University of Nigeria, Nsukka

DEPARTMENT OF ELECTRONIC ENGINEERING

POSTGRADUATE PROGRAMMES IN ELECTRONIC ENGINEERING

1. PHILOSOPHY

The doctoral and masters programmes prepare students for creative teaching, research, development and professional works in academic, industrial and military applications of electronic engineering in any one of the areas of specializations. The programmes aim at preparing graduate students to be able to understand and analyze electronic materials, components and complete electronic systems, and simulate their behaviours on computers in other to specify new sub-systems and effect adaptation and development. The students are also trained to be able to specify, design, develop and commission hardware and instruments of varying degrees of complexity in their special areas.

The Doctoral programme is expected to probe much deeper into issues than the master programme. The programme should be able to develop/design techniques in electronic engineering in the pursuit of new principles and new or better engineering materials and techniques.

2. OBJECTIVES

The Department of Electronic Engineering postgraduate programmes are intended to achieve the following objectives:

i. Prepare graduate students to be able to understand and analyze electronic materials, components and complete systems through modeling and simulation;
ii. Train postgraduate students to be able to design, develop, install and maintain hardware and instruments of varying degrees of complexity in their special area;
iii. Obtain high levels of graduate student achievement in Electronic Engineering through reliance on laboratory hands-on activities thereby producing graduates with the requisite expertise for satisfying career with Educational Institution, Industry, Business and Government;
iv. Promote technology transfer, continuing engineering education training and re-training in the specialized areas in Electronic Engineering;
v. Produce graduates capable of initiating and leading Research and Development (R & D) works in the areas of specialization,
vi. Prepare candidates to be able to design, develop and test efficient electronic systems in real time.
vii. Produce the highest educated and trained manpower that will ameliorate and eventually reverse the acute shortage of academics in the specialized areas;

viii. Produce the highest level of consultants capable of providing technical solutions to Governments, Industry and Business, and
ix. Promote collaboration between specialists/experts in the specializations.

3. SCOPE

Electronic Engineering postgraduate programme was created to develop and execute a world-class electronic engineering postgraduate programme intended to provide sound theoretical and practical training for graduate students. 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 the research and development in Information and Communication Technology (ICT).

The postgraduate programmes of the Department of Electronics Engineering are being offered at two levels, namely: Masters and Doctoral levels. The Master degree is in two forms: Master of Engineering (M.Eng.) and Master of Science (M.Sc.) both in Electronic Engineering specific specialization. The Masters and Doctoral (Ph.D) programmes lay emphasis on both theoretical and practical (project) aspects of postgraduate work especially as it relates to the technological needs of the nation. Both programmes offer specialization in the following areas:

- Communication,
- Digital Electronics and Computer and
- Control Engineering.

4. ADMISSION REQUIREMENTS

4.1 Masters Programmes

Candidates for M.Sc. and M.Eng. must possess B.Sc or B.Eng. degree certificate with minimum GPA of 2.50. The applicants must have Electronic Engineering background or other related discipline. The applicants are, in addition, expected to satisfy the current postgraduate programme admission requirements in the department/faculty.

4.2 Doctor of Philosophy Programme

The candidates for Ph.D degree must possess the minimum of M.Sc. or M.Eng. degree certificate with GPA OF 3.0/4.0 or 3.5/5.0 minimum requirement. The applicant must have Electronic Engineering background and any other minimum requirement as in the current postgraduate programme in the department/faculty.

5. AREAS OF SPECIALIZATION

The areas of specialization for M.Sc, M.Eng. and Ph.D include:

i. Communication,
ii. Control Engineering.
iii. Digital Electronic and Computer and

6. DURATION OF PROGRAMMES

6.1 Masters Programmes

The M. Sc. and M. Eng. Degree programmes have defined duration based on the mode of the programme i.e. whether part-time or full-time mode.

Full-time	3 semesters minimum
	6 semesters maximum
Part-time	6 semesters minimum
	8 semesters maximum

6.2 Doctor of Philosophy Programmes

The Ph.D. degree programme has a defined duration based on the mode of the programme i.e. whether part-time or full-time mode.

Full-time	6 semesters minimum
	8 semesters maximum
Part-time	8 semesters minimum
	14 semesters maximum

7. MODE OF STUDY

Doctor of Philosophy and Masters programmes are pursued on both full-time and part-time modes where the minimum credit loads are 30 units.

7.1 Masters Programmes

The M. Sc. and M. Eng. degrees are obtained through course work predominated programmes and dissertation. All candidates for Masters in Electronic Engineering pass through individualized remedial programme approved by the Departmental Postgraduate Studies Committee. The core courses are compulsory for the candidates and they are intended to harmonize the students' diverse academic backgrounds and equip them with the necessary tools for meaningful work in their various areas of specialization. The pass score for the courses is 50%.

7.2 Doctor of Philosophy Programmes

The Ph.D degree is obtained through course work and comprehensive research to be embodied in a thesis which is defended orally before a constituted panel. The Ph.D research must show incontrovertibly satisfactory level of originality and creativity and shall generally result in the development of a new technique processes or correlation and in the advancement of knowledge beyond the current frontier. Candidates qualify to proceed into research aspect of the programme only after obtaining 60% score average from course work. Unsuccessful candidates are allowed only second opportunity to re-access the course work.

8. CERTIFICATION

8.1 Masters Programmes

At the end of the masters programme the graduates are awarded the M. Eng. or M.Sc. degree certificates.
M. Eng. - If graduate has first degree in Engineering.
M. Sc. - If graduate has non-Engineering first degree.

8.2 Doctor of Philosophy Programmes

At the end of the Ph.D programme the graduates are awarded the Ph.D degree certificates.

9. 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 Engineers in the society today cannot be over-emphasized. This is because Electronic Engineering permeates almost every aspect of life and industry. 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.

LIST OF APPROVED SUPERVISORS

PROFESSORS

1. C. I. Ani

   M.Sc. (Moscow), M.Phil (Sussex), PhD (Wales), MNSE

   Data Communication and Networks Resource Management

2. O. U. Oparaku

   B. Eng (Nig), PhD (Newcastle UT), MNSE

   Solid State/Semiconductor Electronics and Solar Energy

SENIOR LECTURERS

1. O. N. Iloanusi (Doctoral Supervisor)

   B. Eng (Nig.). M.Eng. (Nig.), PhD (Nig.), MNSE

   Biometrics, Digital System Design, Digital Signal Processing, and Logic Design

2. M. A. Ahaneku (Masters Supervisor)

   B.Eng. (FUTO), M.Sc. (FUTO), Ph.D (Nig.), MNSE

   Microwave and Satellite Communications, Radio and Telecommunication,

3. V. C. Chijindu

B. Eng. (ASUTECH), M. Eng. (ESUT), Ph.D (UNIZIK), MNCS

Software Engineering, Image Engineering and Digital System Design

4. N. J .Eneh

B. Eng. (ESUT), M. Eng. (ESUT), Ph.D (UNIZIK), MNSE

Control Systems and Digital System Design

5. U. A. Nnolum

B. Eng. (UK), M. Eng. (UK), Ph.D (UK)

Software Engineering, Digital System Design and Digital Signal Processing

6. C. C. Udeze

B. Eng. (UNIZIK), M. Eng. (UNIZIK), Ph.D (UNIZIK), MNSE, COREN

Control Systems, Datacenter Networks and Digital System Design

STRESS AREAS	CODES
Foundational Courses	0
Communication	1
Digital Electronics & Computers	2
Control	3

M. Sc. and M. Eng. COURSE OUTLINE

A. COMMUNICATION SPECIALIZATION

Compulsory Courses

Course Code	Course Title	Units
ECE 610	Communication Theory	3
ECE 611	Communication Networks & Protocols	3
ECE 612	Communication Modeling & Simulation	3
ECE 613	Network Traffic Control	3
ECE [ ]	(Two Elective Courses)	6
		18 Units

Research

ECE 601	Seminars	3
PGC 601	Research Methodology and ICT in Engineering	3
ECE 600	Project	6

12 Units

Optional/Elective Courses

Course Code	Course Title	Units
ECE 614	Microwave & Satellite Communication	3
ECE 615	Mobile Communication	3
ECE 616	Networks Design & Implementation	3
ECE 617	Optical Systems	3
ECE 618	Microwave Communication System Design	3
ECE 619	Radar And Navigation Systems	3

(Two courses only are required to be chosen.)

B. DIGITAL ELECTRONICS AND COMPUTERS SPECIALIZATION

Compulsory Courses

Course Code	Course Title	Units
ECE 620	Digital System Design	3
ECE 621	Computer Systems Architecture I	3
ECE 622	Software Engineering Development	3
ECE 625	Digital Integrated Electronics	3
ECE 623	Computer Systems Architecture II	3
ECE 626	Digital Signal Processing	3
ECE [ ]	(Two Elective Courses)	6
		24 Units

Research

ECE 601	Seminars	3
PGC 601	Research Methodology and ICT in Engineering	3
ECE 600	Project	6
		12 Units

Optional/Elective Courses

Course Code	Course Title	Units
ECE 624	Software Engineering Project Management	3
ECE 627	Web Engineering and Cyber Security	3
ECE 628	Biometrics and Image Processing	3
ECE 629	Nanoelectronics and Optoelectronics	3

(Two courses only are required to be chosen.)

C. CONTROL SPECIALIZATION

Compulsory Courses

Course Code	Course Title	Units
ECE 630	Stochastic Control	3
ECE 631	Optimal Control	3
ECE 632	Multivariable Control	3
ECE 635	System Modeling and Simulation	3
ECE [ ]	(Two Elective Courses)	6
		18 Units

Research

ECE 601	Seminars	3
PGC 601	Research Methodology and ICT in Engineering	3
ECE 600	Project	6
		12 Units

Optional/Elective Courses

Course Code	Course Title	Units
ECE 633	Linear Systems	3
ECE 634	Large Scale Systems	3
ECE 636	Control Strategies	3
ECE 637	Linear System Theory	3
ECE 638	System Control	3

(Two courses only are required to be chosen.)

Ph.D COURSE OUTLINE

Compulsory Courses

Course Code	Course Title	Units
ECE 712	Modeling & Simulation Practice	3
ECE 713	Advanced Security Engineering	3
ECE [ ]	(One Elective Course)	3
		9 Units

Research

ECE 701	Seminars I	3
PGC 701	Synopsis and Research Grant Writing	3

ECE 702	Seminars II	3
ECE 700	Thesis	12
		21 Units

Optional/Elective Courses

Course Code	**Course Title**	**Units**
ECE 710	Network Management & Reliability	3
ECE 714	Long-Distance Networks	3
ECE 716	Advanced Signal Processing	3

(One course only is required to be chosen.)

COURSE DESCRIPTIONS

ECE 600 Project Report (6 Units)

Each candidate for a Masters degree shall be assigned a suitable research project approved by the Departmental Postgraduate Studies Committee. The results of the research shall be embodied in a project report.

PGC 601: Research Methodology and ICT in Engineering (3 Units)

Use of advanced analytical tools like MATLAB/SIMULINK, SCILAB/XCOS, etc for solution of engineering problems and their applications (Application of these softwares depends on the various problems formulated in different departments and in the specific specializations).

Information literacy, information sources (media, publishers, agreggators); validity of information, plagiarism and legal aspects.

Information search – search engines, journal repositories, academic (social) networks, search strategies, personal contacts, tools for managing references.

Integrating information literacy in research, cloud computing, audiovisual tools, e.g powerpoint presentations.

Literature review: Reading and summarizing relevant articles, critical analysis and evaluation of research, identification of themes and comparators, writing review documents and identification of research (or knowledge) gaps.

Scientific method and nature of evidence: Experimental methods and design methods *(as may be applicable to individual departments and research areas)*, data collection and management of quantitative data. Human participants – expert reviews, focus groups, questionnaires and interviews.

Project management and report writing: project planning, report structure and style, general report writing techniques.

ECE 601 Seminars (3 Units)

Each master's candidate shall present at least one seminar on his/her research project before graduation.

ECE 610 Communication Theory (3 Units)

Signals (Deterministic and random) and Systems; Signal processing (signal domain transformations, convolution, sampling, quantization, compression and coding); Modulation and Demodulation (Analogue and digital); Information theory; Noise; Error control coding.

ECE 611 Communication Networks and Protocols (3 Units)

LAN - Physical Structure; Medium Access Control; LAN Standards – IEEE 802.x; LAN Interconnections – Bridges, Routers & Gateways. MAN - DQDB, FDDI; WAN - PSTN; PSDN; ISDN; B-ISDN; INTERNET; ATM; FRAME RELAY; SONET; Advanced Network Architectures.

OSI-layer protocols; Protocol Design – Protocol Specification and Implementation. ASN.1 Representation and Pseudo-Coding. HDLC; X.25; TCP/IP and IPx

ECE 612 Communication Modeling & Simulation (3 Units)

Teletraffic; Queuing Theory; Traffic Modeling (Data, Voice and Video Modeling); Network Systems Modeling - Loss System and Delay System;

Computer Simulation Modeling - Computer Simulation using Object Oriented Network Simulation Packages – SPSS, MATLAB Simevent, OPNET: Riverbird modeler, Network II.5, BONES.

ECE 613 Network Traffic Control (3 Units)

Network Algorithm and shortest path routing; Broadcast Routing information;

Flow models optimal routing and topological design; Characterization of optimal routine; Window flow control; Rate control scheme; Rate Adjustment Algorithm; Flow control protocols in practice.

ECE 614 Microwave & Satellite Communication (3 Units)

Relay System – Relay Stations and Signals dimensioning, Multiplexing (FDM, WDM, TDM, SDM). Satellite System; Earth Stations; Orbiting Stations; Signal propagation modes and signal interferences. Fibre Optic - Structure & Operation. Optical component systems. Optical System Installation.

ECE 615 Mobile Communications (3 Units)

Channelization – FDMA, TDMA, CDMA. Spread Spectrum. Frequency Hopping. Cordless telecommunication technology. Radio paging technology. GSM and Cellular Technologies. 2G; 2.5G, 3G and LTE technologies.

ECE 616 Networks Design and Implementation (3 Units)

Feasibility and design plan. System specification; Systems structure and component selection and dimensioning; Signaling –SS7 (physical and protocol architecture); Performance analysis and maintenance.

ECE 617 Optical Systems (3 Units)

The wave nature of light. Polarization, the principle of superposition, interference, diffraction. Black body radiation. Photoluminescence, cathocoluminescence. The cathode ray tube. Light emitting Diodes. Plasma displays, liquid crystal Displays, Numeric displays. LASERS. Radiation emission principles. Classes of lasers. Laser Applications, Photo-detectors. Fibre optical waveguides. Optical waveguides. Optical communication systems. Reflection, refraction, and diffraction properties of light. Polarization properties of light. Diffractive Optics, Coherence and Interference. Introduction to Holography

ECE 618 Microwave Communication System Design (3 Units)

Route and site selection; influence of terrain, weather, rain and obstructions. Calculation of path profiles. Use of aerial maps. System Noise Objectives. ITU-T/R international circuits. Choice of equipment; radio equipment, RF combiners; guides, antenna systems, randomes, repeaters and

links and the estimates. System reliability estimates. Calculation of the probability of outages due to propagation.

ECE 619 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. Airbone direction finders, air traffic control radar beacon, instrument low approach system, loran, microwave landing systems. Omega. Inmarsat.

ECE 620 Digital Systems Design (3 Units)

Revision of key SSI and MSI combinational circuits: adders, subtractors, decoders, encoders, multiplexers and demultiplexers. Design with SSI and MSI combinational circuits. Revision of LSI combinational circuits: ROMs, PLA, PAL. Design with LSI combinational circuits. Revision of sequential circuits: RS, JK, D and T flip-flops. Design with sequential circuits. Design of counters, Registers, RAM. Register Transfer. Hardware Description Languages: VHDL, SystemVerilog. Sequential digital systems description and design in VHDL. Basic building blocks and language constructs. Register Transfer-Level Design. Controller/datapath partitioning. Simulation and synthesis principles. Built in Test: Principles, structures, signature analysis. Multiple Clock Domains: Transferring data between clock domains.

ECE 621 Computer Systems Architecture I (3 Units)

Computer Fundamentals and Classification, Computer Design by layers: from Applications to Transistors; Design goals (speed, cost, size, power consumption, etc.).

Quantitative Principles of Computer Design: Make the Common Case Fast; Amdahl's Law and application; CPU Performance Equation.

BASIC ARCHITECTURE OF A STORED PROGRAM COMPUTER

Scope of architecture: Instruction Set Architecture, Micro-Architecture of Organization and Hardware. Requirements to be considered in designing a new machine. Elements of a generic micro-architecture: CPU, Bus, Memory, Input-Output, Peripherals. Microarchitecture of Intel 80 x 86 microprocessor as illustrative examples. Von–Newman versus Harvard Architecture. Von–Newman Bottleneck.

Seven Key Elements of Instruction Set Architecture (ISA). Assembly Language Programming.

MEMORY

Characteristics of Memory; Memory Hierarchy Performance Parameters; Types of Semiconductor Memories and applications; Memory design; Memory Interleaving. Virtual Memory – Hard disk.

ECE 622 Software Engineering Development (3 Units)

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.

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.

Software Engineering development using Object Orientation

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.

ECE 623 Computer Systems Architecture II (3 Units)

Acceleration Mechanisms: Cache and Pipelining. Cache Memory Systems. Overview of Memory Hierarchy. Cache Mapping Function; How cache operates; Cache effectiveness: Hit, Miss, Hit ratio, miss ratio. Cache components: SRAM, TRAM, Cache Controller. Cache Classification. Locality of Reference; Types of Locality – Temporary and Spatial. Implications of Locality. Cache Placement Policy or Cache Organization – Direct, Set Associative, Fully Associative; Comparison of Cache Organization; Cache Design examples.

Read and Write Policies: Write through, Write back, Replacement Policy. Cache misses: Compulsory, Capacity, Conflict. Illustrative examples: Pentium and i7 cache structures.

PIPELINING (Instruction Level Parallelism)

Pipelining Techniques; Pipeline Unites (Stages), Pipeline with staging Latches; Space Time Graphs.

Instruction –time diagram. Operation of the Pipeline. Instruction Overlap and Pipelining. Pipeline for RISC Processor; Pipeline equations, Pipeline efficiency. Instruction Pipeline Hazards; Detecting Hazards, Data Dependencies, Output dependencies, Forwarding.

Superscalar Processors; Superscalar design with Specialized execution units; Out-of-Order instruction Issue; Centralized, Distributed Instruction Windows. Differences between non-pipelined and pipelined processors, Register Renaming; Reorder buffer. Arithmetic Pipelines: Illustrative examples – How Pentium and i7 processors implement pipelining.

Multiprocessors and multithreading

ECE 624 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.

ECE 625 Digital Integrated Electronics (3 Units)

PURIFICATION OF SEMICONDUCTORS MATERIALS:

Zone refining, Crystal growth technique – Czochralkiprocess, Float Zone technique, Bridgemann – Stockbarger Method, Epitaxial Growth. Vacuum deposition techniques – physical vapour deposition, Metallurgic chemical vapour deposition, Molecular beam Epitaxy, Cathode sputtering, ion-implantation. Integrated Circuits Device Fabrication. The Planer technology – wafer preparation, oxidation, photolithography, ion-implantation, testing, bonding and packaging. Digital integrated circuit logic families and their operational characteristics – TTL, CMOS. Analysis of digital integrated circuits. Applications of digital integrated circuits.

Creation of Vacuum. Vacuum Pumps:

Types of vacuum pumps – Positive displacement pumps, Diffusion pumps, Cryogenic pumps, Turbomolecular pumps. Pressure ranges of vacuum pumps.

ECE 626 Digital Signal Processing (3 credits)

Introduction to Digital Signal Processing . Time and Frequency Characterization of Signals and Systems. Discrete-Time Systems. Basic System Properties. Discrete-Linear Time-Invariant Systems. Short-time Fourier Analysis. The Discrete-Time Fourier Transform. Sampling, Quantization and Aliasing. Nyquist Frequency / Discrete-time processing of continuous-time signals. Sampling Rate Conversion. Quantization and Oversampled Noise Shaping. Fast Fourier transforms Algorithms. The Z-Transform. Inverse Z-Transform. Analysis and characterization of LTI systems using the Z-Transform. Digital Filtering. Discrete-Time Filters described by Difference Equations: First-Order Recursive Discrete-Time Filters / Non-recursive Discrete-Time Filters. IIR, FIR Filter Structures. Computer Techniques in Filter Synthesis. Realization of Filters in Hardware and Software. Filter Design: IIR Filters. Filter Design: FIR Filters.

ECE 627 Web Engineering and Cyber Security (3 Units)

WEB ENGINEERING

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.

CYBER SECURITY

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.

ECE 628 Biometrics and 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. Introduction to biometrics. Applications of biometrics. Biometric Data Collection. Overview of computer vision methods. Computer vision and image processing. Automated analysis of computer images. Fingerprint biometrics. Performance limits and performance evaluation.

ECE 629 Nanoelectronics and Optoelectronics (3 Units)

Nanoelectronics

Overview of Nanotechnology – Fundamental Concepts and Applications.

Introduction of Nanoelectronics – description of electronics at the nanoscale – principles of quantum mechanics, the wave-particle duality, wave functions and Schrodinger equation. Electronic properties of molecules, carbon nanotubes and crystals, energy ban formation and origin of metals, insulators and semiconductors. Nanomaterials for electronic applications. Nanoelectronic devices – nanowire MOSFETSs, nanotubes FETS, quantum dot lasers, field emission displays, solar cells, nano sensors.

Optoelectronics

Quantum mechanical effects of light on electronic materials. Photovoltaic effect (photodiodes, phototransistors, photomultipliers, optoisolators, integrated optical circuits. Photoconductivity and its application in photoresistors, photoconductive camera tubes, charge-coupled imaging devices, photoemissive camera tube. Stimulated emission – injection laser diodes, quantum cascade lasers. Radiative recombination devices – light emitting diodes. Optical fibre communication, optocouplers.

ECE 630 Stochastic Control (3 Units)

Prediction theories of filtering; Kalama Filtering. Control of Stochastic system, System identification; Cost Functions. Minimum Variance Control. Certainty equivalent principle. Stationary noise disturbances; Optimal Control law for Special noise models. Least squares estimation and control. The Fokker-plan-Kolmogorov Equation. Method of moments, Yaupon Theory; Circle Criteria, Separation theorem. Optimality, Piece-wise representation and numerical Analysis of non-linear Stochastic system.

ECE 631 Optimal Control (3 Units)

Linear programming Dynamic programming. Calculus of variations. Hill climbing techniques. Poutryagins maximum principles. Hamilton-Jacobi Theory. Matrix Ricatti Equations. Extremization and linear integrals via Green's Theorem. Theory of second variations. The singular problem. Some sufficient conditions. Generalized controls; Linear optimal controls via spectral factorizations.

ECE 632 Multivariable Control (3 Units)

Functional Controllability system matrix, matrix-fractionand inverse matrix descriptions for dynamical system. Multivariable poles and zeros; Frequency domain multivariable stability Criteria; Generalized diagonal dominance. Singular value decompositions. Criteria for robustness; Normality.Quasi-Nyquist and Multivariable root loci. Non-proper system frequency response. Non-interacting control. Modal control. Pole assignment; state and output feedback. Disturbance rejection. Design examples from industrial problems.

ECE 633 Linear Systems (3 Units)

Basic systems concepts: systems, models, representations, dynamical systems representation; Input/output representation state space description singular points and flow pattern in state space, pancake theory and Benison theorem. Linear System; controllability, operability, minimal representation, stability criteria, Lyapunov stability theory. Equivalent discrete systems Z and W

Transforms; discrete data, dynamical system sampling theory. Equivalent discrete Systems Z and W transforms, discrete data, dynamical systems sampling theory. Stochastic processes, processes, stationary processes, models for stationary. Processes, models for stationary processes. Linear filters, impulse response Functions, frequency response functions, autocorrelation functions and spectral. Density functions; Wiener-Khinchin relations.

ECE 634 Large-Scale System (3 Units)

Large scale system Modeling in time and frequency domains. Aggregation, Descriptor-Variables, perturbation Methods. Moment matching, Continues partial fraction expansions and Approximations, Error minimization. Hierarchical Control of large scale systems. Decentralized Control and stabilization, Robust System control.

ECE 635 System Modeling and Simulation (3 Units)

Modeling different levels (of systems complexity) for different applications; Design verification, fault analysis, time analysis and testing. Concept of dynamic feedback systems, including; stability, adaptive control and Characteristics of linear vs non-linear systems. Artificial intelligence and Microprocessor application. An introduction to systems, analysis by simulation; continuous, non-linear and Distribution system. Analog simulation with logic elements and hybrid Systems. Solution of difference equations using state space and Z-transform Methods, numerical integration; stability. Digital simulation of one discrete (CPPSS) AND ONE CONTINUOUS (CSMP) simulation language; Pseudorandom members.

ECE 636 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 refernce 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.

ECE 637 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. Reach ability 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.

ECE 638 System Control (3 Units)

The minimum effort control; The regulator control; The tracker control; Digital control implementation; Process identification; Advanced Control strategies: NIMC, Adaptive, Fuzzy Logic; MPC and GLC

ECE 700 Thesis/Dissertation (12 Units)

Each candidate for a Doctoral degree shall be assigned a suitable research project approved by the Departmental Postgraduate Studies Committee. The results of the research shall be embodied in a thesis/dissertation.

PGC 701 Synopsis and Research Grant Writing (3 Units)

Choice of broad research area with considerations of interdisciplinary topics, Identification of research/ knowledge gaps and research objectives.

Role of technical reports in engineering projects. Fundamental principles of technical writing. Format of different types of reports, outlines, purpose and scope, technical discussion details, role of appendix, function of figures, equation editors, tables and illustration. Literature search, references (citings and listings). Nature of recommendations and conclusions. Guides for writing memoranda, business letters. Oral presentation of technical reports and thesis. Synopsis writing

Developing long-term research plan, Identification of potential funding agencies and their requirements. Research objectives in relation to interests of the funding agencies. Estimating research timelines, Budget preparation, manpower requirements and availability, research facilities, legal issues, etc

ECE 701 and ECE 702 Seminars (3 Units each)

Each doctoral candidate shall present at least three seminars on his/her research project before graduation. At least, one seminar shall be presented at faculty level before graduation.

ECE 710 Network Management and Reliability (3 Units)

Fault; Configuration; Performance; Accounts; and Security Management. Management Protocols – SNMP, CORBA and CMIP; Management Information Base (MIB).

Reliability; Network Monitoring Techniques – Local and Remote

ECE 712 Modeling & Simulation Practice (3 Units)

Advanced Queuing Theory - Loss System and Delay System; Analytical Modeling and Simulation using EXCEL spread sheet. Computer Simulation Modeling and Simulation using Object Oriented Network Simulation Packages – SPSS, MATLAB;

ECE 713 Optical Networking (3 Units)

Optical Technologies Required; Derived Technology Applications; Overlay Networks; Two-Layer Networks are Emerging; Optical Switching; Distributed Switching; MEMS Switching; Practical Optical Add–Drop Multiplexer; OXCs and OADMs Enhance Availability and Survivability; Improvements in the Management of the New Network Architecture; All-Optical Cross-Connects; Options for Optical Layer Signaling; Four Classes of Optical Networks; Generic Networks; Optical Bidirectional Line-Switched Rings; Generalized Multiprotocol Label Switching (GMPLS); Selected GMPLS Terminology; The GMPLS Protocol Suite; GMPLS Switching Based on Diverse Formats; Bundling Links; Standardization of Optical Control Plane Protocols; GMPLS and ASON Differ; Hierarchical Routing in Optical Networks

ECE 714 Long-Distance Networks (3 Units)

Design Problems; Transmission Factors in Long-Distance Telephony; Design of Long-Distance Links; Design of Line-of-Sight Microwave Systems; Design of Satellite Communications; Fiber-Optic Communication Links.

ECE 715 Advanced Security Engineering (3 Units)

The multidisciplinary nature of security. Background: types of attacks and attackers; range of systems. Overview of security standards and best practices. Access control; authentication techniques, passwords and password vulnerabilities. Data protection. Basic Cryptography; Certificates; Crypto-primitives and cyphers. Privacy and anonymity. Trust. Trust mechanisms and level of trust. Computer security; software and platform security. Network security; attack detection and mitigation. ATM security; E-commerce security. Card security; GSM and SIM cards; Payment systems. Security of database applications; injection attacks; Cross-site scripting. Penetration listing and Web-based systems / Cyber security. Fraud and loss prevention: Banking Security. National security.

ECE 716 Advanced Signal Processing (3 Credits)

DT Processing of CT Signals and CT Processing of DT Signals: Fractional Delay

Data Acquisition: Sampling in time, aliasing, interpolation, and quantization, sampling Rate Conversion, spectral analysis. Quantization and Oversampled Noise Shaping. IIR, FIR Filter Structures. Filter Design: IIR Filters. Filter Design: FIR Filters.

Multirate Systems and Polyphase Structures. Linear Prediction and All-pole Modeling. The Discrete Fourier Transform (DFT). Linear Filtering with the DFT. Spectral Analysis with the DFT. FFT Algorithms. Short-time Fourier Analysis. Modulated Filter Bank.

Image processing I: Extension of filtering and Fourier methods to 2-D signals and systems.

Image processing II: Interpolation, noise reduction methods, edge detection, homomorphic filtering.