course Contents

Linear Algebra. Elements of Matrices, Determinants, Inverses of Matrices. Theory of Linear Equations. Eigen Values and Eigen Vectors. Analytical Geometry. Coordinate Transformation. Solid Geometry. Polar, cylindrical and spherical coordinates. Elements of functions of several variables. Surface Variables. Ordinary Integrals. Evaluation of Double Integrals, Triple Integrals, Line Integrals and Surface Integrals. Derivation and Integrals of Vectors. The gradient of scalar quantities. Flux of Vectors. The curl of a vector field, Gauss, Greens and Stoke's theorems and applications. Singular Valued Functions. Multivalued Functions. Analytical Functions. Cauchy Riemann's Equations. Singularities and Zeroes. Contour Integration including the use of Cauchy's Integral Theorems. Bilinear transformation.

**GET 302: Engineering Mathematics IV (3 Units C: LH 45) Learning Outcomes**

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

1. solve second order differential equations;
2. solve partial differential equations;
3. solve linear integral equations;
4. relate integral transforms to solution of differential and integral equations;
5. explain and apply interpolation formulas; and
6. apply Runge-Kutta and other similar methods in solving ODE and PDEs.

**Course Contents**

Series solution of second order linear differential equations with variable coefficients. Bessel and Legendre equations. Equations with variable coefficients. Sturn-Louville boundary value problems. Solutions of equations in two and three dimensions by separation of variables. Eigen value problems. Use of operations in the solution of partial differential equations and Linear integral equations. Integral transforms and their inverse including Fourier, Laplace, Mellin and Handel Transforms. Convolution integrals and Hilbert Transforms. Calculus of finite differences. Interpolation formulae. Finite difference equations. RungeKutta and other methods in the solutions of ODE and PDEs. Numerical integration and differentiation.

**OLD CONTENT**

Complex derivatives and analytic functions. Bilinear transformations, conformal mapping. Contour integration, Cauchy's integral theory, residue theorem. Applications. Riemann surfaces. Bessels equation and Fourier series. Legendre functions. Simultaneous differential equations with constant and variable coefficients. Special functions. Classification of second-order partial differential equations. Laplace, wave and diffusion equations. Initial and boundary value problems. Separation of variables. Similarity solutions. Solution of equations by iteration. Newton – Raphson Method: errors. Numerical differentiation and integration. Simpson's rule. Introduction to interpolation and curve fittings. Statistical Analysis. Regression and correlation – large sampling theory, test hypothesis and quality control.

**EGR 398 (GET 399): Students Industrial Work Experience II (3 UnitsC: 12 weeks) Learning Outcomes**

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

2. demonstrate proficiency in at least any three softwares in their chosen career choices;
3. demonstrate proficiency in some animation videos (some of which are free on YouTube) in their chosen careers;
4. carry out outdoor hands-on construction activities to sharpen their skills in their chosen careers;,
5. demonstrate proficiency in generating data from laboratory analysis and develop empirical models;
6. demonstrate proficiency in how to write engineering reports from lab work;
7. fill logbooks of all experience gained in their chosen careers; and
8. write a general report at the end of the training.

**The experience is to be graded and the students must pass all the modules of the attachment and shall form part of CGPA.**

**Course Contents**

On-the-job experience in industry chosen for practical working experience but not necessarily limited to the student's major (Students are to proceed on three months of work experience i.e. 12 weeks during the long vacation following 300 level). Students are engaged in the more advanced workshops, indoor software design training similar to what they will use in the industry and outdoor construction activities to sharpen their skills. The use of relevant animation videos that mimic industrial scenarios is encouraged. Students are to write a report at the end of the training. As much as possible, students should be assisted and encouraged to secure 3 months placement in the industry. Examples of outline of activities and experiences to which students are expected to be exposed to earn prescribed credits include:

**Section A:** Welding and fabrication processes, automobile repairs, · lathe machine operations: machining and turning of simple machine elements, such as screw threads, bolts, gears, etc. Simple milling machine operations, machine tool maintenance and trouble- shooting, andwooden furniture making processes.

**Section B:** Mechanical design with computer graphics and CAD modelling and drafting. Introduction to Solidworks: software capabilities, design methodologies and applications. Basics part modelling: sketching with SolidWorks, building 3D components, using extruded Bose base · Basic assembly modelling, and solidWorks drawing drafting. Top-down assembly technique exploded view, exploded line sketch. Introduction to PDMS 3D design software; autoCAD mechanical, SPSS.

A comprehensive case study design project. The student should be introduced to the concept of product/component design and innovation and then be given a comprehensive design project.

Examples of projects should include the following:

a. design of machine components;
b. product design and innovation;
c. part modelling and drafting in solidworks; and
d. technical report writing.

# 400 Level

**CPE 401: Microprocessor and Embedded Systems (3 Units C: LH 45)**

**Learning Outcomes**

Upon the successful completion of the course, students will be able to:

1. develop an ALP in 8085 microprocessor using the internal organisation for the given specification;
2. describe the architecture and functional block of 8051 microcontroller;
3. develop an embedded C and ALP in 8051 microcontroller using the internal functional blocks for the given specification;
4. explain various peripheral devices such as 8255, 8279, 8251, 8253,8259 and 8237; and
5. explain microcontroller application and basic architecture of PIC, ARM and ATMEGA processors.

**Course Contents**

A basic microprocessor system: the CPU, memory, I/O, and buses subsystems, basic operation of a microprocessor system: fetch and execute cycle, the architecture of some typical 8-bit, 16-bit microprocessors (INTEL, MOTOROLA) and their features; programming model in real mode: registers, memory, addressing modes; organisation of the interrupt system, interrupt vectors, and external interrupts, implementation of single and multiple interrupts in real mode; programming model in protected mode: registers, memory management and address translation, descriptor and page tables, system control instructions, multitasking and memory protection, addressing modes, and interrupt system; memory interfacing and address decoding; I/O interfacing: memory mapped i/o, isolated i/o, bus timing, i/o instructions; peripheral devices interfacing: 8255 PPI/6821 PIA, 8251 USART/6821 UART, DMA, Timer/Counter chips, etc; instruction set; assembly language Programming of INTEL and MOTOROLA microprocessors; and discussion of a typical system e.g. IBM PC, Apple Macintosh.

**ECE 451: CONTROL THEORY (3 Units)**

Basic concepts and examples of Control Systems. Feedback. Block Diagram Algebra and Signal Flow Graphs. Time Response Analysis. Concepts of Stability: Routh-Hurwitz Stability Criterion. Frequency Response Analysis: Bode Plots, Nyquist Diagram, Nichols Chart. Root Locus Technique. Compensation Techniques. Introduction to non-linear systems. Use of MATLAB, Simulink and Control Toolbox software.

**ELE 407: Data Communication Fundamentals and Networking (3 Units E: LH 30; PH 45) Learning Outcomes**

Upon the completion of this course, students should be able to:

1. describe the theoretical fundamentals of how the Internet works;
2. use a layered model to explain the primary functionalities of internetworking;
3. identify algorithms and functionalities to allow reliable data transport over an unreliable network;
4. explain the fundamental protocols in the Internet and apply them to new networks;
5. describe Software Defined Networking, fundamental concept and its impact on the Internet; and
6. explain the fundamentals of link layer protocols.

**Course Content**

Data communication standards and policies; Data communication components and systems - hardware; Data communication signals; Modes and types of transmission; Source coding principles and structures; Transmission media and the characteristics; Network configuration concepts; Network medium access control techniques; Network interconnection techniques and devices. Principles of private and public networks; Networks and services, Line coding principles.

access protocols, data center networking, Wireless Networking, Wireless links, characteristics, IEEE 802.11 wireless LANs (Wi-Fi), Network Security, Message integrity, authentication, Securing e-mail, securing TCP connections: SSL, Firewalls and IDS.

**ELE 411: Advanced Electronic Circuits Design (3 Units E: LH 30; 45)**

**Learning Outcomes**

On successful completion of this course a student will be able to:

1. analyse and design analogue electronic circuits using a variety of techniques;
2. understand the theory of operation of the main components used in analogue electronic systems;
3. analyse and deign amplifiers, op amps circuits and filters;
4. understand the principles of feedback theory and the operation of oscillators; and
5. use the techniques, skills, and modern engineering tools such as pSpice, Electronic Workbench, necessary for engineering practice.

**Course Contents**

pSpice simulation; Design of BJT-based amplifier systems; Design of FET-based amplifier systems; Current-series feedback design; Current-series feedback design; Voltage-shunt feedback design; Differential amplifier; Op-amp IC applications; Positive feedback and oscillator circuits; Advanced electronic laboratory skills (design, analysis, construction, and measurement of advanced analog electronic circuits using discrete devices (diodes, bipolar junction transistors, MOSFETs).

**TEL 423: Power Electronics (2 Units E: LH 30)**

**Learning Outcomes:**

On the completion of this course, students should be able to:

1. understand the principles of power control by switching; demonstrate the benefits of switched mode circuits; be familiarised with the commonly used semiconductor switching devices;
2. demonstrate a full understanding on several DC-DC converters; perform analysis on their operation principles; develop design equations for selecting their components;
3. be able to explain how the steady-state AC voltage and current are related to each other in power circuits using phasor analysis;
4. understand and be able to quantify active, reactive and apparent power;
5. comprehend the operation principles for several thyristors-based rectifiers; quantify the current harmonics and the average power drawn by a rectifier; and
6. understand the H-bridge based inverters and their several control methods; develop the skills in analysing the different modes of operations for the inverters; gain the understanding on how the power is delivered or absorbed by grid-connected inverters.

**Course Contents**

The basics of three-phase circuits, connections, voltage and current analysis and real and reactive power calculations; the fundamentals of electricity conversion from the form supplied by the source to the forms required by the load; power electronic conversion techniques, including the basic converters (DC-DC, AC-DC and DC-AC) and their power switching and control methods; the methods of circuit analysis applicable to switched mode circuits; essential properties of the relevant semiconductor devices; simple converters for practical applications. Characteristics of power devices; DC-DC converters; AC Current, Voltage and Power; AC-DC converters and Inverters (DC-AC converters).

**ECE 473 (ELE 318): Digital Electronics II (DIGITAL LOGIC THEORY)(2 Units E: LH 30)**

**Learning Outcomes**

Upon the successful completion of this course, students should be able to:

1. perform base 2, 8, 16 and BCD-code (binary-coded decimal) calculations;
2. design a minimal combinatorial logic circuit that solves binary logical tasks;
3. design a minimal sequential circuit that solves binary logical tasks;
4. describe the structure of a logic gate;
5. explain the principles of programmable circuits;
6. explain the principles of analog-to-digital (AD) - and digital-to-analog (DA) conversion;
7. design synchronous networks with sequential flow charts;
8. design sequential circuits for programmable logic device (PLD) circuits; and
9. programme a PLD type Field-Programmable Gate Array (FPGA).

**Course Contents**

Introduction to Computing Systems; Switch Design; Boolean Algebra; Gate Design and Simplification; Building Blocks; Number Systems and Arithmetic; Latches and Registers; Counters; State Machines; Memory; Datapaths; Introductory Assembly Programming.

Laboratory projects will include use of PC-based CAD environment that supports schematic capture, logic simulation, and HDL-based logic synthesis on FPGAs (field-programmable gate arrays). Small-scale integrated circuits will be used for early labs; HDL-based logic synthesis on FPGA-based design boards will be used for more advanced design implementations.

[OLD CONTENT: Review of Number systems (Binary, Octal, Decimal, Hex), Radix/ Diminished complements. Review of logic gates. Boolean Algebra. Algebraic minimization of Boolean expressions. Karnaugh maps including don't care conditions. Combinational logic design with NAND and NOR gates. Design of arithmetic circuits with XOR gates. Package count versus gate count in design.

Sum of products (SOP) expressions; product of sums (POS) expressions. Implementation using Primitive and Universal gates. Decoders, Encoders, PLA, ROMs. Sequential Logic.

The basic memory element. R-S, J-K, D, T and master-slave flip-flops. Flip-flop characteristic and excitation tables. Triggering in synchronous systems. Ripple and synchronous counters, latches and registers. Synchronous sequential systems: Analysis: the concept of state, state diagrams and state table. Analysis procedure. Design: Design procedure. State assignment and state reduction. Design implementation in D, JK, T and R-S flip flops. Asynchronous sequential systems: Hazards and race conditions. Elementary circuit analysis. Introduction to VHDL.]

**ECE474 : Hardware Design Techniques and Verification (2 Units E: LH 30)**

**Learning Outcomes**

Upon successful completion of this course, students will be able to demonstrate

1. adequate knowledge in digital electronics and digital design concepts;

2. ability to design and implement digital circuits under realistic constraints and conditions;
3. ability to debug, verify, simulate digital circuits;
4. ability to devise, select, and use modern techniques and tools needed for digital design; and
5. ability to work in a team.

**Course Contents**

Elements of digital computer design; control unit, micro-programming, bus organisation and addressing schemes; micro-processors, system architecture, bus control, instruction execution and addressing modes; machine codes, assembly language and high-level language programming, micro-processors as state machines; microprocessor interfacing: input/output; technique, interrupt systems and direct memory access; interfacing to analogue systems and applications to D/A and A/D converters; system development tools: simulators, EPROM programming, assemblers and loaders, overview of available microprocessor application.

**CPE 411: Hardware Design Techniques and Verification (2 Units E: LH 30)**

**Learning Outcomes**

Upon successful completion of this course, students will be able to demonstrate

1. adequate knowledge in digital electronics and digital design concepts;
2. ability to design and implement digital circuits under realistic constraints and conditions;
3. ability to debug, verify, simulate digital circuits;
4. ability to devise, select, and use modern techniques and tools needed for digital design; and
5. ability to work in a team.

Course Contents

Elements of digital computer design; control unit, micro-programming, bus organisation and addressing schemes; micro-processors, system architecture, bus control, instruction execution and addressing modes; machine codes, assembly language and high-level language programming, micro-processors as state machines; microprocessor interfacing: input/output; technique, interrupt systems and direct memory access; interfacing to analogue systems and applications to D/A and A/D converters; system development tools: simulators, EPROM programming, assemblers and loaders, overview of available microprocessor application.

**CPE 413: Research Methods (2 Units E: LH 30) Learning Outcomes**

Upon successful completion of this course, students will be able to:

1. Describe and explain key research concepts, issues, types of research and the systematic process of research gap identification and documentation and use contexts;
2. Search for, assembling and critically analysing research articles, papers and reports and general literature;
3. Formulate and evaluate research objectives, questions and hypotheses;
4. Developing a research proposal or industry project plan;
5. Identify and develop appropriate data acquisition and analysis methods and instrument;
6. Design/structure and lead the research process using appropriate research designs;
7. Use appropriate tools/techniques, including computer soft- and hardware /technologies to interpret, discuss and report/present the result and conclusions derived from research data analysis in oral or written form; and
8. Prepare/format/package research results/output for academic, journal articles, technical and other reports and exhibitions/fairs (scientific, trade, etc.) as an individual or team/work group.

**Course Contents**

Origins and definitions of research; problem identification and formulation; research types/design; qualitative, quantitative and mixed methods of research; measurement; sampling; data analysis; interpretation of data and technical report writing; use of encyclopedia, research guides, handbooks, academic databases for computing and computer engineering discipline; use of tools/techniques for research production: referencing formats/styles and software; research management and reporting best practices; plagiarism- definitions, types, detection software; basics of document analysis, systematic review and management methods; practical documentation/presentation projects/seminars.

**ECE 421: APPLIED ELECTRONICS II (3 Units)**

Feedback oscillators and the Berkhausen criterion. Practical oscillator circuits: phase-shift, Wien bridge, Hartley, Colpitt, Crystal, etc. Frequency stability of oscillators. Ideal operational Amplifier. Connection as non-inverting and inverting amplifier. The differential amplifier, transfer characteristics of the differential amplifier (Differential amplifier as a modulator and multiplier). Operational amplifier parameters (common-mode rejection ratio, offset voltages and currents etc) Class A, AB, B and push –pull power amplifiers. Analysis of power amplifiers and head sinks. Thermal stabilization. Complimentary and quasi-complimentary output stages. Application of analogue integrated circuits. Analysis and design of integrated operational amplifiers and advanced circuits such as wideband amplifiers, instrumentation amplifiers, multiplier circuits, voltage controlled oscillators and phase locked loops. Design techniques for advanced analogue circuits containing transistors and operational amplifiers

**ECE477 (CPE 405): Fundamentals of Software Engineering (2 Units C: LH 30)**

**Learning Outcomes**

Upon successful completion of this course, the student should be able to:

1. identify, formulate, and solve software engineering problems, including the specification, design, implementation, and testing of software systems that meet specification, performance, maintenance and quality requirements;
2. elicit, analyse and specify software requirements through a productive working relationship with various stakeholders of a software development project;
3. function effectively as a team member;
4. understand professional, ethical and social responsibility of a software engineer;
5. participate in design, development, deployment and maintenance of a medium scale software development project;
6. convey technical material through oral presentation to, and interaction with, an audience;
7. convey technical material through written reports which satisfy accepted standards for writing style;
8. use Unified Modeling Language in software specification documents; and
9. evaluate the impact of potential solutions to software engineering problems in a global society, using the knowledge of contemporary issues and merging software engineering trends, models, tools, and techniques.

**Course Contents**

Introduction to software engineering fundamentals; object-oriented programming; number representations; data structure and algorithms, Abstraction, modules and objects; designing for efficiency; object-oriented software design and implementation.

Overview of Software Engineering

Software; Nature of Software; Importance of Software; Differences between Software and hardware; characteristics of software that distinguishes it from other products people build. Types of software: Component – off – the – shelf (COTS), Bespoke, Differences between COTS and Bespoke. Application software. Middleware, Operating Systems, Utilities.
Software Engineering as a Profession
Profession as a body of knowledge, Code of Ethics and Professional Body regulating the profession; Software Engineering Code of Ethics and Professional Practice developed by ACM/IEEE – CS; Whistle-Blowing and Ethical Dilemma. Software Engineering and Practice. Software Ethics.

**ASE 471 SOFTWARE ENGINEERING DEVELOPMENT (3 units)**
The Engineering of Software
Software Development Layers; Software Development process and Case for processes in Software Engineering; Generic Activities during Software Engineering: Definition, Development and Support. Subdivision of Generic activity into actions, tasks and tasks sets. Software Engineering Generic Process Framework or Common Process Framework; The five Generic Process Framework Activities – Communication, Planning, Construction and Deployment; Umbrella Activities and Typical Umbrella Activities.
Software Engineering Life Cycles
Steps in Software Engineering Life Cycle – Requirements Elicitation; Systems Analysis and Specification; Systems Design, Implementation (Coding and Integration); Commissioning and Maintenance. Methods for Requirement Elicitation and Requirement Challenges. Waterfall model; Iterative and Incremental Development; Spiral Development; Rational Unified Process Development; Agile Development techniques; Extreme Programing Development techniques; Scrum; Test-driven development; Manual versus Automated Testing, Refactoring; Advantages and disadvantages of different software development method for an application.

**ASE 472 SOFTWARE ENGINEERING DEVELOPMENT using Object Orientation (3 units)**
Concepts of Object, class, attributes and methods in Object Oriented Analysis and Design; Object Oriented Design Principles: Abstraction. Modularization, Information Hiding. Unified Modeling Language (UML); Different types of diagrams used in UML and their uses; Use Case diagram as interaction between actors and the system itself; Class Diagrams and their representation; Class Associations: Generalization, Aggregation, Composition and Inheritance; State Diagrams and examples of Activity Diagrams; Component Diagrams; Deployment Diagrams.
Object Oriented Programming.

**EGR 498 (GET 499): Students Industrial Work Experience III (8 Units C: 24 weeks) Learning Outcomes**

Students on Industrial Work Experience Scheme (SIWES) are expected to:

1. be exposed and prepared for the Industrial work situation they are likely to meet after graduation, by developing their occupational competencies;
2. bridge the existing gap between theory and practice of programmes through exposure to real-life situations, including machines and equipment handling, professional work

methods and ethics, human relations, key performance assessment methods, and ways of safeguarding the work environment – human and materials;

3. experience/simulate the transition phase of students from school to the world of work and the environment seamlessly,and expose them to contacts for eventual job placements after graduation;
4. be motivated to identify the industrial and practice engineering challenges of their place of engagement and the larger society and creatively device impactful solutions to them; and
5. exploit the opportunity to improve and utilise their acquired critical thinking and innate creativity skills, during the program and SIWES Seminar presentation respectively.

**Course Contents**

On-the-job experience in industry chosen for practical working experience but not necessarily limited to the student's major (24 weeks from the end of the first semester at 400-Level to the beginning of the first semester of the following session. Thus, the second semester at 400-Level is spent in industry). Each student is expected to work in a programme related industry, research institute or regulatory agencies etc, for a period of 6 months under the guidance of an appropriate personnel in the establishment but supervised by an academic staff of the Department. On completion of the training, the student submits the completed Log book on the experience at the establishment., Also, there will be a comprehensive report covering the whole of the student's industrial training experiences (GET 299, GET 399 and GET 499), on which a seminar will be presented to the Department for overall assessment.

# 500 LEVEL

**GET 501: Engineering Project Management (3 Units C: LH 45)**

**Learning Outcomes**

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

1. explain the basics of project management as it relates to the Engineering discipline;
2. demonstrate knowledge and understanding of engineering, management and financial principles and apply these to their own work, as a member and/or leader in a team, to manage projects and in multi-disciplinary environments;
3. conduct, manage and execute projects in multi-disciplinary areas;
4. possess the skills needed for project management; and
5. work within the budget when executing a project for proper management.

**Course Contents**

Project management fundamentals – definitions, project environment, nature and characteristics, development practice, management by objectives, and the centrality of engineering to projects, infrastructures, national and global development. The scope of project management – organisational, financial, planning and control, personnel management, labour and public relations, wages and salary administration and resource management.

Identification of project stakeholders; beneficiaries and impacted persons – functions, roles, responsibilities. Project community relations, communication and change management. Project planning, control and timeliness; decision making, forecasting, scheduling, work breakdown structure (WBS), deliverables and timelines, logical frameworks (log frames), risk analysis, role of subject matter experts (SMEs), role conflicts; Gantt Chart, CPM and PERT. Optimisation, linear programming as an aid to decision making, transport and materials handling. Monitoring and Evaluation – key performance indices (KPIs); methods of economic and technical evaluation. Industrial psychology, ergonomics/human factors and environmental impact considerations in engineering project design and management. Project business case

- financial, technical and sustainability considerations. Case studies, site visits and invited industry professional seminars. General principles of management and appraisal techniques. Breakthrough and control management theory; production and maintenance management. Training and manpower development. The manager and policy formulation, objective setting, planning, organising and controlling, motivation and appraisal of results.

**GET 502: Engineering Law (2 Units C: LH 30)**

**Learning Outcomes**

Students will be able to:

1. describe and explain the basic concept, sources and aspects of law;
2. describe and explain the major differences between the various categories of law, courts and legal jurisdictions;
3. describe and explain legal principles and their application in professional engineering design and management services and their professional liability implications; and
4. develop reasoned analysis of real-life or hypothetical engineering scenarios using the legal principles undertake critical analysis of reliable information to develop, and practically present technical reports for use in varying judicial/quasi-judicial settings including as an expert witness.

**Course Contents**

Common Law: its history, definition, nature and division. Legislation, codification interpretation. Equity: definition and its main spheres. Law of contracts for Engineers: Forms of contract and criteria for selecting contractors; offer, acceptance, communication termination of contract. Terms of Contracts; suppliers' duties – Damages and other Remedies. Termination/ancellation of contract Liquidation and Penalties; exemption clauses, safety and risk. Health and Safety. Duties of employers towards their employees. Duties imposed on employees. Fire precautions act. Design for safety. General principles of criminal law. Law of torts: definition, classification and liabilities. Patents: requirements, application, and infringement. Registered designs: application, requirements, types and infringement. Company law. Labour law and Industrial Law. Business registration.

**ELE 505: Artificial Intelligence and Engineering Applications (3 Units C: LH 45)**

**Learning Outcomes**

Upon the completion of this course, the student shall be able to:

1. demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations;
2. apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning;
3. demonstrate awareness and good understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models;
4. demonstrate proficiency developing applications in an 'AI language', expert system shell, or data mining tool; and
5. demonstrate proficiency in applying scientific methods to models of machine learning.

**Course Contents**

Introduction to Artificial Intelligence: Intelligent Agents and Applications of Artificial Intelligence.

Knowledge Representation and Reasoning: Propositional logic, Theory of first order logic, Inference in First order logic, Forward and Backward chaining, Resolution, Probabilistic reasoning, Utility theory, Hidden Markov Models (HMM), Bayesian Networks.

**Machine Learning**: Supervised and unsupervised learning, Decision trees, Statistical learning models, Learning with complete data – Naive Bayes models, Learning with hidden data – EM algorithm, Reinforcement learning.

**Pattern Recognition**: Introduction, Design principles of pattern recognition system, Statistical Pattern recognition, Parametre estimation methods – Principle Component Analysis (PCA) and Linear Discriminant Analysis (LDA), Classification Techniques – Nearest Neighbour (NN) Rule, Bayes Classifier, Support Vector Machine (SVM), K – means clustering.

**ELE 507: Digital Signal Processing and Applications (3 Units C: LH 45)**

**Learning Outcomes**

On the successful completion of this course, the student should be able to:

1. specify the sampling, quantization, and signal conditioning requirements for a given DSP application;
2. identify components of a DSP hardware system and program a DSP processor in the C language;
3. estimate spectra of discrete-time signals using the fast Fourier transform (FFT) in MATLAB and implement the FFT on a DSP chip;
4. determine and interpret the z-domain transfer function of a discrete-time system and design discrete time filters in the z domain using the pole-zero method;
5. design finite impulse response (FIR) and infinite impulse response (IIR) discrete-time filters for lowpass, high-pass, bandpass, bandstop, and arbitrary frequency response applications;
6. implement digital filter designs in MATLAB and on a DSP chip; and
7. analyse discrete-time filter banks and multi-rate signal processing systems.

**Course Contents**

Review of discrete-time signals and systems with emphasis on sampling and quantization. Introduction to DSP hardware architecture, including fixed-point vs. floating-point processors and the multiply-accumulate unit. Convolution and spectral analysis using the discrete-time Fourier transform. The discrete Fourier transform, the fast Fourier transform (FFT), and use of the FFT for convolution and spectral analysis. Z- transforms, pole-zero analysis of discrete-time systems, and pole-zero-based digital filter design. Analysis of FIR and IIR discrete-time systems with emphasis on phase response. Design and implementation of FIR digital filters. Design and implementation of IIR digital filters. Introduction to multi-rate signal processing and filter banks.

**ELE 512: Industrial Electronics Design (3 Units E: LH 45)**

**Learning Outcomes**

Upon the successful completion of this course, students will be able to:

1. explain basic elements of Industrial motor control: determine the use of different control devices and motor starters;
2. understand fundamental elements of power electronics: diode-based rectifiers, harmonics and PF distortion, thyristor principles and control, tyristor-based rectifier and inverter;
3. explain the operation of cycloconverter; SCR-based converter and triggering range and firing angles;
4. analyse DC-to-DC switching converters, DC-to-AC switching converters and analyse PWM techniques in dc switching; and
5. understand electronic Control of DC and AC Motors.

**Course Contents**

Solid-state devices and circuits; Programmable controllers; Thyristors; Lasers; Fiber optics ; Power supplies; Op-amp circuits; Open- and closed-loop (feedback) systems; Input devices

;Output devices; AC and DC motors; Motor control devices; Robots and other motion control systems; Data communications.

**ELE 513: Embedded Systems Design and Programming (2 Units E: LH 30)**

**Learning Outcomes**

On the completion of the course, students will be able to:

1. analyse and explain the basic building blocks of embedded systems hardware;
2. identify relevant components and building blocks for embedded solutions;
3. evaluate different embedded system architectures;
4. describe the hardware and software architecture of processors used in embedded systems (2);
5. use embedded system development platforms and environments;
6. specify relevant embedded systems requirements such as memory, processor speed and energy consumption;
7. develop experience in assembler and C programming languages (5); and
8. build embedded system solutions with the help of common hardware interface units

**Course Contents**

Introduction to microcomputers and embedded systems: Processor architectures, microcontrollers used in embedded systems; CPU, memory and input output units; Interrupts; Introduction to hardware level programming of embedded systems: Programming in assembler, Programming in C, Development platforms for embedded software; Introduction to microcomputer interfaces: Digital I/O, Serial I/O, Timers, Analog- to-digital conversion, Pulse Width Modulation (PWM)

**ELE 519 & 529: Final Year Project I & II (5 Units C: LH 15; PH 180)**

**Learning Outcomes**

The student(s) will develop a technology and/or system to solve a known and significant electronic engineering problem and design and, where possible/practicable, build/produce/ manufacture some relevant new hardware/device(s) representing the solution using the skills acquired in the programme.

**Course Contents**

Individual student or group of students' projects undertaken to deepen knowledge, strengthen practical experience and encourage creativity, entrepreneurship and independent/team work (as may be the case). The project ends in a comprehensive written report of a developed system, and/or product/service and oral presentation/defense before a panel of assessors one of whom must be external to the University awarding the electronic engineering degree

**ECE551: Control Engineering (2 Units E: LH 30)**

**Learning Outcome**

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

1. have working knowledge of process control;
2. model engineering processes from first principles and use step response data;
3. design controllers for different process applications;
4. use the techniques, tools and skills related to process control, computer science and modern process control engineering in modern engineering practice; and
5. communicate system related concepts effectively.

**Course Contents**

Feedback concept, advantages, system classification, structures; Control system components

- mechanical, electronic hydraulic, thermal, position control; Transient analysis of servo- mechanism, signal regulators compensation techniques; Series/parallel feedback controllers. System transfer functions, signal flow graphs, stability, Routh-Hurwitz criteria.

**ECE 511: DIGITAL SYSTEMS DESIGN (3 Units)**

Controller design methods including microprogramming technique. Case Studies and Design Exercises on Programmable logic (Flash, CPLD, FPGAs). Use of Hardware description languages (VHDL or Verilog) for describing the implementations of digital logic. Implementation of counters, timing, finite-state machines. Simulation

and Synthesis of logic circuits. ASICS and DSPs. Timing Analysis. PCB design techniques.

**ECE 512: RELIABILITY ENGINEERING (2 Units)**

Elementary Reliability Theory. Introduction to Reliability, Maintainability and Availability. Reliability Block Diagram: series, parallel, series-parallel, redundant systems and types. Failure time distributions: derivation of hazard rate function, the bathtub curve, exponential model. Reliability Assessment at design phase: Fault-tree analysis, FMEA, FMECA, parts count analysis, parts stress analysis. Reliability assessment at production phase: Weibull analysis, Duane model and Reliability growth. Reliability Tests. Reliability of Electronic systems.

**ECE 521: INDUSTRIAL ELECTRONICS DESIGN (2 Units)**

The application of electronics to energy conversion and control; Phase-controlled rectifier / inverter circuits, dc/dc converters, and motion control systems; Characteristics of power semiconductor devices; diodes, bipolar and field effect transistors, and thyristors; Interfacing the analog and digital world; Transducers and their applications in sensing light, voltage, pressure, motion, current, temperature, etc; Mechanical relays, solid state relays, and stepping motors; Real-time control and remote control concepts in instrumentation; Microprocessor and microcomputer based systems; Fire alarm, burglar alarms, and general home and industrial instrumentation.

**ECE 524: SOLID STATE ELECTRONICS (2 Units)**

Review of the physics, theory, and technology of integrated circuit fabrication. Physics and properties of semi-conductors, including high field effects, carrier injection and semi-conductor surface phenomena, devices technology (e.g., BJT, FETs), bulk and epitaxal material growth and impurity control. Metal-semi-conductor interface properties. Stability and methods of characterization: controlled and surface-controlled devices. Physical electronics of semiconductor junction and MOS devices. Modeling of microelectronic devices and basic microelectronic circuit analysis and design. Relation of electrical behavior to internal physical processes; development of circuit models. Single-ended and differential linear amplifiers and other integrated circuits.

Basic processing techniques such as diffusing, oxidation, epitaxy, photolithography, chemical vapor deposition, and plasma etching. Introduction to Nanoelectronics.

**ECE 526: OPTOELECTRONICS (3 Units)**

The wave nature of light. Polarization. The principle of superposition, interference, diffraction. Reflection, refraction, and diffraction properties of light. Photoluminescence. Light emitting Diodes. Plasma displays, liquid crystal displays and numeric displays. Lasers: Radiation emission principles, Classes of lasers. Laser Applications. Photodetectors. Optical waveguides. Optical communication systems. Introduction to Holography.

**ECE 528: MEDICAL ELECTRONICS (3 Units)**

Basic physiological considerations for non-medical personnel. Patient safety code for electromedical apparatus. Transducers for monitoring physiological events. Electromedical instrumentation design. ECG and EMG amplifier design. Basic principles of electrical impedance measurements. Use of sonics and ultrasonics in medical electronics. The use of microprocessors in the design of electromedical instrumentation. Interfacing the analog and digital world as it applies to medical instrumentation. Principles and applications of mass transport and electrical signal generation for biological membranes, cells and tissues. Electrical properties of cells; ion transport; equilibrium, resting and action potential. Analysis of computation needs of clinical medicine. Architecture and design of healthcare information systems.

**ECE 540: INTRODUCTION TO RADAR AND NAVIGATION SYSTEMS (3 Units)**

Operation, history, applications. Radar Equation, Radar range, minimum detectable signal, noise, cross section of a target, transmitter power, antenna parameters. CW, Doppler, moving-target indication, tracking radar, laser radar. Radar transmitters, receivers and antennas. Propagation of radar waves. Airborne direction finders, air traffic control radar beacon, instrument low approach system, LORAN, microwave landing systems. Omega. Inmarsat.

**ECE 541: COMMUNICATION SYSTEMS (3 Units)**

Microwave frequencies and uses; microwave transmission in transmission lines and waveguides, microwave circuits: impedance transformation and matching. Passive microwave devices, resonant and filter circuits. Active microwave devices: Klystron and magnetron tubes and semi-conductor devices for microwave generation. Antennas: Antenna theory; definition of antenna parameters; practical antennas – dipole antenna, antenna arrays and parabolic antennas. Antenna design issues.

Electromagnetic wave propagation: propagation in the ionosphere, troposphere and in stratified media; principles of scatter propagation; applications in general broadcast: television and radio.

**ECE 542: TELECOMMUNICATION ENGINEERING (2 Units)**

Terminal Equipment: Analogue and Digital. Transmission modes. Switching and switches: Space and Time. Exchange stations: Private and Public. Multiplexing and De-multiplexing: Frequency (FDM) and Time (TDM). Fundamentals of channelization: Frequency (FDMA), Time (TDMA) and Code (CDMA). Spread spectrum. Public Switched Telephone Network (PSTN); Traffic and trunking. Public Switched Data Network (PSDN); Integrated Synchronous Digital Network (ISDN) and B-ISDN. Telecommunication network numbering system and services. Mobile communication technology. Satellite Systems: Earth stations, Space stations and Links. Fundamentals of microwave relay system and signal path estimation.

**ECE 544: MICROWAVE COMMUNICATION SYSTEM DESIGN (3 Units)**

Route and site selection: influence of terrain, weather, rain and obstructions. Calculation of path profiles. Use of aerial and topographical maps. System Noise Objectives. ITU-T/ITU-R international circuits. Choice of equipment: radio equipment, RF combiners, waveguides, antenna systems, radomes, repeaters and links. System reliability estimates. Calculation of the probability of outages due to propagation.

**ECE 546: COMMUNICATION NETWORKS (3 Units)**

Network planning principles; standards. Modeling and simulation basics: network traffics and network nodes. Queuing theory fundamentals, resources and services demand calculations; forecasting and QoS issues. Network reliability. ISO-OSI reference model. Network protocols: specification. SS7 Signaling fundamentals. Network protocol architectures basics: LAN, MAN, WAN (Internet), ISDN, B-ISDN, ATM and GSM networks: Architectures and Operations.

**ECE 548: TELEVISION AND RADIO (3 Units)**

The video signal, scanning, timing, synchronizing line and field frequencies. Transmission standards and systems. Television camera, tubes, the image orthicon and the vidicon-television broadcast and receiver systems. Radio broadcast and reception systems. International recommendations for sound and television broadcasting. Broadcasting studio and studio equipment. Compatibility, natural light, colour perception, three colour theory, luminance, Hue, and saturation colour television camera, the luminance signal, values of luminance (Y) and colour difference signals on colours. Polarity of the colour difference signals; colour TV display tubes; Delta-Gun colour picture tube.

**ECE 549: ELECTROACOUSTICS (3 units)**

The sound wave: propagation and characteristics. Basic principles of acoustics. Transducers. Microphones, loudspeakers: characteristics and applications. Electroacoustrical and electromechanical analogies, acoustics of buildings; reverberation time, sound equalization diffuse and free-field considerations, noise absorption and insulation. Recording and reproduction systems and media. Introduction to aultrasonics, applications.

**ECE 551: CONTROL ENGINEERING (3 Units)**

State-Space Representation of Linear Systems. State feedback. Realization of systems having specified transfer function: Transformation of System Models and Canonical Model Forms. Solutions of State Equations. Concepts of Controllability and Observability. Controllability and Observability Matrix. Modal control observers. Use of MATLAB, Simulink and Control Toolbox software. Applications in circuit synthesis and signal processing.

**ECE 552: ADVANCED CONTROL ENGINEERING (3 Units)**

Types of system nonlinearities, small perturbation methods, describing functions, phaseplane analysis. Principles of sampled systems. Applications of Z-transforms.

System performance and stability. State space analysis of control systems. The transition matrix. Controllability and observability, pole assignment. On-line computer control. Derivation of digital control algorithms. Microprocessor application. Introduction to adaptive control: Hill climbing and model reference adaptive systems. Lyapunov's direct method of stability analysis. Lyapunov's functions. Stability regions for sample non-linear systems. System identification and testing methods. Applications of statistical correlation techniques. Use of MATLAB, Simulink and Control Toolbox software.

**ECE 554: PROCESS CONTROL (3 Units)**

Study of control systems used in different fields of Engineering. Fundamentals of process control. Mathematical representation and analysis. Use of computers in process control. Process control design.

**ECE 556: LINEAR SYSTEM THEORY (3 Units)**

Review of elementary linear algebra. Eigenspaces. Vector space partitions. Vector matrix differential equations. The transition matrix. State space theory of linear dynamical systems. Reachability and pole assign ability. Introduction to optimal control with quadratic cost. The Lyapunov matrix equation and the matrix Ricatti

equation. Introduction to polynomial algebras leading to system theory in the Frequency domain. The system matrix. Introduction to Lyapunov stability theory. Random processes in dynamical systems. Use of MATLAB, Simulink and Control Toolbox software.

**ECE 562: AUTOMATION (3 Units)**

Computer-based test equipment. Faulting in digital systems; Introduction to Robotics; components and functions of robots; end effector; Robot co-ordinate systems; manipulator kinematics; robot programming.

**CPE 511: Machine Learning and Applications (3 Units C: LH 45)**

**Learning Outcomes**

On the successful completion of this unit, students should be able to:

1. identify the characteristics of datasets and compare the trivial data and big data for various applications;
2. select and implement machine learning techniques and computing environment that are suitable for the applications under consideration;
3. solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues;

4. understand and apply scaling up machine learning techniques and associated computing techniques and technologies;
5. recognise and implement various ways of selecting suitable model parametres for different machine learning techniques; and
6. integrate machine learning libraries and mathematical and statistical tools with modern technologies like hadoop and mapreduce.

**Course Contents**

Introduction to machine learning; ; introduction to R or Python for machine learning: statistics for analytics: descriptive statistics, inferential statistics, estimation and hypothesis testing, ANOVA; machine learning: unsupervised learning – clustering, supervised learning – classification, decision trees, random forest, and model performance measures.

**ECE 571: MICROPROCESSOR SYSTEMS (3 Units)**

Hardwired logic contrasted with programmed logic. Microcomputer applications. Elements of microcomputer architecture: bus, microprocessor, memory, input-output, peripherals. Single chip and multi-chip microcomputers. Overview of available microcomputer systems. Internal architecture: 3-bus concept, microprocessor operation. Microprocessors as state machines. Microprocessors instruction set; Instruction format, addressing modes; instruction execution. Comparison of available microprocessors. Machine language, assembly language and high level language programming. Synthesis of combinational logic circuits with ROMS and PLA's.

**ECE 572: COMPUTER SYSTEMS DESIGN (3 Units)**

Advanced computer architecture, parallel processing. Elementary CUP design, performance improvement techniques. Interface design techniques. Interface and bus standards. Interfacing to common peripherals such as disc drivers and monitor. Common interface cards in microcomputers. Computer security: threats to computer software and hardware. Viruses. Hardware and software techniques for protecting computers. Computer networking. Further computer applications. Selecting and configuring computer systems for various applications. Current trends in all types of computer.

**ECE 574: DIGITAL SIGNAL PROCESSING (2 Units)**

The concepts of sampling. Quantization and Aliasing. Discrete-time signals and systems, discrete convolution. The Z-transform. Z-plane poles and zeros. Discrete Fourier series. Discrete Fourier Transform; Fast Fourier Transform. Concept of digital filtering. Types of digital filters and their properties. Digital transfer function. One-dimensional recursive and non-recursive filters. The approximation problem in network theory. Synthesis of low-pass filters. Spectral transforms and their application in synthesis of high-pass and band-pass filters. Computer techniques in filter synthesis. Convolution in MATLAB. Digital Signal Processing using MATLAB. Digital transfer function. One-dimensional recursive and non-recursive filters. Sampling in MATLAB

**ECE 576: MICROPROCESSOR SYSTEMS DESIGN (3 Units)**

Elements of microcomputer design; memory design; design of minimum 8-bit microcomputer. Introduction to 16 and 32 bit microprocessors, coprocessors, Digital Signal Processing Chips and Bit Slice Processors. Advanced architectural features and methods of improving system performance such as pipelining, cache memory, parallel processing etc. Current trends in microprocessor architecture. Multiprocessing systems. Introduction to the transputer. Advanced microprocessor applications.

**ECE 577: Artificial Intelligence and Engineering Applications (3 Units C: LH 45)**

**Learning Outcomes**

Upon the completion of this course, the student shall be able to:

1. demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations;
2. apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning;
3. demonstrate awareness and good understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models;
4. demonstrate proficiency developing applications in an 'AI language', expert system shell, or data mining tool; and
5. demonstrate proficiency in applying scientific methods to models of machine learning.

**Course Contents**

Introduction to Artificial Intelligence: Intelligent Agents and Applications of Artificial Intelligence.

Knowledge Representation and Reasoning: Propositional logic, Theory of first order logic, Inference in First order logic, Forward and Backward chaining, Resolution, Probabilistic reasoning, Utility theory, Hidden Markov Models (HMM), Bayesian Networks.

**Machine Learning**: Supervised and unsupervised learning, Decision trees, Statistical learning models, Learning with complete data – Naive Bayes models, Learning with hidden data – EM algorithm, Reinforcement learning.

**Pattern Recognition**: Introduction, Design principles of pattern recognition system, Statistical Pattern recognition, Parametre estimation methods – Principle Component Analysis (PCA) and Linear Discriminant Analysis (LDA), Classification Techniques – Nearest Neighbour (NN) Rule, Bayes Classifier, Support Vector Machine (SVM), K – means clustering.

**ECE 578: ARTIFICAL INTELLIGENCE AND ROBOTICS (3 Units)**

An introductory description of the major subjects and directions of research in AI programming techniques, basic problem solving techniques, knowledge acquisition and representation, AI languages (LISP and PROLOG). Others include computer interface, machine learning, natural language understanding, knowledge-based and expert systems, computer vision, robotics, relationship of AI to software engineering and database methodology. Societal impact of AI and Robotics. The use of Python programming language in Artificial Intelligence and Robotics. Machine vision and pattern recognition. Applications of identification trees, neural nets, genetic algorithms, and other learning paradigms.

**ECE 592: DEGREE PROJECT (4 Units)**

The aim of the final year project is to enable a student carry out an investigation in depth on a suitable topic in electronic engineering. The execution of a project usually involves the student in some oral of the following activities: library research design, construction, testing, practical investigation, computer programming. The student presents a mini-thesis and undergoes an oral examination.

**ASE 502 SOFTWARE ENGINEERING PROJECT MANAGEMENT (3 units)**

Why Software Engineering Project Management. Project Management Concepts: People; Products; Process and Projects. The Scope Triangle: Quality, Time and Cost; Tradeoffs

inherent in Software Project Management. Managing most important resource – People; Project Staffing; Team Work.
Managing the Software Development Process
Estimating Software Projects; Contracts; Project planning and monitoring; Project Scheduling; Costing and Budgeting; Models of Software projects.
Quality Management
Software Quality; Why software fails; Concepts in Quality Assurance; Software Standards; Reviews and Inspections; Capability Maturity Modeling; ISO 9000 Standards; Metrics.
Risk Management
Software Risks: Characteristics of High Risk Projects; Risk Analysis and Management; Relationship between Software Risks and Software Failures: Likelihood of Failure, Impact of Failure; Checklist for Software Risks.

**ASE 571 Web Engineering (3 Units)**
Computing Technologies: The Internet and the Web; Impact. Attributes of Web-based Applications (WebApps); Framework for Web Engineering (WebE)
Web Development
Requirements for High Quality WebApps: Design Goals; Design Pyramid for WebApps: Interface Design; Aesthetic Design; Content Design; Architectural Design; WebApp Architecture: Model-View-Controller (MVC) Architecture; Navigational Design, WebE Team. Website Design; Web Portal Design; Web Project Management.

**ASE 572 IMAGE PROCESSING (3 UNITS)**
Overview of Images and Image Processing. Image acquisition and sampling theory. Image transformations: Fourier, Discrete Cosine and Wavelet. Image transformations using MATLAB toolboxes. Histogram processing and linear filtering. Neighbourhood operations. Spatial filtering in MATLAB. Frequency domain filtering in MATLAB. Image noise reduction. Spatial and adaptive noise filters. Image registration. Image Segmentation.

**ASE 573 COMPONENT-BASED SOFTWARE DEVELOPMENT (3 units)**
Modern software development techniques. Design and development of component based software using Java and C++. Modeling, analysis and visualization using data structures and algorithms. Sorting and searching algorithms. Numerical simulation techniques. Network methods and e-business applications.

**ASE 574 BIOMETRICS RECOGNITION (3 UNITS)**
Introduction to Biometrics. Fingerprint, face, iris, voice, gait, retina, hand geometry, finger vein and other biometric characteristics. Biometric acquisition and sensing devices. Biometric performance metrics. Biometric statistical analysis. Performance evaluation and error rates – false accept rates, false reject rates, equal error rates, detection error tradeoffs, receiver operating characteristics. Biometric evaluation using MATLAB. Formation of biometrics feature descriptors and matching algorithms.

**ASE 575 Cyber Security (3 Units)**
The Security Landscape. Threats, Attacks, Attackers or Adversaries; Types of attacks and attackers. Vulnerabilities. Data Protection: Confidentiality, Integrity and Availability. Access Control – Identification, Authentication Techniques, Authorization; Password. Biometric Security. Privacy and Anonymity. Basic Cryptography; Certificates. Skill Gaps in Cyber Security; Cybercrime and Cybercrime “as-a-service”. Framework for applying Cyber Security. Viruses and malware.

**ASE 577 COMPUTER VISION (3 UNITS)**
Overview of computer vision methods. Computer vision and biometric image processing. Machine and deep learning applied to biometrics.

# Minimum Academic Standards

## Equipment

| | | |
|---|---|---|
| 3 | 3φ Synchronous motor | |
| 4 | 3φ Squirrel cage induction motor | |
| 5 | 3φ slip ring induction motor | |
| 6 | 1φ Alternator | |
| 7 | D.C Generator (series, shunt, compound) | |
| 8 | 3φ Sq. Cage induction motor | |
| 9 | D.C compound motor | |
| 10 | 3φ Auto transformer | |
| 11 | 1φ capacitor start capacitor run induction motor (Crompton greaves) | |
| 12 | 1φ, split phase induction motor | |
| 13 | 1φ repulsion motor | |
| 14 | 1φ shaded pole induction motor | |
| 15 | Universal motor (ac/dc) | |
| **Control and Instrumentation Laboratory** | | |
| 1 | Linear Variable Differential Transformer MODULE KIT | Or Equivalent |
| 2 | Temperature measurement trainer kit | |
| 3 | Strain measurement trainer kit | |
| 4 | Process control simulator | |
| 5 | temperature control system | |
| 6 | Synchros transmitter and receiver trainer kit | |
| **Machine Design and Simulation Laboratory** | | |
| 1 | Computer set (Workstation) | Or Equivalent |
| **Power Electronics / Electrical Drives Laboratory** | | |
| 1 | Chopper / inverter PWM Controller | Or Equivalent |
| 2 | 3Ph. Converter firing unit | |
| 3 | SCR pulse controller with 3Ph. SCR module | |
| 4 | Intelligent power module | |
| 5 | Smart power module with chopper/ inverter PMW controller | |
| 6 | fully controlled converter power circuit | |
| 7 | 3Ph. isolation transformer | |
| 8 | Series inverter kit | |
| 9 | Cosine law triggering of ac/dc converter | |
| 10 | 3Ph. IGBT based PWM inverter | |
| 11 | Chopper inverter | |
| 12 | 1Ph. capacitor start motor | |
| 13 | DC shunt motor | |
| 14 | 3 Ph. induction motor with GEP sensor | |
| 15 | 3Ph. slip ring induction motor | |

| | | |
|---|---|---|
| 16 | 1Ph. isolation transformer | |
| 17 | 3Ph. diode bridge trainer kit | |
| 18 | TRIAC voltage control kit | |
| **Power System Laboratory** | | |
| 1 | Idmtover current relay of earth fault testing kit | Or Equivalent |
| 2 | Microprocessor based over/under voltage relay with testing kit | |
| 3 | Percentage biased differential relay with testing kit | |
| 4 | High voltage oil testing kit | |
| 5 | Single phase transmission line kit | |
| **High Voltage Laboratory** | | |
| 1 | Impulse generator with voltage divider | Or Equivalent |
| 2 | Lightning impulse setup (can be used for universal purposes) | |
| 3 | Cascaded transformers | |
| 4 | Digital partial discharge detectors | |
| 5 | Capacitance and loss angle measuring bridge | |
| 6 | Modules (capacitors, resistors, spark gaps, rectifiers, pressure vessels etc.) | |
| 7 | Dielectric frequency response analyser | |
| 8 | RTDS (Real Time Digital Simulator) | |
| 9 | Omicron CMC 356 and 256 with GPS synchronisation (universal testing solutions) | |
| 10 | Omicron Dirana (Insulation Diagnosis) | |
| 11 | Omicron CPC 100, with current boost up to 2000A | |
| 12 | Portable impulse generator | |
| 13 | Voltage and current probes, including Rogowski current probes | |
| 14 | Tektronix oscilloscopes 4054 B, 2014 and TBS 2000 Differential and distance relays that can be used to test different protection strategies. | |
| **Microprocessor Laboratory** | | |
| 1 | 8051 Based MC Trainer Kit | Or Equivalent |
| 2 | DC Motor Speed Measurement and Control | |
| 3 | EPROM Programmer | |
| 4 | Logic Controller Interface | |
| 5 | Thyristor SCR Trainer Pulse Generator | |
| 6 | 89C51 CPU Card | |
| 7 | 80196 CPU Card | |
| 8 | ADUC 812 CPU card | |
| 9 | C-Cross Compiler for 8051 | |
| 10 | PC Keyboard and LCD Display Card | |
| 11 | Measurement Card | |
| 12 | Relay Card | |
| **Renewable Energy Laboratory** | | |
| 1 | Alternative Renewable Energy Trainer (RENY0001) | Or Equivalent |
| 2 | Photovoltaic Solar Energy Unit Trainer (RENY0004) | |
| 3 | Fuel Cell Teaching Experiment Platform | |
| 4 | Portable Solar Power Experiment Box | |
| 5 | Power Battery Management System Test Bench | |
| 6 | Portable Solar Power Experiment Box | |
| 7 | Power Battery Management System Test Bench | |
| 8 | Solar PV modules with stand | |
| 9 | Solar Stand (Tilting) | |

| | | |
|---|---|---|
| 10 | Channel Data logger system with the following Sensors: Anemometer Sensor; Silicon Type pyranometer sensor; Surface temperature sensor. | |
| **Electrical Workshop** | | |
| 1 | Transformer Oil Testing Kit | Or Equivalent |
| 2 | 3 Phase Induction Motor (Winding Study) | |
| 3 | Coil Winding Machine | |
| 4 | Megger Metre | |
| 5 | Hand Operated Crimping Tool | |
| 6 | Single Phase Induction Motor | |
| 7 | Cathode Ray Oscilloscope | |
| 8 | Cable Fault Locator | |
| 9 | Power Drilling Machine | |
| 10 | Wattmeters and Energymeters | |
| 11 | Galvanometers and Voltmeters | |
| 12 | Ammeters and Multimeters | |
| 13 | Function Generators | |
| 14 | Soldering iron | |

## Minimum Academic Standards

## Equipment

### List of Required New Laboratories and Equipment

| S/N. | Laboratory/Workshop | Essential Equipment and Components |
|---|---|---|
| 1 | Basic Electrical Engineering Lab (Applied Electricity Laboratory) | Dual Power Supplies; Digital Multimetre, Various electronic components (ICs, BJTs, MOSFETs, Diodes, Resistors, Capacitors, Inductors, etc.). PCs loaded with software for electronic circuits simulation |
| 2 | Electronics and PCB Laboratory | PCs with specialised electronics design software, Oscilloscopes (Digital and Analogue), Function generators, Analogue training kits, Digital training kits, Breadboards. Various electronic components (ICs, BJTs, MOSFETs, Diodes, Resistors, Capacitors, Inductors, etc.). PCs loaded with software for electronic circuits simulation PCB making machine including: Art Work Film Maker, Curing Machine (Oven), Dip Coating Machine, U.V Exposure Unit, Etch Etching Machine,Chemicals for PCB Processing |

| | | |
|---|---|---|
| 3 | Digital Electronics and Microprocessor Lab | Dual Power Supplies, Digital multimetre, Digital IC Testers, Microprocessor kits, EPROM Programmer/Eraser, Interfacing cards for Process applications, Micro-controller kits with PC Interface, Texas Instruments DSP Kits, Analog Devices DSP, PCs with simulation softwares (Proteus Pro, MATLAB + relevant tool boxes) |
| 4 | Data Communication Lab | Function Generators, Oscilloscopes (Analogue and Digital Storage), Signal Generators, Various Analog /Digital Study and Trainer Kits, Fiber Optic Trainer Kits, Digital Communication Training kits, Amplitude Modulation/Demodulation Trainer Frequency Modulation/Demodulation Trainer, Pulse Code, Network analyseanalyser and Spectrum AnalyseAnalysers, SWR Metre, Power metre, Optical power metre, Industrial standard simulation tools such as OPNET, MATLAB for signal processing. |
| 5 | Data Communication and Networking Lab | Computer System with latest specifications, 19" Rack, Port Switch, Windows 2003 Server or Latest version (10 user License), Red hat Linux (20 user License), Data Backup utility Software, Data Communication Trainer Board, LAN Trainer System, Trainer Boards to study Frequency Division Multiplexing/ Demultiplexing and Time Division Multiplexing/ Demultiplexing, Digital Multimetre, Wireless access points, Wi-Fi LAN Cards, Network/Bandwidth management Software (Cybernetra or Equivalent), Trainer Board to study Working of MODEM, LAN Cable tester, Crimping tool, Display Boards of various types of cables and connectors used in Computer networks, Online UPS (5 KVA), Network Printer, Antivirus (10 user License) |
| | Embedded Systems Lab | Microcontroller kits, Target board, DSP Starter kits, Modeling and Simulation software (MATLAB), PC-Based Oscilloscope, Linux Single Board computer, FGPA Evaluation kit, Xilinx Embedded Development kit |
| | Instrumentation and Control Lab | Workstations equipped with LABVIEW and MATLAB for designing and simulating analog and digital controllers; transducers and trainers. |
| | Final Year Project Lab | |

**Staffing Academic Staff**

The NUC guidelines on staff/student ratio of 1:15 for Engineering and Technology departments shall apply. However, there should be a minimum of six full-time equivalents of Staff in the department. There is need to have a reasonable number of Staff with doctoral degrees as well as sufficient industrial experience. With a minimum load of 15 Units per semester for students and a minimum of six full-time equivalent of staff in each programme, staff should have a maximum of 15 contact hours per week for lectures, tutorials, practical's and supervision of projects.

NUC requirement encourages all academic staff to have PhD degrees; hence appointment of academic staff is preferably to the Lecturer cadre. Only in exceptional cases are candidates with great promise appointed to Graduate Assistant and Assistant Lecturer positions for the purpose of being developed to the Lecturer cadre as registered PhD candidates.

**Academic Support Personnel**

Teaching Assistant/Demonstrators to help lecturers in the conduct of tutorials, practical's and field work. This category of personnel is not expected to be regular staff as they are to be paid on the basis of approved hourly rate.

**Administrative Support Staff**

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

**Technical Support Personnel**

The services of technical support staff, which are indispensable in the proper running of laboratories and workshop/studios 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. The minimum of academic staff to technical staff ratio of 5:1 should be maintained.

**Minimum Number of Staff**

Subject to the general standards specified by NUC:

1. there should be a minimum of two PhDs and four M.Eng degree holders full-time academic staff to mount the programme;
2. each workshop or laboratory should have an adequate number of staff with the right mix, such that each unit or section in that workshop or laboratory can run efficiently; and
3. there should be an adequate number of administrative staff of the appropriate caliber for the office of the Head of Department to run.

**Student/Staff Ratio**

The minimum staff-to-student ratio should be 1:15 from 200 level to 500 level.

**Library**

In addition to the university and faculty libraries, the programme must have a departmental library that is well equipped with specialized books and journals in both physical collections and E-collections (E-Resources) of various types. Various field and research reports of the programme must also be available in the library for staff, students and researchers.

The library must be connected to subscribe repository of:

1. Institutions (national and international)
2. Open access sources
3. Professional Bodies' e-learning platforms
4. Relevant international organizations

The library must also have adequate facilities for the following:

1. reading;
2. provisions for lending; and
3. reservation unit for specialized materials.

## Classrooms, Laboratories, Workshops, Clinics and Offices

The NUC recommends the following physical space requirement:

| **Academic** | **m²** |
|---|---|
| Professor's Office | 18.50 |
| Head of Department's Office | 18.50 |
| Tutorial Teaching Staff Space | 13.50 |
| Other Teaching Staff Space | 7.00 |
| Technical Staff Space | 7.00 |
| Science Staff Research Laboratory | 16.50 |
| Engineering Staff Research Laboratory | 14.50 |
| Seminar Space per student | 1.85 |
| Drawing Office Space (A.O. Board) (Per Student) | 4.60 |
| Drawing Office Space (A.I. Board) (Per Student) | 3.70 |
| Laboratory Space | 7.50 |
| Non-Academic | |
| Secretarial Space | 7.00 |

## Office Accommodation

The requirements for office accommodation are:

1.13 academic offices on paper

2. 1 professorial type in the department. Size: each of the office is about 13.5 m

| **S/N** | **Office** | **No in Room** | **Facilities** |
|---|---|---|---|
| 1. | HOD | 1 | Table, chairs, A/C, filing cabinet, bookshelves, computer unit, Secretary and facilities. |
| 2. | Professor | 1 | Table, chairs, A/C, filing cabinet, bookshelves, computer unit, Secretary and facilities. |
| 3. | Reader | 1 | Table, chairs, A/C, filing cabinet, bookshelves, computer unit. |
| 4. | Senior Lecturer | 1 | Table, chairs, A/C, filing cabinet, bookshelves, computer unit. |
| 5. | Lecturer I | 2 | Table, chairs, fan, filing cabinet, bookshelves. |
| 6. | Lecturer II | 3 | Table, chairs, fan, filing cabinet, bookshelves. |