UNIVERSITY OF NIGERIA

Faculty of Engineering

Department of Electrical Engineering

Revised Five-Year Standard Undergraduate Degree Programme in Electrical Engineering

2017

Revised Five-Year Standard Undergraduate Degree Programme in Electrical Engineering

Brief History of the Department

The teaching of Engineering in the University of Nigeria was started in October 1961 by a team of workers from the Netherlands University Foundation for International Cooperation. The foundation was entrusted with the major responsibility of developing the Engineering Programme. The first teaching staff in Electrical Engineering was recruited in the 1962/63 academic year and comprised three lecturers. The foundation lecturers were highly motivated and committed. They fashioned and developed for the first intake of Electrical Engineering Students at the University of Nigeria an innovative curriculum designed for the needs of a new nation.

The postgraduate programme started in 1982, offering Masers and PhD programs in Electric Power Systems, Electrical Machines and Drives System, Automatic Control Systems and Power Electronics and New Energy Systems.

In 1995 the main laboratory was gutted by fire, it took until 2012 for the building to be rebuilt and this time it was expanded and modernized. In 2010, the pre-fabricated wooden building housing the offices and classrooms was also gutted by fire and the entire department now has to be relocated to the rebuilt laboratory. At present, the department can boast of 24 academic staff members, 15 technical staff and three administrative staff.

Philosophy

The Department of Electrical Engineering, University of Nigeria, a non-sectarian, public educational institution, believes in the pursuit of knowledge, values and skills necessary for the improvement of the Nigerian society. It has faith in the dignity of the human person, in the democratic process, in the reward for individual excellence, in the freedom of a person to worship God according to his conscience without imposing it others and respect for constituted authority. Thus, the department believes that the development of the individual as a person and worker is an effective means in building a better family, community and nation, and a better world.

Objectives

The objectives of the five-year undergraduate degree programme in Electrical Engineering are to train men and women of all races to:

- design, develop and install electrical equipment and systems including renewable energy systems;
- operate and maintain electric power systems, drives, control systems, etc
- grow through industrial practice,

- further studies and research in the development of improved electrical devices and systems and in the advancement of Electrical Engineering knowledge.

Scope

The program includes both practical and theoretical courses. The students' undertake laboratory workshop practices and experiments in basic electrical engineering technologies. They are updated by undertaking lectures in general sciences like Chemistry, Physics and Mathematics. They then pursue general engineering knowledge in all fields of engineering embarking on theoretical and practical workshop practices. With these, the candidates are equipped to undertake courses in Electric Circuits, Electronic Systems, Electric Power Systems, Electrical Machinery, Electromagnetic Fields and Waves, New Energy Systems, Power Electronics, High Voltages Systems and Control Systems.

Job Opportunities

Graduates are properly equipped to take on challenging jobs such as design, development and production of hardware and software for industries such as Electric Power Systems, Production companies, Construction firms, Software Companies, Oil Companies etc. There are also numerous job opportunities in Mining, Research Institutes and Academic Institutes.

Entry Requirements

The minimum entry requirement is five ordinary credits level passes including English Language, Chemistry, Physics and Mathematics obtained in not more than two sittings. Combination of the O-level results obtained from any two of Senior Secondary School Certificate or West African School Certificate Examination or General Certificate of Education Examinations or National Examination Commission (NECO) is acceptable.

Stress Areas

Codes	Stress Areas
0	Foundational Courses
1	Circuits and Systems
2	Electronics in Power
3	Power Systems
4	Communications in Power
5	Laboratories
6	Electrical Machines and Drives
7	Measurement, Instrumentation, Computer and Control Systems
8	Electromagnetics, Fields and Waves
9	Projects, Field work and Technical Writing

COURSE OUTLINE

FIRST YEAR

FIRST SEMESTER

COURSE CODE		TITLE	CREDIT UNITS
		Major Course	
EGR	101	Introduction to Engineering	2
		Required Ancillary Courses	
MTH	111	Elementary Mathematics I	3
MTH	112	Elementary Mathematics II	3
PHY	121	Fundamentals of Physics I	3
PHY	195	Practical Physics II	2
CHM	101	Basic Principles of Chemistry	2
CHM	171	Basic Practical Chemistry	2
		General Studies Courses	
GSP	101	Study Skills and Basic Research Methods	2
GSP	111	The Use of Library and Study Skills	2
		TOTAL	**21**

SECOND SEMESTER

COURSE CODE		TITLE	CREDIT UNITS
		Major Course	
EGR	102	Applied Mechanics	3
		Required Ancillary Courses	
MTH	122	Elementary Mathematics III	3
PHY	116	General Physics for Physical Sciences	2
PHY	124	Fundamentals of Physics III	3
CHM	112	Basic Principles of Physical Chemistry	2
CHM	171	Basic Principles of Organic Chemistry	2
		General Studies Course	
GSP	102	Basic Grammar and Varieties of Writing	2
		TOTAL	**17**

SECOND YEAR

FIRST SEMESTER

COURSE CODE		TITLE	CREDIT UNITS
		Major Course	
EEE	211	Basic Electrical Engineering	3
		Required Ancillary Courses	
CVE	211	Strength of Materials I	2
CVE	212	Strength of Materials Laboratory	1
EGR	201	Materials Science	2
MEC	211	Engineering Drawing	2
MEC	261	Thermodynamics I	2
MTH	207	Advanced Mathematics VII	2
		General Studies Courses	
GSP	201	Basic Concepts and Theories of Peace and Conflict	2
GSP	207	Logic, Philosophy and Huma Existence	2
		TOTAL	**18**

SECOND SEMESTER

COURSE CODE		TITLE	CREDIT UNITS
		Major Course	
EEE	251	Basic Electrical Engineering Laboratory Practice	1
		Required Ancillary Courses	
ECE	271	Engineering Computer Programming	3
ECE	281	Engineering Computer Programming Laboratory	1
CVE	221	Fluid Mechanics I	2
CVE	211	Fluid Mechanics Laboratory	1
MEC	261	Workshop Technology I	2
MTH	206	Advanced Mathematics VI	2
MTH	208	Advanced Mathematics VIII	2
		General Studies Courses	
GSP	202	Issues in Peace and Conflict Resolution	2
GSP	208	Nigerian Peoples and Culture	2
		TOTAL	**18**

THIRD YEAR

FIRST SEMESTER

COURSE CODE		TITLE	CREDIT UNITS
		Major Courses	
EEE	313	Circuit Theory I	3
EEE	351	Electrical Machines Laboratory	1
EEE	361	Electrical Machines I	3
EEE	371	Measurement and Instrumentation	3
EEE	381	Electromagnetic Fields and Waves I	2
		Required Ancillary Courses	
ECE	321	Physical Electronics	3
ECE	381	Physical Electronics Laboratory	1
STA	205	Statistics for Physical Sciences and Engineering	2
CED	341	Introduction to Entrepreneurship I	2
		TOTAL	**20**

SECOND SEMESTER

COURSE CODE		TITLE	CREDIT UNITS
		Major Courses	
EEE	314	Circuit Theory II	2
EEE	322	Applied Electronic Systems	2
EEE	332	Electric Power Systems Principles	3
EEE	352	Electrical Power Systems Laboratory	1
EEE	354	Measurement and Applied Electronics Laboratory	1
EEE	356	Electrical Drives Laboratory	1
EEE	382	Electromagnetic Fields and Waves II	2
EEE	362	Electrical Machines II	2
		Required Ancillary Courses	
EGR	302	Engineering Analysis	4
CED	342	Introduction to Entrepreneurship I	2
		TOTAL	**20**

FOURTH YEAR

FIRST SEMESTER

COURSE CODE		TITLE	CREDIT UNITS
		Major Courses	
EEE	421	Power Semiconductor Devices and Circuits I	2
EEE	441	Communication Principles	3
EEE	451	Communications and Fields Laboratory	1
EEE	453	Control and Logic Systems Laboratory	1
EEE	461	Electrical Machines III	2
EEE	471	Digital Signal Processing	2
EEE	473	Control Logic Circuit Design	2
EEE	475	Control Systems Engineering I	3
		Required Ancillary Course	
EGR	401	Computational Methods	3
		TOTAL	**19**

SECOND SEMESTER

COURSE CODE		TITLE	CREDIT UNITS
		Major Courses	
EEE	492	Mini Projects	3
EEE	494	Seminar and Industrial Visits	3
EGR	402	Student Industrial Work Experience Scheme (SIWES)	10
		TOTAL	**16**

FIFTH YEAR

FIRST SEMESTER

COURSE CODE		TITLE	CREDIT UNITS
		Major Courses	
EEE	521	Power Semiconductor Devices and Circuits II	2
EEE	531	Electric Power System Analysis, Planning and Protection	3
EEE	533	Switchgear and High Voltage Engineering	2
EEE	541	Power Systems Communication and Control	2
EEE	561	Electrical Machines Design	2
EEE	581	Electromagnetic Fields and Waves III	2
EEE	573	Computer Software and Applications	2
		Electives (Any Two Courses Should Be Taken)	
EEE	535	Power System Distribution	2
EEE	537	Power System Optimization	2
EEE	571	Computer Organization	2
		TOTAL	**19**

SECOND SEMESTER

COURSE CODE		TITLE	CREDIT UNITS
		Major Courses	
EEE	512	Renewable and New Energy Systems	3
EEE	522	Application of Semiconductor Devices in Power Systems	2
EEE	532	Electrical Services Design, Reliability and Maintainability	3
EEE	572	Control Systems Engineering II	3
EEE	592	Project	4
		Electives (Any Two Courses Should Be Taken)	
EEE	562	Electric Motor Drives	2
EEE	574	Discrete Control Systems	2
EEE	576	Introduction to Optimal Control	2
		TOTAL	**19**

COURSE DESCRIPTION

EEE 211: ELECTRICAL ENGINEERING I **3 credit units**

SI System of Units

Electrostatic and Electromagnetic Fields: Electric Field Intensity, Potential and Potential Difference. Magnetic Field Intensity, Flux and Flux Density, Magnetic Circuits, Inductors. Direct Current (DC) Circuit Analysis: Kirchoff's Law, Mesh and nodal equations, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer. Transients: Resistive-inductive (RL) and Resistive-Capacitive (RC) Circuits. Alternating Current (AC) Circuit Analysis: Alternating Current, voltage, frequency, phase angle, maximum, rms. and average values of waveforms. Inductive and capacitive reactance; power in AC circuits; Use of complex algebra in the solution of AC circuits; Resonance. Transformers. AC and DC Machines: Principles of operation; Circuit models for transformers and machines. Three phase AC system: Three phase balance system; Delta/star connections; line and phase voltages and currents. Measurement: Electric current, voltage, frequency and power measurements; measurement of resistance, capacitance and inductance. Bipolar and Field Effect Transistors-biasing, dc characteristics diode characteristics and diode rectifiers (Single phase and Three phase); Zener diodes and its regulating characteristics.

EEE 251: BASIC ELECTRICAL ENGINEERING LABORATORY - 1 credit unit

Resistance measurement, condition for maximum power transfer, Inductance and capacitance measurement, verification of network theorems, Alternating Current (AC) series circuits, Measurement of power and power factor, excitation of Direct Current (DC) generator, load characteristics of a shunt DC motor, load characteristics of separately excited DC motor, Open and short circuit test for a transformer, static characteristics of junction diode and transistor; Half and full wave rectification; determination of copper temperature co-efficient by Wheatstone Bridge, Measurement of voltage, current and power in three phase star/delta connections, simple domestic installation practices.

EEE 313: CIRCUIT THEORY I – 3 credit units

Network Theorems and Network Topology: Networks Theorems, Telegen's Theorem, The Duality Principles; Network Topology; General steady state and transient network solutions. Network Transformations; state space formulation of networks. Magnetically coupled networks. Resonance in networks. Time domain analysis of network: Application of integro-differential equations to network; Initial and final conditions. Forced responses and natural behaviour. Step and Impulse responses.

EEE 314: CIRCUIT THEORY I – 3 credit units

Frequency domain analysis of networks:, Network functions; poles and zeroes; frequency response curve; Bode plots and Nyquist plots. Signal classification: Fourier series and periodic signals; Fourier integral and non-periodic signals; Application of Fourier series in network analysis. Network Synthesis: Introduction to passive network synthesis. Computer aided analysis of linear and non-linear circuits.

EEE 322: APPLIED ELECTRONIC SYSTEMS – 2 credit units

Amplification: Circuit Elements used in amplification, Classification of amplifiers, representation of an amplifier circuit as a voltage, current, resistance and transconductance amplifier. Biasing and stabilization of Bipolar Junction Transistor (BJT) and Field Effect Transistor (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. Feedback on gain, input and output impedances. Analysis of feedback amplifiers. Stability and compensation techniques.

EEE 332: ELECTRIC POWER SYSTEMS PRINCIPLES - 3 credit units

Introduction: Power systems and sources of Electric energy, structure and Electric power system. The three phase system: balanced and unbalanced systems. Load characteristics of a transmission lines. Transmission and distribution of Electric Energy, Current and voltage relations in a transmission line. Regulation and loses. Construction of overhead lines and underground cables, power system equipment, standard and safety.

EEE 351: ELECTRICAL MACHINES LABORATORY - 1 credit unit

Transformers: Short circuits and open circuits test, experimental determination of circuit parameters, efficiency and regulation measurements from load test, measurement and observation of harmonics in three phase connections. DC Machines: Measurement of circuit parameter and performance characteristics of dc motors and generators (separately excited, shunt, series, compound). Induction Machines: Open circuit and short circuit tests, load tests, circuit parameter and efficiency measurements. Synchronous Machines: Open circuit performance measurements, short circuit tests, load and synchronization tests. Observations and measurements of hysteresis loops. Simple motor drive tests with solid-state converters.

EEE 352: ELECTRIC POWER SYSTEMS LABORATORY - 1 credit unit

Measurements on differently connected three phase circuits. Verification of methods of measurement of three-phase power. Synchronization of generators to busbar voltages.

Voltage and current measurements, three phase transmission line models. Power factor improvement tests. Over-current relay tests on simulated faults.

EEE 354: MEASUREMENT AND PHYSICAL ELECTRONICS LABORATORY - 1 Unit

Testing of indicating instruments; DC and AC Measurements; Resistance with Bridges; Transducer Testing and output measurements: Capacitive and inductive transducers in frequency modulated (FM) systems, piezoelectric, photoelectric, thermocouples, cathode ray oscilloscopes: study of features and operation, triggering, storage, measurement of voltage, current and phase difference; signal generators: study of features and output waveforms, measurement of output signal harmonic contents frequency discrimination; Digital multimeters: features and operation details, measurement of voltage, current and resistance.

EEE 356: ELECTRICAL DRIVES LABORATORY - 1 credit unit

Excitation of DC Generator, Load characteristics of a shunt DC motor, load characteristics of a separately excited DC motor, Open and short circuit test for a transformer, Synchronisation of synchronous machines to an existing busbar.

EEE 361: ELECTRICAL MACHINES I – 3 credit units

Magnetic circuits. Electromechanical energy conversion principles. The universal electric machine. DC machines: classifications, principles of operation, operating characteristics, ratings, efficiency and applications. Transformers: theory, equivalent circuit and efficiency, open-circuit test and short-circuit test. Three-phase induction motor: theory and operation, equivalent circuits, phasor diagram and operating characteristics. Elementary theory and operation of synchronous machines

EEE 362: ELECTRICAL MACHINES II – 2 credit units

Generalised electrical machines. DC machine transients. Parallel operation of Transformers. Modeling of Single phase induction motors. Three-phase phase induction motors, parallel operation and circle diagram of three-phase induction motors. Derivation of equivalent circuit of three-phase synchronous machines, round rotor and salient pole synchronous machines, parallel operation and operating charts of synchronous machines

EEE 371: MEASUREMENT AND INSTRUMENTATION - 3 credit units

Measurements in general, errors, methods, SI units system, R-L-C-E standards, indicating meters in general, static and dynamic properties, calibration problems. Moving coil meters- A, V, ohm, Galvanometer -special types, universal meter, ratiometer. Moving iron meters, - A, V; Electrodynameters; -A, V, W, Cos fi meter. Integrating meters, instrument for higher

frequencies. Electrostatic and thermal meters, calibration problems: Measurement of R, L, C using indicating meters, Instrument transformers, DC potentiometers. AC Bridges, Magnetic quantities measurement, C.R.O as a measuring instrument, Electronic voltmeters, Digital measuring equipment in general, digital voltmeters and counters. Non-electrical measurements in general. Active transducers: - thermoelectric, photoelectric, electromagnetic, piezoelectric. Passive transducers: - inductance, capacitance, resistance, thermoelectric, strain gauge, magneto elastic, hallotrons apparatus working on amplitude modulation, sensors and apparatus for vibration and acceleration measurement. Recorders and various systems of recording. Dynamic properties of measuring transducers-errors transfer function, correction techniques. Transistorized measuring transducers-errors transfer function, correction techniques. Transistorized measuring transducers, sensitivity and stability problems of electronic measuring transducers. Measurement of displacement, velocity, acceleration, force, pressure, temperature, torque, revolving speed. Function generators, wave analysers; Analog (A) and digital (D) data acquisition systems: tape recorders, D/A and A/D conversions, sample and hold circuits.

EEE 381: ELECTROMAGNETIC FIELDS AND WAVES I - 2 credit units

Basic Vector Analysis: Gradient, Divergence, Curl. Stokes Theorem, Gauss Theorem, Ampere Circuital Law. Faraday's Law. Electrostatic Fields due to distribution of charge, magnetic fields in and around current carrying conductors. Time varying magnetic and electric fields. Conduction and displacement currents.

EEE 382: ELECTROMAGNETIC FIELDS AND WAVES II - 2 credit units

Review of Time Varying Fields. Maxwell's equations (In rectangular co-ordinates, integral form and differential form). Derivation of Maxwell's equations. Wave equation and its solutions. Plane Waves in Vacuo, lossy dielectric and conducting media. Pointing theorem, power and energy. Boundary conditions. Reflection and Transmission of plane waves. Standing Waves.

EEE 421: POWER SEMICONDUCTOR DEVICES AND CIRCUITS I - 2 credit units

Power semiconductor devices; static and dynamic characteristics of power diodes; thyristors, triacs, and transistors, current and voltage ratings; parallel series operation; manufactures data. Modulation Techniques. Triggering circuits for semiconductor devices. Protection of semi-conductor devices. Power semiconductor circuits (analysis, design): Classification of conversion and inversion circuits.

EEE 441: COMMUNICATION PRINCIPLES - 3 credit units

Analysis and Synthesis of Waveforms: Fourier series and transform analysis, filtering. Amplitude modulation (AM); double sideband, single sideband and vestigial sideband modulation schemes; simple modulator, power and bandwidth performance. Angle modulation: frequency modulation. Phase modulation, bandwidth requirements, clippers and limiters. Amplitude modulation signal reception: discrimination, frequency tracking loop, phased lock loop and noise performance. Commercial radio systems. Transmission Media: Attenuation in open space, air cable and fibre channels; construction of cables and fibres, sampling theorem, pulse amplitude modulation, pulse width modulation, multiplexing, quantisation systems and pulse code modulation, delta modulation, causes and correction of errors in Pulse code modulation (PCM) and Differential Modulation (DM), ideal and matched filters, frequency acquisition, phase referencing and timing. Line codes, block encoding and Shanon's theorem. Antenna principles. Communication systems and devices: microphones, loudspeakers, broadcasting, the radio, the television, satellite communication

EEE 451: COMMUNICATION AND FIELDS LAB – 1 credit unit

Experiments on modulation techniques (AM, FM, PCM) and experiments on waveguides, transmission lines, aerials (Rhombic and Yagi), modern antenna systems, satellite television broadcasting.

EEE 453: CONTROL AND LOGIC SYSTEMS LABORATORY - 2 credit units

Time and frequency domain measurements of control system response; gain, lag and lead compensation of a closed loop servo system; closed loop control of a non-linear control system, verification of describing function principle, observation of phase trajectories; performance measurement of proportional and proportional plus integral speed controlled dc motor; performance verification of analogue, hybrid and digital control of servo motor position. Implementation of Logic circuits, Triggering circuits for power semiconductor devices; Development of brad boards; Programmed switching of devices.

EEE 461: ELECTRICAL MACHINES III – 2 credit units

Transformers: Core types and shapes, winding, cooling; in rush currents; harmonics in three phase transformers; parallel operation; autotransformers, instrument transformer, satiable reactors. DC machines: review of excitation methods and performance characteristics; armature reaction, interlopes, compensating windings; rating and efficiency; universal motor, permanent magnet motor. Induction motor: Three phase induction motor winding, rotor types, circle diagram, ratings, control methods; single phase induction motors -types and methods of starting, performance review and applications; synchros, linear induction motors.

Synchronous Machines: Types -salient and cylindrical; circle diagrams and V-curves; synchronous generator on infinite busbar; parallel operation.

EEE 471: DIGITAL SIGNAL PROCESSING – 2 credit units

Discrete time signals and linear systems. The Z-transform. The discrete Fourier transform. The fast Fourier transform. Infinite impulse response filters. Finite impulse response filters. Finite word length effects in digital filters. Multirate signal processing. Statistical digital signal processing. Applications of digital signal processing. Digital signal processors.

EEE 473: CONTROL LOGIC CIRCUIT DESIGN – 3 credit units

Review of digital IC logic families: HTL; CMOS; TTL; Combinational logic design: tabular minimisation. Sequential logic: state method for implementation. Operational amplifiers, timers, multipliers, phase locked loops, A/D and D/A converters and their control applications. Control system components: thyristors, synchros, relays, potentiometers as error detectors, transducers, control valves, hydraulic pumps. Logic circuit design for selected problems.

EEE 475: CONTROL SYSTEMS ENGINEERING I - 3 credit units

Basic concept and examples of control systems; block diagram and signal flow graph representations, transfer functions calculations, mason's rule; concepts of stability; system classification and error constants; Time response analysis; frequency response analysis; Bode analysis.

EEE 492: SEMINARS AND INDUSTRIAL VISITS - 3 credit units

Each student will be required to present a seminar on an approved topic in Electrical Engineering. Industrial visits to firms, industries, electric power stations and other relevant organizations will be organized for the students. The experiences and knowledge acquired during industrial visits to supplement research knowledge a chosen seminar topic will be assessed in a project report, which must be presented and defended by the student.

EEE 494: MINI PROJECT - 3 credit units

Each student will be required to present a mini project on an approved topic in Electrical Engineering which should be submitted at the end of the semester.

EEE 521: POWER SEMICONDUCTOR DEVICES AND CIRCUITS II – 3 credit units

Ac to dc conversion- uncontrolled and controlled three phase rectification; dc-to-dc conversion – one quadrant, two quadrant and four quadrant dc choppers; dc to ac conversion – voltage-fed and current-fed single phase and three phase inverters; ac to ac

conversions-line-commutated ac controllers, line commutated frequency changers or cycloconverters, force commutated ac controllers and frequency changers.

EEE 531: ELECTRIC POWER SYSTEM ANALYSIS, PLANNING AND PROTECTION

3 credit units

Modelling of power systems Components. Load flow studies. Fault studies. Power system stability, load growth and forecasting, Introduction to power systems planning and operation using mathematical programming techniques. Protection: requirement, current and voltage level protection, time grading, principles of simple differential protection schemes.

EE 533: SWITCHGEAR AND HIGH VOLTAGE ENGINEERING - 2 credit units

Generation and measurement of high voltage and current. Corona, corona losses, e-m noise, Dielectric strength: breakdown mechanism in solids, liquids and gases. Lightning phenomena: surge in transmission lines due to lightning and switching and their analysis. Protection of lines and apparatus against surges. Elements of high power circuits interruption circuit and physical phenomena, circuit breakers, types and problems. Impulse testing and safety practices. Insulation Co-ordination. Electric cables and condensers.

EEE 541: POWER SYSTEMS COMMUNICATION AND CONTROL 2 credit units

Review of transmission line theory. Review of communication theory. High frequency communications on power lines. Carrier systems and power line carrier applications. Multiplexing, telemetering. Signal processing and data transmission. Control of power generation. Voltage and VAR control, AVR and regulating transformers.

EEE 561: ELECTRICAL MACHINE DESIGN - 2 credit units

Electric Machine Construction Materials: Cables magnetic cores, insulating materials and their specifications. Cooling: Heating and Temperature rise data/curves and Ventilation/Cooling curves. Winding arrangements, flux flow and distribution in the cores for different windings. Flux wave approximations and calculation. Basic principles of electric machine design using machine output and dimensions. Design of inductors, transformers, dc machines, induction motors, synchronous machines: determination of machine core shapes and dimensions, winding cable current rating, insulation and cooling specifications for given machine output rating. Computer Aided Design of Electrical Machines.

EEE 581: ELECTROMAGNETIC FIELDS AND WAVES III - 2 credit units

Plane Waves in Transverse Electromagnetic (TEM) transmission lines. Coaxial lines, strip lines. Equivalent circuit for a TEM transmission line, characteristic impedance, propagation constant. Fundamentals of Wave Guides Antennae.

EEE 573: COMPUTER SOFTWARE AND APPLICATIONS – 2 credit units

Review of Matrix Operations and Numerical Iteration Procedures. Solution of Integrodifferential equations using programming softwares. Mathematical Modelling of Electrical Systems and Devices for Computational Purposes. Dynamic and Transient Simulation of Physical Systems. Analysis of Electrical Devices and Systems by Finite Element and related Softwares. Computer aided Design of Electrical Devices and Systems. Inferential Statistics and Statistical Analysis of Data using Computer Softwares and Other Tools. Proficiency in Softwares like MATLAB®, ANSYS®, SIMPLORER®, EXCEL® and SPSS® and their toolboxes.

EEE 535: POWER SYSTEM DISTRIBUTION - 2 credit units

Distribution System Planning and Automation. Load characteristics. Applications of Distribution Transformers. Design of Subtransmission Lines and Distribution Substations. Design Considerations of Primary and Secondary Systems. Voltage Drop and Power Loss Calculations. Power factor capacitors and applications. Protection: Fault current calculations; types, characteristics and rating of fuses, circuit breakers and lighting arrestes; co-ordinated protection design.

EEE 537: POWER SYSTEMS OPTIMISATION - 2 credit units

Introduction to the formulation of optimization problems: Problem variables, problem constraint, the objective function. Calculus based techniques: Unconstrained Minimisation: Powell's method of conjugate directions, Gradient methods, second order methods. Constrained Minimisation Problems: Indirect methods by unconstrained minimization, penalty function approach. Direct methods for constrained optimization; Lagrange multipliers, Kuhn Tucker conditions; methods of feasible directions. Linear (LP) and Non-linear programming. Application of LP to power systems problems economic dispatch, automatic load shedding generation expansion studies. Non-Calculus Based Methods: Guided random search techniques: Evolutionary algorithms, simulated annealing, genetic algorithms;

EEE 571: COMPUTER ORGANISATION - 2 credit units

Number Systems and Codes: Decimal, Binary, Octal, Hexadecimal, signed numbers arithmetic, the ASCII code. Types and Nature of computer logic components: gates/buffers, flip-flops, counters, registers, timers/clocks, latches, decoders, encoders, arithmetic logic unit. Major paths of computer: processor, memory, I/O devices. Buses; an example microcomputer instruction formats, Addressing modes, Instruction Types, Flow of Control.

Microprogramming. Inter-facing: I/O chips, address decoding. Assembly Language: Format, Assembly process, macros, linking and loading; multilevel machines.

EEE 512: RENEWABLE AND NEW ENERGY SYSTEMS – 3 credit units.

Solar radiation and its measurement: solar constant, solar radiation at the Earth's surface, radiation geometry and measurements data, radiation on tilted surfaces and estimation of average solar radiation. Physical principles of the conversion of solar radiation into heat, flat-plate collectors. Energy balance equation and collector efficiency. Thermal analysis of flat plate collectors and useful heat gained. Solar energy storage and applications.

Basic principles of wind energy conversion: power in the wind, forces on the blades, wind energy selection sites, basic components of wind energy conversion system, classifications. Types of wind machines – horizontal and vertical axis machines. Analysis of aerodynamic forces acting on the blade. Wind energy generator and load control. Applications of wind energy.

Biomass energy conversion technologies: wet and dry processes, classification of biogas plants and applications

EEE 522: APPLICATION OF SEMICONDUCTOR DEVICES IN POWER SYSTEMS

2 credit units

Distributed Generation Technologies and its Interface to Utility Systems; Power Quality. FACTS Controllers, Shunt-connected Controllers, Series-connected Controllers, Combined Shunt & Series-Connected Controllers. Static VAR Compensators (SVC) and STATCOM, Unified Power Flow Controllers (UPFC), Unified Power Quality Conditioners (UPQC).

EEE 532: ELECTRIC SERVICES DESIGN, RELIABILITY AND MAINTENABILITY

3 credit units

Basic Electrical Installations-Distribution system. Regulations-LEE, NEC, Nigerian standards. Cables-types, ratings. Wiring system, protection of low voltage installation. Earthing. Auxiliary electrical systems-Fire alarm, telephone, elevator circuits. Proposals, contract document preparation. Design of electrical installation -domestic, industrial, commercial, air-conditioning. Testing and certification. Illumination. Introduction to Reliability, maintainability. Elementary reliability theory and its application to power systems and electronic components. Designing for higher reliability.

EEE 572: CONTROL SYSTEMS ENGINEERING II - 3 credit units

Nichol's charts, Nyquist Stability Analysis; Root Locus Stability Analysis; System Compensation; Introduction to non-linear system. State space representation of Linear systems, solution of state equations; state variable feedback, observability and controllability;

state space Trajectories, Linearization; Properties and Synthesis of Multivariable control systems; Introduction to digital control.

EEE 592: PROJECT - 4 credit units

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

EEE 562: ELECTRIC MOTOR DRIVES – 2 credit units

DC Motor Control: Basic equations for armature voltage and field flux control of motor speed; Forward and reverse running regenerative braking conditions; solid state dc motor control using controlled rectifiers and dc to dc choppers; open loop and closed loop analysis of controlled separately excited dc motor. Three-phase Induction Motor Control: Basic speed/torque control principles by pole changing, frequency and stator voltage variation; solid state induction motor open loop drives using inverters, ac controllers, slip energy recovery schemes; closed loop control schemes by constant air gap flux control and slip frequency control; D-Q axis analysis of controlled induction motor. Three phase synchronous motor control: Basic equations of armature voltage, frequency and rotor angle control of motor speed/torque. Inverter-fed synchronous motor drive configurations; dynamic analysis of controlled 3-phase synchronous motors.

EEE 574: DIGITAL/DISCRETE CONTROL SYSTEMS - 2 credit units

Digital Signal Conversion and Processing; Z-transform; the state variable technique; stability of digital control systems; time domain analysis, frequency domain analysis; controllability and observability; Digital controllers, the maximum principle; the digital observer; microprocessor control.

EEE 576: INTRODUCTION TO OPTIMAL CONTROL - 2 credit units

Definition of the optimal control problem: static versus dynamic optimal control. Formulation of optimal control problems; performance indices, necessary condition for optimum control of continuous systems, principles of optimality, calculus of variation, Hamilton Jacobi Theory, Pontryagin's maximum principle and dynamic programming. Time Optimal Control Problems; optimal control of linear plants: the optimal regulator, problems with bounded state variables and bounded controls, singular control problems.