جامعة أم القرى

كلية الهندسة والعمارة الإسلامية

ماجستير العلوم في الهندسة الكهربائية بالرسالة

- مسار هندسة الالكترونيات
- مسار هندسة الاتصالات
- مسار هندسة القوى الكهربائية

10. Program's Details:

(a) Compulsory courses (all disciplines, both tracks)

Course Number	Credit Hours	Course Title
802600	3	Advanced Mathematics for Engineers
802601	3	Advanced Numerical and Statistical Methods
802602	3	Engineering Design and Research Methods

(b) General Courses (all disciplines, both tracks):

Course Number	Credit Hours	Course Title
802605	3	Modeling and Simulation
802606	3	Operations Research
802607	3	Advanced Control Systems
802608	3	Digital Control Systems Analysis and Design
802609	3	Nonlinear Control Systems
802610	3	Intelligent Control
802611	3	Optimal Control Engineering
802612	3	Data Acquisition Systems
802613	3	Sensors and Instrumentations
804516*	3	Finite Element Analysis*
804517*	3	Operation Research Optimization Models*

* Courses offered by MSc program of Mechanical Engineering department. The description of these courses can be found in Mechanical Engineering department curriculum.

(c) Electronics Discipline Courses:

Course Number	Credit Hours	Course Title
802620	3	Quantum Mechanics for Electrical Engineers
802621	3	Advanced Semiconductor Materials
802622	3	Advanced Semiconductor Devices
802623	3	Advanced IC Technology
802624	3	Semiconductor Characterization Methods

802625	3	Micro-Electro-Mechanical Systems
802626	3	Charge Transport Models
802627	3	Nano-Electronic Devices
802628	3	Nano-Optics
802629	3	Semiconductor Optoelectronics
802630	3	Advanced Analog Integrated Circuits
802631	3	Advanced Digital Design
802632	3	RF IC Design
802633	3	Analog Signal Processing
802634	3	Computer Aided VLSI Design
802692	3	Advanced Topics in Electronics Engineering

(d) Communications Discipline Courses:

Course Number	Credit Hours	Course Title
802640	3	Stochastic Processes
802641	3	Pattern Recognition
802642	3	Detection Theory
802643	3	Image Processing and Remote Sensing
802644	3	Advanced Digital Image Processing
802645	3	Introduction to Biomedical Imaging
802646	3	Statistical and Computational Intelligence
802647	3	Advanced Digital Signal Processing and Filter Design
802648	3	Time-Frequency and Multi-Rate Signal Processing
802649	3	Speech Processing
802650	3	Electromagnetic Radiation and Antennas
802651	3	RF Circuit Design
802652	3	Radio Wave Propagation
802653	3	Modern Telecommunication Systems
802654	3	Satellite Communications
802655	3	Spread Spectrum Communication
802656	3	Advanced Wireless Communication
802657	3	Regulations and Policies in the Telecommunications Industry
802658	3	Error Control Coding
802659	3	Wireless Communication Networks
802694	3	Advanced Topics in Communications Engineering

(e) Power Discipline Courses:

Course Number	Credit Hours	Course Title
802660	3	Applications of Power System Protection
802661	3	Intelligent Protective Relaying
802662	3	Digital Signal Processing for Numerical Protection
802663	3	Advanced Power Electronics
802664	3	Power Electronics Applications
802665	3	Electric Machines and Motor Drives
802666	3	Special Electrical Machines
802667	3	Photovoltaic Systems: Analysis, Operation, and Design
802668	3	Renewable Energy and Distributed Generation
802669	3	Wind Energy Generation Systems
802670	3	Integration of Alternative Energy Sources
802671	3	Power System Planning and Reliability
802672	3	Power System Modeling and Control
802673	3	Electric Power Quality
802674	3	FACTS: Models, Control and Applications
802675	3	Smart Grids in Power Systems
802676	3	Electric Safety and Grounding System Design
802677	3	High and Extra High Voltage Engineering Applications
802678	3	Statistical Applications in High Voltage Engineering
802679	3	Study of Power System Transients
802680	3	High Voltage Power Cables
802696	3	Advanced Topics in Electrical Power Engineering

Master's Degree Plan, Thesis Track

First semester

Course #	Course Title	Credit hours
802600	Advanced Engineering Mathematics	3
802601	Advanced Numerical & Statistical Methods	3
802602	Engineering Design Process and Research Methods	3
	Total Credit hours	9

Second semester

Course #	Course Title	Credit hours
* 8026xx	Minor or Major/General Elective course 1	3
* 8026xx	Major Elective course 1	3
* 8026xx	Major Elective course 2	3
	Total Credit hours	9

Third semester

Course #	Course Title	Credit hours
* 8026xx	Minor or Major/General Elective course 2	3
* 8026xx	Major Elective course 3	3
* 8026xx	Major Elective course 4	3
	Total Credit hours	9

Fourth semester

Course #	Course Title	Credit hours
802699	M.Sc. Thesis	9
	Total Credit hours	9

Total 36 hours

*** 8026xx: An elective course number from the available courses**

Courses' Descriptions (Compulsory Courses)

Course Number	Course Title	Units
802600	**ADVANCED MATHEMATICS FOR ENGINEERS**	**3**

Objectives

Students will learn various concepts of advanced mathematics used in Engineering applications including system of linear and nonlinear differential equations, vector analysis, Fourier integral, special functions and calculus of variation. The emphasis in this course will not be on abstract theory and proofs but on techniques that can be used to solve problems.

Description

System of ordinary differential equations (ODEs), eigenvalues and eigenvectors, nonlinear systems, partial differential equations (PDEs), boundary value problems, engineering application models of ODEs and PDEs, special functions: Legendre polynomials, Bessel's functions, Laplace transform: convolution and integral equations, vector integral calculus: double and triple integrals, Green, divergence, and Stokes's theorems, Fourier transform and Z-transform, Calculus of variations and linear programming.

Pre-requisite Knowledge

Basics of ordinary and partial Differential Equations, Laplace Transform, vectors, Fourier series.

Keywords

System of ordinary differential equations, Partial differential equations, Special functions, Laplace transform, vector integral calculus, Fourier transform, Calculus of variations.

References

1. J. David Logan, "Applied Mathematics", John-Wiley & Sons, 4th Edition, May 2013.
2. Erwin Kreyszing, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons, 2011.
3. Sudhakar Nair, "Advanced Topics in Applied Mathematics: For engineering and Physical Sciences", Cambridge University Press, 2011.
4. Chiang C. Mei, "Mathematical Analysis in Engineering - How to Use the Basic Tools", Cambridge University Press, 1995.
5. Peter B. Kahn, "Mathematical Methods for Scientists and Engineers", John-Wiley & Sons, 1990.

Course Number	Course Title	Units
802601	**ADVANCED NUMERICAL AND STATISTICAL METHODS**	**3**

Objectives

Students will learn various concepts related to numerical and statistical analysis methods with emphasis on computer programming techniques used to implement these methods. The analysis will include dealing with numbers, solving equations, differential equations, error analysis.

Description

Numerical methods: Interpolation and approximation with polynomials, Least squares curve fitting, Solution of system of linear and nonlinear equations, Numerical integration and differentiation, Solution of ordinary and partial differential equations, Approximation by Spline functions, Use of computer techniques.

Statistical methods: Random variables, estimation and detection, expectation and correlation, Bay's theorem, hypothesis testing, use of computer techniques in statistical analysis

Pre-requisite Knowledge

Linear Algebra, Ordinary Differential Equations (ODEs), Partial Differential Equations (PDEs), Trapezoidal Rule, Simpson's rule, Taylor` series, basic probability theory.

Keywords

Interpolation, Polynomials, Curve Fitting, Linear and nonlinear Equations, Numerical solution of differential Equations.

References

1. Mark Embree, "Numerical Analysis I", Rice University, 2012.
2. Jan Awrejcewicz, "Numerical Analysis: Theory and Applications", InTech, 2011.
3. Youssef Saad, "Numerical Methods for Large Eigenvalue Problems", SIAM, 2011.
4. Douglas W. Harder, Richard Khoury, "Numerical Analysis for Engineering", University of waterloo, 2010.
5. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John-Wiley & Sons, 2006.
6. Roy D. Yates and David Goodman, “Probability and Stochastic Processes: A Friendly Introduction for Electrical and Computer Engineers”, 2nd Edition, Wiley, 2004
7. Sheldon M. Ross, “Introduction to Probability and Statistics for Engineers and Scientists,” fifth edition, Academic Press, 2014.

Course Number	Course Title	Units
802602	**ENGINEERING DESIGN AND RESEARCH METHODS**	**3**

Objectives

This course instills the life-long learning, creative problem solving, team design, and communication (written, oral, graphical, and visual) skills into engineering students. The professional engineers design their projects within certain economic, environment, societal, and global constraints. They also consider ethics, safety, health, life cycle, manufacturability, and sustainability when designing projects. The objectives of this course are also to familiarize students with the research process and methodology enabling them to perform Engineering Research and write scientific and engineering research articles for publishing.

Description

Introduction to Engineering Design Process; defining real problem based on customers' needs, generating alternative solutions to meet the desired needs, selecting the best alternative based on realistic constraints and customer needs based selection criteria, implementing the best alternative, and evaluation the solution. Design Project Proposal writing.

Research methodology; Overview of the Research process, Literature Search, Report Writing, Data Collection and Data Presentation, Statistical Analysis of Data and Sampling, Making a Presentation, and Survey Research Methods.

Pre-requisite Knowledge

Each Student should have the basic knowledge of Probability Theory and Statistics, working knowledge of MATLAB and MS Excel including 2D and 3D graphics, Data Collection and Sampling Theory.

Keywords

Engineering Design, Sampling Theory, Realistic Constraints, Research Process.

References

1. Kart T. Ulrich and Steven D. Eppinger, "Product Design and Development", McGraw-Hill International edition, 4th Ed., 2008.
2. Class Notes.

Courses' Descriptions (General Elective Courses)

Course Number	Course Title	Units
802605	**MODELING AND SIMULATION**	**3**

Objectives

This course presents concepts of computer-based modeling and simulation applicable to various domains of engineering. This includes theoretical concepts, methods, and applications of modeling and simulation techniques.

Description

Basic concepts of modeling and simulation, modeling of electronic systems (electronic devices and electronic circuits), modeling of communication systems, modeling of power devices and systems, numerical simulation, finite difference method, finite element method, numerical solution of system of linear equations, solution of nonlinear equations, Newton-Raphson method, curve fitting, parameter extraction, error analysis, implementation of case studies using MATLAB.

Pre-requisite Knowledge (Subject to Department Consent)

Matrix algebra, basic numerical analysis course, basics of electronic devices.

Keywords

Modeling, Simulation, MATLAB.

References

1. S. Selberherr , “Analysis and Simulation of Semiconductor Devices”, Springer, 2013.
2. B.P. Zeigler, H. Praehofer, T.G. Kim, “Theory of Modeling & Simulation”, Academic Press, second edition, 2000.
3. Yue Fu, Zhanming Li, Wai Tung Ng, Johnny K.O. Sin, "Integrated Power Devices and TCAD Simulation (Devices, Circuits, and Systems)", CRC Press, 2014.
4. Giuseppe Massobrio, Paolo Antognetti, “Semiconductor Device Modeling”, McGraw-Hill Professional; first edition, 1998.
5. Michel C. Jeruchim, Philip Balaban, K. Sam Shanmugan, “Simulation of Communication Systems: Modeling, Methodology and Techniques”, 2nd Edition, Springer, 2000.

Course Number	Course Title	Units
802606	**OPERATIONS RESEARCH**	**3**

Objectives

To familiarize the students with the basic terminology of operation research, including mathematical modeling, feasible solution, optimization, and iterative computations. By the end of the course students will be able to use quantitative methods and techniques for effective decisions–making; model formulation and applications that are used in solving engineering problems.

Description

This course will cover a wide range of topics in operations research including modeling with linear and dynamic programming, Simplex method and sensitivity analysis, Duality and post-optimal analysis, Transportation model and its variants, Network models, Advanced linear programming, Goal programming and its stability, Integer linear programming, Deterministic inventory models, Decision analysis and games, Simulation modeling.

Pre-requisite Knowledge (Subject to Department Consent)

Calculus of Several Variables, Linear or Matrix Algebra, Basic Optimality Conditions, Sensitivity Analysis, Review of Probability, Conditional Probability, Generating Function.

Keywords

Linear Programming, Dynamic Programming, Sensitivity Analysis, Goal Programming, Transportation Model, Simplex Techniques.

References

1. Feng Chen, "Introduction to Operations Research", 2012.
2. Hamdy A. Taha, "Operations Research: An Introduction", Prentice Hall, 9th Edition, 2011.
3. R. K. Gupta, "Operations Research", 27^{th} Edition, 2010,
4. Frederick S. Hillier and Gerald J. Lieberman, “Introduction to Operations Research", 9^{th} Edition, 2009.
5. Wayne Winston, "Operations Research: Applications and Algorithms", Duxbury Press; 4^{th} Edition, 2003

Course Number	Course Title	Units
802607	**ADVANCED CONTROL SYSTEMS**	**3**

Objectives

In this course students will learn to analyze and design classical controllers by using the approaches based on Root-locus plots and Bode plots. Students will learn about the stability analysis using Nyquist method. Students will learn to design PID controllers with frequency response and optimization approaches. Students will learn how to tune the designed PID controller for the required specifications. Students will learn how to analyze and design controllers in state-space.

Description

This course is an extension of first course in Control Systems. It will extend the existing concepts of control owned by the students. Main focus is on the controller analysis and design in the frequency domain and in the state-space. PID controller design and tuning are also addressed. It can be said that the students will be capable of initiating research in control applications after completing this course.

Pre-requisite Knowledge (Subject to Department Consent)

Basic course in control systems.

Keywords

Controller design, Controller analysis, Frequency domain, State space, PID controller.

References

1. Ogata, K., “Modern Control Engineering”, Prentice-Hall, 5th ed., 2010.
2. Kuo, B. C., “Automatic Control Systems”, Prentice-Hall, 8th ed., 2002.
3. Khalil H., “Nonlinear Systems”, Prentice Hall, 3rd ed., 2001.
4. Haddad W. M. and Chellaboina V. S., “Nonlinear Dynamical Systems and Control: A Lyapunov-Based Approach”, Princeton University Press, 2008.
5. Kirk D. E., “Optimal Control Theory: An Introduction”, Prentice Hall, 1998.
6. Math Works Inc., “Matlab User Guide, Control Systems Toolbox, and Signal Processing Toolbox”, Latest edition.

Course Number	Course Title	Units
802608	**DIGITAL CONTROL SYSTEMS ANALYSIS AND DESIGN**	**3**

Objectives

In this course, students will learn about typical digital control loops in a control system. Students will understand the concepts of sampling, aliasing and related phenomena in time and frequency domain. Students will learn how to use Z-transform to analyze discrete-time control loop. Students will learn how to analyze and synthesize digital control loops in time domain and in frequency domain. Student will be able to design state observer based controllers.

Description

Digital control is used in most of the process controllers. This course introduces practical methods to analyse digital control loops. Various methods of discretization of continuous-time controllers are discussed. Time domain, frequency domain and state-space methods are studied. Digital control case studies will add further insight into the subject. After this course, students will hopefully be able to understand applied research in this area.

Pre-requisite Knowledge (Subject to Department Consent)

Basic course in control systems.

Keywords

Discretization, Digital control design, Sampling, State observer.

References

1. Astrom, K. J. and Wittenmark B., "Computer Controlled Systems: Theory and Design", Prentice-Hall, 3rd ed., 2011.
2. Leigh. J. R., "Applied Digital Control: Theory, Design and Implementation", Prentice-Hall, 2nd ed., 2006.
3. Franklin G. F., Powell J. W., and Workman M., "Digital Control of Dynamic Systems", Pearson Education; 3rd ed., 2005.
4. Ogata K., "Discrete-Time Control Systems", Prentice-Hall, 1995.
5. Phillips, C. L. And Nagle H. T. Jr., "Digital Control System Analysis and Design", Prentice-Hall, 3rd ed., 1994.
6. Math Works Inc., "Matlab User Guide, Control Systems Toolbox, and Signal Processing Toolbox", Latest edition.

Course Number	Course Title	Units
802609	**NONLINEAR CONTROL SYSTEMS**	**3**

Objectives

This course aims to deliver to the students knowledge about main theories used to analyze nonlinear systems. Students will learn how to analyze the nonlinear systems using Phase Plane and Lyapunov's stability methods. Students will learn how to develop and apply the concept of absolute stability theory of Popov. Students will learn about bilinear systems. Students will learn how to optimally control non-linear systems.

Description

This research level course addresses non-linear control loops. Lyapunov and Popov stability theories are introduced. This is primarily an analysis course, therefore, describing functions and phase plane analysis techniques are addressed. Nonlinear optimal and sub-optimal control synthesis are also covered. It is expected that students will be able to understand applied research going on in this field after completing the course.

Pre-requisite Knowledge (Subject to Department Consent)

Basic course in control systems.

Keywords

Non-linear systems, Describing function, Lyaponov's stability, Bilinear systems.

References

1. Haddad W. M., Chellaboina V. S., “Nonlinear Dynamical Systems and Control: A Lyapunov-Based Approach”, Princeton University Press, 2008.
2. Vidyasagar M., “Nonlinear Systems Analysis”, Prentice-Hall, 2002.
3. Khalil H., “Nonlinear Systems”, Prentice Hall, 3rd ed., 2001.
4. Isidori, “Nonlinear Control Systems”, Springer-Verlag, 1995.
5. Math Works Inc., “Matlab User Guide, Control Systems Toolbox, and Signal Processing Toolbox”, Latest edition.

Course Number	Course Title	Units
802610	**INTILLIGENT CONTROL**	**3**

Objectives

Students will learn fuzzy logic, fuzzy theory and its applications to control systems. Students will understand the architectures and learning and recall algorithms of Artificial Neural Networks (ANNs). Students will learn how to use Fuzzy logic and ANNs for classical control problems. Students will be able to develop prototype programs using soft computing methods.

Description

This course covers the major ingredients of soft intelligent techniques, which includes fuzzy systems computing, artificial neural networks, and neuro-fuzzy systems computing. Both theoretical and computational aspects of these computing techniques will be addressed. Important control problems will be addressed and programmed for solution by these techniques. It is hoped that students will be able to write applied research proposal related to this area.

Pre-requisite Knowledge (Subject to Department Consent)

Basic course in control systems.

Keywords

Fuzzy logic, Neural networks, Soft computing, Intelligent control.

References

1. Ross T. J., “Fuzzy Logic with Engineering Applications”, John Wiley, 3rd ed., 2010.
2. Tanaka K., and Wang H. O., “Fuzzy Control Systems Design and Analysis”, John Wiley, 2001.
3. Haykins S., “Neural Networks and Learning Machines”, Prentice Hall, 3rd ed., 2009.
4. Heaton J., “Introduction to the Math of Neural Networks”, Heton Rsearch Inc., 2012.
5. Eiben A. E., and Smith, J. E., “Introduction to Evolutionary Computing”, Springer Verleg, 2007.
6. Kenneth A. De Jong, “Evolutionary Computation”, MIT Press, 2001.
7. Math Works Inc., “Matlab User Guide, Fuzzy Systems Toolbox and Neural Networks Toolbox”, Latest edition.

Course Number	Course Title	Units
802611	**OPTIMAL CONTROL ENGINEERING**	**3**

Objectives

Students will learn how to develop mathematical models of linear and non-linear optimization problems and find their solutions. Students will be able to develop an insight to dynamic programming for optimization. Students will learn calculus of variation as applied to optimal control engineering. Students will learn how to define various optimal (minimum time, minimum energy) control strategies. Students will learn how to numerically program an optimal control problem. Students will learn applications of optimal control through various case studies

Description

This course will cover the constrained optimization techniques, which will include linear programming, non-linear programming and dynamic programming. Some application problems will be considered and the optimal solution(s) will be sought for them using the appropriate optimization techniques. Calculus of variation will be introduced as applied to optimal control. Control strategies like optimal time and optimal energy will be discussed. In practical control problems, one is often forced to design a numerical optimal control law. For this reason steepest descent method and method of variation of extremals will be studied. Some case studies will also be given to the students.

Pre-requisite Knowledge (Subject to Department Consent)

Basic course in control systems.

Keywords

Linear programming, Non-linear programming, Dynamic programming, Calculus of variation, Optimal control strategies.

References

1. Ravindran A., Ragsdell K. M., and Reklaitis G. V., “Engineering Optimization: Methods and Applications”, 2nd ed., John Wiley, 2006.
2. Athans M. and Falb, P. L., “Optimal Control: An Introduction to the Theory and Its Applications”, Prentice Hall, Dover Edition, Reprint 2006.
3. Kirk, D. E., “Optimal Control Theory: An Introduction”, Prentice-Hall, Dover Edition, 2004.
4. Fletcher R., “Practical Methods of Optimization”, 2nd ed., John Wiley, 2000.

Course Number	Course Title	Units
802612	**DATA ACQUISITION SYSTEMS**	**3**

Objectives

The student will learn fundamentals of electronic collection of data from measurement devices and basics of electronic digital control of external equipment.

Description

Introduction to Data Acquisition and Control, Essentials of Computer Interfacing and Programming of Instruments, Developing Virtual Instruments in LabVIEW, Principles of Graphical Programming in LabVIEW, Basics of Measurement: Sensors and Transducers, Analog-to-Digital and Digital-to-Analog Conversion, Digital Input/Output, Timers and Counters, Fundamentals of Linear and Digital Control, Instrumentation Buses: Serial (RS232C, USB) and Parallel (GPIB) Elements of Data Analysis: Averaging, Filtering and Smoothing Data Analysis: Curve Fitting Wireless Sensor Networks, Advanced Signal Analysis: Correlation, Fourier Transform.

Pre-requisite Knowledge (Subject to Department Consent)

Instrumentation, sensor concepts, mathematical modeling.

Keywords

Data acquisition, Analog to Digital converter, Digital I/O, Computer Interfacing.

References

1. Piromalis D., Tseles I.D., Systems Applications for Data Acquisition, Athens: Modern Publishing, (2012)
2. Tsele I.D., Aquisition and Data Processing, Athens: Modern Publishing, (2002)

Course Number	Course Title	Units
802613	**SENSORS AND INSTRUMENTATIONS**	**3**

Objectives

Demonstrate an understanding of recent developments in sensor enabling technologies. To analyze the performance of a sensor system, including transducer, electronics and signal processing.

Description

Sensors and instruments for environmental monitoring. Optical Fiber Sensors. Sensor instrumentation. Implementation and operation of advanced instrumentation and sensor systems. Sensor networks, advanced sensor conditioning methods, smart sensor systems and error analysis. Signal processing. Smart sensors and systems.

Pre-requisite Knowledge (Subject to Department Consent)

Instrumentation, Basic electronics, Mathematical modeling in signal processing.

Keywords

Sensors, Transducers, Actuators, Signal conditioning

References

1. Mukhopadhyay, Subhas Chandra, "Smart Sensors, Measurement and Instrumentation", Springer, 2005
2. Allan S. Morris "Measurement and instrumentation principles, 3rd edition", Cambridge University Press, 2008.
3. William C. Dunn, " Introduction to Instrumentation, Sensors and Process Control", Artech House, 2006

Courses' Descriptions (Electronics)

Course Number	Course Title	Units
802620	**QUANTUM MECHANICS FOR ELECTRICAL ENGINEERS**	**3**

Objectives

This course provides a background of quantum theory that is necessary for those who start work on micro or nano-electronic structures.

Description

Concepts of modern physics: Duality theory of particle and wave, De Borglie hypothesis, Wave-packet and group velocity, Wave function, Uncertainty principle. Mathematical foundations of quantum mechanics, Basic postulates of quantum mechanics, Schrödinger equation, Infinite and finite potential wells, Tunneling effect, Periodic potential and Kronig-Penney Model of solids, Harmonic oscillator, Basis functions, Operators, Dirac notation. Approximation methods: WKB and perturbation theory. Quantum mechanical treatment of MOSFETs.

Pre-requisite Knowledge

Electrodynamics, Differential and partial differential equations, Complex numbers and Matrices.

Keywords

Wavefunction, Schrödinger equation, Quantization and tunneling effects, and Quantum theory of solids.

References

1. Arthur Beiser, “Concepts of Modern Physics”, 6th Edition, McGraw Hill, 2002.
2. D. A. B. Miller, “Quantum Mechanics for Scientists and Engineers”, Cambridge University Press, 2008.
3. David Ferry, "Quantum Mechanics-An Introduction for Device Physicists and Electrical Engineers", 2nd Edition, IoP, 2001.
4. Nouredine Zettili, “Quantum Mechanics-Concepts and Applications”, John Wiley & Sons, 2009.
5. A. F. J. Levi, “Applied Quantum Mechanics” ", 2nd Edition, Cambridge University Press, 2006.

Course Number	Course Title	Units
802621	**ADVANCED SEMICONDUCTOR MATERIALS**	**3**

Objectives

This course provides the student with the various electronic, optical and magnetic properties of materials that are used in modern electronic devices.

Description

Crystal Structure, Reciprocal lattice, Crystal binding, crystal vibrations and phonons, Free electron Fermi Gas, Electric and Thermal conduction in solids, Band Structure of Selected Semiconductors, Equilibrium and Non-equilibrium electrical properties of semiconductors, Fermi surfaces and Metals, Optical processes and Excitons, Superconductivity, Dielectrics and Ferro-electrics, Diamagnetism and Paramagnetism, Ferromagnetism and Antiferromagnetism, Magnetic resonance, Non-crystalline solids.

Pre-requisite Knowledge (Subject to Department Consent)

Basics of semiconductor physics, Electromagnetism, Differential equations.

Keywords

Semiconductor structure and properties, Dielectrics, Magnetic materials.

References

1. Rolf E. Hummel, "Electronic Properties of Materials", Springer, 3rd edition, 2011.
2. Safa Kasap, "Principles of Electronic Materials and Devices", McGraw-Hill, 3 edition, 2005.
3. P. Yu and M. Cardona, "Fundamentals of Semiconductors: Physics and Materials Properties", Springer; 4th edition, 2010.
4. C. Kittel, "Introduction to Solid State Physics", Wiley, 8 edition, 2004.
5. G. He and Z. Sun, "High-k Gate Dielectrics for CMOS Technology", Wiley-VCH, 2012.

Course Number	Course Title	Units
802622	ADVANCED SEMICONDUCTOR DEVICES	3

Objectives

By the end of this course the student will be familiar with the basic properties and design parameters of modern VLSI devices as well as the factors affecting their performance. Emphasis will be on Metal-Oxide-Semiconductor (MOS) transistors with their various structures.

Description

Evolution of VLSI Technology, Review of the physics of p-n junctions and MOS structures, Metal-Semiconductor (MS) contacts, high-field effects, long-channel and short-channel MOSFETs, high-k dielectrics, SOI devices: Double-gate (DG) MOSFET, FinFET, Multiple-gate MOSFETs, Memory devices.

Pre-requisite Knowledge (Subject to Department Consent)

Basics of electronic devices: p-n junctions and bulk MOSFETs.

Keywords

VLSI devices, MOSFET, SOI-MOSFET, DG-MOSFET, FinFET, MS contacts.

References

1. Yuan Taur and Tak H. Ning, "Fundamentals of Modern VLSI Devices", Cambridge University Press, 2nd edition, August 2009.
2. J.-P. Colinge , "FinFETs and Other Multi-Gate Transistors", Springer, 2008.
3. Chenming Hu, "Modern Semiconductor Device for Integrated Circuits", Prentice Hall, 2009.
4. Donald Neamen, "Semiconductor Physics and Devices", 4th Edition, McGraw hill, 2011.
5. Gang He and Zhaoqi Sun, "High-k Gate Dielectrics for CMOS Technology", Wiley-VCH; 2012.
6. R. S. Muller, T. I. Kamins and Mansun Chan, "Device Electronics for Integrated Circuits", 3rd Ed., Wiley and Sons, 2002.
7. S. M. Sze and K. K. Ng, "Physics of Semiconductor Devices," 3rd Edition, Wiley Interscience, 2007.

Course Number	Course Title	Units
802623	**ADVANCED IC TECHNOLOGY**	**3**

Objectives

To make the student familiar with the different techniques used in process technology for silicon IC manufacturing.

Description

Crystal Growth and Wafer Preparation, Epitaxy, Oxidation, lithography, Plasma Etching, Chemical Vapor Deposition (CVD, Ion Implementation, Metallization, Process Simulation, MOS gates dielectric, Device isolation, Shallow junction, Contacts, Interconnects, Process integration, BiCMOS, SOI and Multi-gate transistors fabrication technologies, Yield and Reliability, Future technology evolution: strained silicon, nanowires.

Pre-requisite Knowledge (Subject to Department Consent)

Fundamentals of solid state engineering, Basics of MOSFET and BJT, Energy band structures.

Keywords

Epitaxial growth, CVD, lithography, Plasma Etching, MOSFET, BiCMOS, SOI and Multi-gate technology.

References

1. Gary S. May and Simon M. Sze, “Fundamentals of Semiconductor Fabrication”, Wiley, 2003
2. Richard C. Jaeger, “Introduction to Microelectronic Fabrication: Volume 5 of Modular Series on Solid State Devices” Prentice Hall; 2 edition, 2001
3. J. D. Plummer, M. D. Deal and P. B. Griffin, “Silicon VLSI Technology: Fundamentals, Practice and Models”, Prentice Hall, 2000
4. A. Nazarov, J. P. Colinge, F. Balestra and J. P. Raskin, “Semiconductor-On-Insulator Materials for Nanoelectronics Applications (Engineering Materials)”, Springer, 2011.
5. M. Razeghi, "Fundamentals of Solid State Engineering", Springer, 3rd Edition, 2009.

Course Number	Course Title	Units
802624	**SEMICONDUCTOR CHARACTERIZATION METHODS**	**3**

Objectives

There are two main objectives of the course: (1) to familiarize the students with electrical and optical characterization techniques utilized in semiconductor materials, (2) to provide the students with electrical methods of evaluating electronic device parameters.

Description

Measurement techniques for semiconductor materials: resistivity, doping type and concentration, doping profile, carrier lifetime, bulk mobility, energy band gap, barrier height and contact resistance. Measurement of oxide thickness and trapped charge. Photoluminescence analysis of semiconductors, Electron-beam, ion-beam, x-ray characterization, Deep-level transient spectroscopy. I-V characterization of MOSFET parameters: effective channel length and width, threshold voltage, mobility, series resistance and DIBL coefficient. Analysis of surface and interface defects by C-V and transient techniques.

Pre-requisite Knowledge (Subject to Department Consent)

Basics of Solid state electronics, semiconductor devices.

Keywords

Semiconductor Measurement Techniques, MOSFET mobility and series resistance, lifetime measurements.

References

1. Dieter K. Schroder, "Semiconductor Material and Device Characterization", John Wiley & Sons, 2006.
2. B. G. Yacobi, "Semiconductor Materials", Springer, 2002.
3. C. Lamberti, "Characterization of semiconductor heterostructures and nanostructures", Elsevier Books, 2008.

Course Number	Course Title	Units
802625	MICRO-ELECTRO-MECHANICAL SYSTEMS	3

Objectives

The main objective of this course is to explore the various aspects of microelectromechanical systems (MEMS) including: fabrication techniques, structural mechanics, material properties and applications. Student will be familiarized with MEMS design building blocks and modeling.

Description

Microfabrication of semiconductor and inorganic MEMS. Bulk and surface micromachining techniques. Material properties, structural behavior, suspension elements, electrostatic actuation, pressure sensors, thermal sensors, piezoresistive and capacitive sensing. Inertial sensors, such as accelerometers and gyroscopes. System level MEMS circuits, such as amplifiers and feedback. MEMS modeling: lumped-element, reduced order and finite element. Packaging, partitioning, testing and calibration.

Pre-requisite Knowledge (Subject to Department Consent)

Integrated Circuit Fabrication, Electromagnetism, Mechanics and Optics.

Keywords

MEMS, Sensors, Transducers.

References

1. Chang Liu, "Foundations of MEMS", Prentice Hall, Second Edition, 2011.
2. Nadim Maluf, “An Introduction to Microelectromechanical Systems Engineering ", Artech House Print on Demand, Second Edition, 2004.
3. Ki Bang Lee, “Principles of Microelectromechanical Systems ", Wiley-IEEE Press, 2011.
4. Ville Kaajakari, "Practical MEMS: Design of microsystems, accelerometers, gyroscopes, RF MEMS, optical MEMS, and microfluidic systems", Small Gear Publishing, 2009.
5. Stephen D. Senturia, “Microsystem Design”, Springer, 2005

Course Number	Course Title	Units
802626	**CHARGE TRANSPORT MODELS**	**3**

Objectives

By the end of this course, the student should learn the physical principles and theoretical foundation of carrier transport in electronic devices including semi-classical and quantum-mechanical approaches.

Description

Semi-classical carrier transport models: Boltzmann transport equation, balance equations, hydrodynamic model, Drift-diffusion model; Quantum transport models: Ballistic transport, Landauer formula, quantum conductance, Non-equilibrium Green Function formalism and its application on nanoscale devices.

Pre-Requisite Course(s)

Advanced Semiconductor Devices (803522)

Keywords

Carrier transport, Boltzmann transport equation, hydrodynamic model, Drift-diffusion model, Quantum transport, ballistic transport, Non-equilibrium Green Function formalism.

References

1. Mark S. Lundstrom, “Fundamentals of Carrier Transport”, Cambridge University Press, 2009.
2. Mark S. Lundstrom and Jing Guo, “Nanoscale Transistors: Device Physics, Modeling and Simulation”, Springer, 2010.
3. Supriyo Datta, “Quantum Transport: Atom to Transistor”, Cambridge university Press, 2013.
4. Supriyo Datta, “Electronic Transport in Mesoscopic Systems”, Cambridge university Press, 1997.
5. Supriyo Datta, “Lessons from Nanoelectronics: A New Perspective on Transport”, World Scientific Publishing Company, 2012.

Course Number	Course Title	Units
802627	**NANO-ELECTRONIC DEVICES**	**3**

Objectives

By the end of this course, the student should learn the physics and electronic properties of nanoscale devices with primary focus on carbon nanotube and Graphene. The student should demonstrate the theory of operation and carrier dynamics of Carbon nanotube field-effect transistors as well as carbon nanotube interconnects.

Description

History of carbon electronics, band structure of Graphene, carbon nanotube types and their electronic properties, carbon nanotubes at equilibrium, carbon nanotube field-effect transistors (CNFETs), CNFET modeling and simulation, carbon nanotube interconnects.

Pre-Requisite Course(s)

Advanced Semiconductor Devices (803522)

Keywords

Carbon nanotubes, Graphene, CNFET, Carbon nanotube interconnects.

References

1. H.-S. Philip Wong and Deji Akinwande, "Carbon Nanotube and Graphene Device Physics", Cambridge University Press, 2011.
2. Ali Javey and Jing Kong, "Carbon Nanotube Electronics ", Springer, 2009.
3. Lundstrom, Mark S. Guo, Jing, "Nanoscale Transistors: Device Physics, Modeling and Simulation", Springer, 2010.
4. Francois Leonard, "Physics of Carbon Nanotube Devices", William Andrew, 2008.

Course Number	Course Title	Units
802628	**NANO-OPTICS**	**3**

Objectives

To provide students the background of science and engineering of light matter interactions at the nanometer scale. Students will learn various nano-optics-based technologies as well as the applications of nano-optics.

Description

Optics in the near-field limit, angular spectrum representation of propagation, light emission in the nanoscale environment, surface plasmons, optical forces, meta- and negative-index materials, and quantum emitters.

Pre-Requisite Course(s)

Nano-Electronic Devices (802627)

Keywords

Light Emission, Surface Plasmons, Optical Forces, Quantum Emitters.

References

1. Sergey V. Gaponenko, "Introduction to Nanophotonics", Cambridge University Press, 2010
2. Lukas Novotny and Bert Hecht, "Principles of nano-optics", Cambridge University Press, 2006.
3. Paras N. Prasad, "Nanophotonics", Wiely, 2004.

Course Number	Course Title	Units
802629	**SEMICONDUCTOR OPTOELECTRONICS**	**3**

Objectives

To provide students with the underlying physics and properties of modern semiconductor lasers. Students will know the recent issues in modern semiconductor optics.

Description

Focus is on the physics of the interaction of photons with semiconductor materials: absorption and gain of semiconductor media. Concepts of laser threshold, population inversion and modulation response. Resonator structures such as distributed feedback lasers, tunable lasers and microring devices. Noise models for semiconductor optoelectronic devices, applications of optoelectronic devices to fiber optic communications.

Pre-requisite Knowledge (Subject to Department Consent)

Semiconductor Device Fundamentals, Quantum Mechanics.

Keywords

Photon-matter interaction, laser, semiconductor optoelectronic devices, Semiconductor Lasers, Laser Diodes, Light Emitting Diodes.

References

1. Takahiro Numai, "Fundamentals of semiconductor lasers", Springer, 2004.
2. Stephan W. Koch and Weng W., "Semiconductor-laser fundamentals", Springer, 1999.
3. Claus F. Klingshirn, "Semiconductor optics", Springer, 2007.
4. W. Martin and W. Schäfer, "Semiconductor optics", Springer, 2002.

Course Number	Course Title	Units
802630	**ADVANCED ANALOG INTEGRATED CIRCUITS**	**3**

Objectives

The course aims to provide students with the knowledge of Analog integrated circuit design. They will be familiarized with CMOS modeling and provided with knowledge of new issues in CMOS devices.

Description

The art of Analog Integrated Circuit Design is to be addressed in advanced level. It covers fundamentals of designing linear CMOS circuits and their noise considerations. Topics to be covered include MOS devices and their modeling, current mirrors, op-amp design, op-amp compensation, comparators, multipliers, voltage references, and sample-and-hold circuits. An introduction to more complicated systems using these building blocks, such as phase locked loops and analog-to-digital converters.

Pre-requisite Knowledge (Subject to Department Consent)

Analog ICs.

Keywords

MOSFET, Single-Stage Amplifiers, Differential Amplifiers, Current Mirrors, CMOS Operational Amplifiers.

References

1. Behzad Razavi, "Design of analog CMOS integrated circuits", McGraw-Hill, 2001.
2. P. R. Gray and R. G. Meyer, "Analysis and Design of Analog Integrated Circuits", Wiely, 2001.
3. B. Baker, "CMOS Circuit Design, Layout, and Simulation", IEEE Press & Wiley, 2005.
4. Phillip Allen and Douglas Holberg, "CMOS Analog circuit design", Oxford University press, 2nd edition, 2002.

Course Number	Course Title	Units
802631	**ADVANCED DIGITAL DESIGN**	**3**

Objectives

This course introduces the students to logic synthesis and FPGA implementation tools and methods. It familiarizes the students with the SoC design concepts and their synthesis and implementation.

Description

High-level digital design methodology using Verilog, Reusable Methodology, HDL coding for synthesis, FPGA based Digital Design, Datapath and Controller Design Partitioning, Design of Datapath Units, Algorithmic state machine based design, Time shared and pipeline architectures, Digital design of high speed computational unit, Single Cycle and Pipelined Processor.

Pre-requisite Knowledge (Subject to Department Consent)

Digital ICs.

Keywords

HDL, FPGA, Synthesis, Implementation, Datapath, Controller design.

References

1. Michael D. Ciletti, “Advanced Digital Design with the Verilog HDL”, Prentice Hall, Second Edition, 2010.
2. J. O. Hamblen, T. S. Hall, and M. D. Furman, “Rapid Prototyping of Digital Systems”, Springer, SOPC Edition, 2008.
3. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis,” Prentice Hall, Second Edition, 2003.
4. Wayne Wolf, “FPGA-Based System Design”, Prentice Hall, 2004.

Course Number	Course Title	Units
802632	**RF IC DESIGN**	**3**

Objectives

This course will cover many fundamental/core topics in circuit design including narrow band and high frequency techniques, noise, distortion, realistic passive component models including on-chip inductors, distributed elements and the effect of nonlinearities.

Description

The design of matching networks and low-noise amplifiers at RF, passive and active filters, mixers, modulators, and demodulators; review of classical control concepts necessary for oscillator design including PLLs and PLL-based frequency synthesizers. Design of low phase noise oscillators. Design of high-efficiency (e.g., class E, F) RF power amplifiers, coupling networks. Behavior and modeling of passive and active components at RF. Narrowband and broadband amplifiers; noise and distortion measures and mitigation methods. Overview of transceiver architectures.

Pre-requisite Knowledge (Subject to Department Consent)

Analog ICs.

Keywords

MOSFET, Low Noise Amplifier, RF Power Amplifier, PLL and PLL-based Frequency Synthesizers, Transceiver Architectures.

References

1. Thomas H. Lee, “The Design of CMOS Radio-Frequency Integrated Circuits" Second Edition, Cambridge University Press, 2006.
2. Behzad Razavi, “Design of analog CMOS integrated circuits”, McGraw-Hill, 2001.
3. P. R. Gray and R. G. Meyer, “Analysis and Design of Analog Integrated Circuits”, Wiely, 2001.
4. Phillip Allen and Douglas Holberg, “CMOS Analog circuit design”, Oxford University press, 2nd edition, 2002.

Course Number	Course Title	Units
802633	**ANALOG SIGNAL PROCESSING**	**3**

Objectives

This course aims to introduce analog signal processing techniques that can be used to perform computation in the analogue front end prior to back end processing and/or communication, with the aim to increase signal integrity as well as reduce the power consumption of the system as a whole.

Description

Introduction to domains and the analog/digital trade off, Current mode Techniques-Translinear Synthesis, Current mode computation, current conveyors, and current mode filters.

Voltage mode Techniques, V-I, I-V converters, Wide range Trans-conductance amplifiers, voltage mode filters, Switch Capacitor Techniques-Integrators, Differentiators, Memory Cells, switched capacitor filters, Spike domain circuits-Integrate and Fire Neurons, Cortical computation

Pre-requisite Knowledge (Subject to Department Consent)

Analog ICs.

Keywords

Current Conveyors, Current mode, voltage mode and mixed mode filters, Switched Capacitors, Trans-conductance Amplifiers.

References

1. F. Yuan, “CMOS Current Mode Circuits for Data Communications”, Springer, 2007.
2. R. Jacob Baker, “CMOS Mixed-Signal Circuit Design”, Wiley-IEEE Press, 2nd Edition, 2009.
3. Behzad Razavi, “Design of analog CMOS integrated circuits”, McGraw-Hill, 2001.
4. C. Toumazou, F. J. Lidgey, D. Haigh, “Analogue IC Design: The Current-mode Approach”, IET, 1993.

Course Number	Course Title	Units
802634	**COMPUTER AIDED VLSI DESIGN**	**3**

Objectives

This course teaches students how to use VHDL compilers, simulation and synthesis tools to describe and verify digital systems in a technology-independent fashion.

Description

VHDL-Modelling of hardware: model of behavior, time and structure. Major VHDL constructs: entity declarations, architecture bodies, subprograms, packages and 'use' clauses. Basic VHDL data types: literals, scalars, vectors. Behavioral description: processes, activation and suspension of processes, sequential assignments, signal assignments, variable assignments, sequential control, procedure and function calls, concurrent statements. Structural description: parts, component instantiation, configuration specifications, busses. Access types: files, file I/O. Testing and verification-VHDL test benches. Procedural abstraction. Exhaustive, random, adhoc testing methods. Test coverage metrics. Synthesis-Multi-level logic minimization techniques: Boolean optimization. Critical path optimization, High level synthesis: state minimization in FSM. Technology mapping: gate arrays, FPGA, PLDs.

Pre-Requisite Course(s)

Advanced Digital Design (802631)

Keywords

Logic Circuits, VHDL modeling, Test and verification, High Level Synthesis, Critical path optimization, FPGA, PLDs.

References

1. Andrew Rushton, "VHDL for Logic Synthesis", John Wiley and Sons Inc Ltd, UK, 3rd Edition, 2011.
2. V. A. Pedroni, "Circuit Design with VHDL", Massachusetts Institute of Technology, 2004.
3. Pong P. Chu, "RTL Hardware Design using VHDL", John Wiley and Sons Inc, NJ, 2006.
4. W. F. Lee, "VHDL Coding and Logic Synthesis with Synopsys", Advanced Micro Devices, Inc., 2000.

Course Number	Course Title	Units

802692	ADVANCED TOPICS IN ELECTRONICS ENGINEERING	3

Objectives

This course is intended to cover any advanced topics in electronics engineering which not included in the program and the student require it to compete his study.

Description

To be provided by the supervisor and the electronics sequence committee.

Pre-requisite Knowledge (Subject to Department Consent)

To be provided by the instructor.

Keywords

To be provided by the instructor.

References

To be provided by the instructor.

Courses' Descriptions (Communications)

Course Number	Course Title	Units
802640	**STOCHASTIC PROCESSES**	**3**

Objectives

To introduce students to the concepts of discrete and continuous random functions to be able to perform computation of correlation function, power spectral density, and response to LTI systems driven by random processes. The students will learn concepts of optimum detection and estimation, Bayesian, Weiner and Kalman filtering to be able to perform processing of random signals and analyze random processes.

Description

Introduction to discrete and continuous-time random processes. Correlation and power spectral density functions. Linear systems driven by random processes. Optimum detection and estimation. Bayesian, Weiner, and Kalman filtering. The stochastic processes that will be developed for the modeling and analysis of systems including: Markov Chains and Processes; Point Processes: Brownian Motion and Martingales.

Pre-requisite Knowledge (Subject to Department Consent)

Random Variables and Signals.

Keywords

Random processes, Weiner and Kalman filtering, Markov Chains and Processes, Point Processes, Brownian Motion and Martingales.

References

1. Alberto Leon-Garcia, “Probability, Statistics, and Random Processes for Electrical Engineering”. Prentice Hall; 3rd edition, January 2008.
2. Athanasios Papouli and S Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", McGraw-Hill Europe; 4th edition, January 2002.
3. C. W. Gardiner, "Handbook of Stochastic Processes", Springer, 2004.
4. M. Scot, "Applied Stochastic Processes for Science and Engineering", Springer 2013.

Course Number	Course Title	Units
802641	PATTERN RECOGNITION	3

Objectives

To provide primarily graduate students with the statistical theory of pattern recognition, including both parametric and non-parametric approaches to classification to be able to perform classification with likelihood functions and general discriminant function. The students will also learn the concepts of density estimation, supervised and unsupervised learning, and classification using sequential and contextual information including Markov and hidden Markov models to perform parameter/feature estimation and classification.

Description

Statistical theory of pattern recognition, including both parametric and nonparametric approaches to classification. Covers classification with likelihood functions and general discriminant function, density estimation, supervised and unsupervised learning, decision trees, feature reduction, performance estimation, and classification using sequential and contextual information, including Markov and hidden Markov models.

Pre-requisite Knowledge (Subject to Department Consent)

Stochastic Processes.

Keywords

Parametric and nonparametric classification, likelihood function, supervised and unsupervised learning, decision tree, Markov and hidden Markov models.

References

1. Artur Sierszeń, Łukasz Sturgulewski, "Evaluation of Reliability of a Decision-Making Process Based on Pattern Recognition", Springer-Verlag, Berlin Heidelberg, 2011.
2. Sergios Theodoridis, Konstantinos Koutroumbas, "Introduction to Pattern Recognition , A MATLAB Approach ", AP, 2010
3. Richard O. Duda, Peter E. Hart and David G. Stork, "Pattern Classification", 2nd edition, Wiley-Interscience; October 2000.
4. Christopher M. Bishop, "Pattern Recognition and Machine Learning". Springer-Verlag New York, October 2007.
5. Phiroz Bhagat, “Pattern Recognition in Industry", Elsevier Science, June 2005.
6. K. Fukunaga, “Introduction to Statistical Pattern Recognition”, 2nd Edition, Academic Press, 1990.

Course Number	Course Title	Units
802642	**DETECTION THEORY**	**3**

Objectives

To provide graduate students with the ability to derive optimal tests for the detection of signals in additive white/ colored Gaussian noise. The students will be able to apply statistical theory of testing to radar signal detection and communication systems and carry out performance analysis of communication/radar receivers.

Description

Signal detection in white and colored noise. Random waveform. Matched filtering. M-ary signal detection, nonparametric detection, sequential hypothesis testing, decision theoretic schemes. Applications in communication and radar signal processing.

Pre-requisite Knowledge (Subject to Department Consent)

Random Variables and Signals. Digital Communication Systems.

Keywords

Signal Detection, Matched Filtering, Non-Parametric Detection, Hypothesis Testing.

References

1. Bernard C. Levy, "Principles of Signal Detection and Parameter Estimation, Springer 2008.
2. V. P. Tuzlukov, “Signal Detection Theory”, Bostn: Birkhauser, 2001.
3. M. K. Steven, “Fundamentals of Statistical Signal Processing: Detection Theory”, NJ: Prentice Hall, 1998.
4. H.V. Poor, “An Introduction to Signal Detection and Estimation”, Springer-Verlag, 1994.
5. H L. Van Trees, “Detection, Estimation, and Modulation Theory”, New York: Wiley, 1971.

Course Number	Course Title	Units
802643	**IMAGE PROCESSING AND REMOTE SENSING**	**3**

Objectives

To provide primarily graduate students with an introduction to modern remote sensing techniques. The course prepares the student to undertake research in remote sensing and related areas, as preparation for post-graduation professional activities in remote sensing, or as a means of further broadening one's background in the general field of image generation and processing. For students interested in image processing in general, it provides a look at the combined optimization of image design and image analysis, and an introduction to techniques applicable for scenes of high complexity.

Description

Introduction to the concepts of remote sensing, image data (multispectral, hyperspectral, LIDAR (Light Radar), microwave, SAR (Synthetic Aperture Radar) etc.) generation and analysis. Basic principles of data acquisition and measurement in natural scenes. Fundamentals of multispectral and hyperspectral data analysis for complex scenes. Application of signal/image processing, statistical and computational pattern recognition/classification algorithms to these problems. Spatial image processing methods and algorithms as appropriate to land scene data. Remote sensing applications in Geographic Information Systems (GIS). Practice with analysis of actual aircraft and spacecraft data in a cross-disciplinary environment, utilizing software packages such as MULTISPEC, MATLAB, ERDAS IMAGINE, ENVI and ESRI.

Pre-requisite Knowledge (Subject to Department Consent)

Undergraduate Course on Sensors, Measurements, and Data Acquisition. Linear Algebra, Plane Geometry, MATLAB (Software Package) Programming.

Keywords

Multispectral Data Analysis, Hyperspectral Data Analysis, Classification Algorithms, Remote Sensing.

References

1. T. M. Lillesand, R. W. Kiefer and J. W. Chipman, John, “Remote Sensing and Image Interpretation”, 4th Edition, Wiley and Sons, 2004.
2. D. Landgrebe, “Signal Theory Methods in Multispectral Remote Sensing”, J. Wiley, 2003.
3. John A. Richards and Xiuping Jia, “Remote Sensing Digital Image Analysis: An Introduction”, Springer-Verlag, 1999.
4. I. Kanellopoulos, G. G. Wilkinson, J. Austin, “Neurocomputation in Remote Sensing Data Analysis”, Springer-Verlag, 1997.

Course Number	Course Title	Units
802644	ADVANCED DIGITAL IMAGE PROCESSING	3

Objectives

To provide the student with a broad, yet strong background in the traditional topics associated with digital image processing, sharpening, interpolation, decimation, linear and non-linear filtering. Provide student with a strong background in topics associated with color imaging, image compression, image restoration, and tomography to be able to perform complete image analysis and indentify the embedded features.

Description

Introduction to digital image processing techniques for enhancement, compression, restoration, reconstruction, and analysis. Lecture and laboratory experiments covering a wide range of topics including 2-D signals and systems, image analysis, image segmentation; achromatic vision, color image processing, color imaging systems, image sharpening, interpolation, decimation, linear and nonlinear filtering, printing and display of images; image compression, image restoration, and tomography.

Pre-Requisite Course(s)

Image Processing and Remote Sensing (802643)

Keywords

Image Enhancement, Image Compression, Image Segmentation, Tomography.

References

1. Stephen G. Satnciu, "Digital Image Processing", InTech, 2012.
2. S. Jayaraman, S. Esakkirajan, T. Veerakumar, "Digital Image Processing", Tata-McGraw-Hill Education, 2011.
3. Maria Petrou, Costas Petrou, "Image Processing. The fundamentals", Wiley, 2nd Ed., 2010.
4. Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", 3rd Ed., Prentice Hall, New Jersey, 2008
5. Al Bovik, “Handbook of Image & Video Processing”, Academic Press, San Diego, 2000.

Course Number	Course Title	Units
802645	INTRODUCTION TO BIOMEDICAL IMAGING	3

Objectives

This course introduces students to the foundations of medical imaging and its applications. Students learn fundamentals and applications of four primary medical imaging techniques: magnetic resonance imaging, ultrasound, nuclear medicine, and X-ray/computed tomography.

Description

Overview of biomedical imaging systems and analysis. Examination of various imaging modalities, including X-ray, ultrasound, nuclear, and MRI. Microscopy including how images are formed and what types of information they provide. Image analysis techniques, including analysis of cardiac ultrasound, mammography, and MRI functional imagery. The physical principles, instrumental design, data acquisition strategies, image reconstruction techniques, and clinical applications of each modality. Recent developments such as multi-slice spiral computed tomography, harmonic and sub-harmonic ultrasonic imaging, multi-slice PET scanning, and functional magnetic resonance imaging. General image characteristics such as spatial resolution and signal-to-noise, common to all of the imaging modalities

Pre-Requisite Course(s)

Image Processing and Remote Sensing (802643)

Keywords

X-Ray, Ultrasound, MRI, Mammography, Microscopy, PET, Tomography.

References

1. Nadine Barrie Smith, Andrew Webb, " Introduction to Biomedical Imaging: Physics, engineering and Clinical Applications", Cambridge Text in Biomedical Engineering, 2010
2. R. Nick Bryan, "Introduction to the Science of Medical Imaging", Cambridge University Press, 2009
3. Andrew Webb, "Introduction to Biomedical Imaging", Wiley IEEE Press, 2003
4. Z. H. Cho, J. P. Jones, and M. Singh, “Foundations of Medical Imaging”, Wiley, 1993.

Course Number	Course Title	Units
802646	**STATISTICAL AND COMPUTATIONAL INTELLIGENCE**	**3**

Objectives

This course introduces students to the foundations of neural networks to be able to perform system identification, pattern recognition using computational algorithms. In depth understanding of Machine Learning in a statistical framework.

Description

Information processing with neural networks, biological and engineering implications, learning algorithms, current neural network models and architectures, implementational topics, applications in areas such as signal/image processing, pattern recognition, optimization, simulation, system identification, nonlinear prediction, communications and control. Provide a broad but in-depth introduction to neural network and machine learning in a statistical framework, all the major popular neural network models and statistical learning approaches are dealt with examples and exercises to develop a practical working understanding.

Pre-requisite Knowledge (Subject to Department Consent)

Advanced Digital Signal Processing and Filter Design

Keywords

Neural Network, System Identification, Non-Linear Prediction, Machine Learning.

References

1. Ki-Lin Du, M.N.S. Swamy, "Neural Network and Statistical Learning", Springer 2014.
2. Satish Kumar,"Neural Networks: A Classroom Approach", Tata McGraw-Hill Education, 2004
3. Yu Hen Hu, Jenq-Neng Hwang, "Handbook of Neural Network Signal Processing (Electrical Engineering & Applied Signal Processing Series)", CRC Press, 2001
4. S. Haykin, “Neural Networks, A Comprehensive Foundation”, 3rd Edition, Prentice-Hall, 1999.

Course Number	Course Title	Units
802647	**ADVANCED DIGITAL SIGNAL PROCESSING AND FILTER DESIGN**	**3**

Objectives

Provide the student with a broad, yet strong background in the traditional topics associated with processing of deterministic digital signals, e.g., discrete-time transforms, and linear filtering. Provide student with a strong background in traditional topics associated with processing of stochastic signals, e.g., spectrum estimation and linear prediction. Introduce the student to some of the more recent developments that promise to have a broad impact on digital signal processing, e.g., nonlinear filtering and adaptive filtering.

Description

Theory and algorithms for processing of deterministic and stochastic signals. Topics include discrete signals, systems, and transforms, linear filtering, fast Fourier transform, nonlinear filtering, spectrum estimation, linear prediction, adaptive filtering, and array signal processing.

Pre-requisite Knowledge (Subject to Department Consent)

Undergraduate course in Digital Signal Processing.

Keywords

Spectrum Estimation, Linear Prediction, Adaptive Filtering, Array Signal processing.

References

1. Vijay K. Madisetti, "The Digital Signal Processing Handbook", 2nd. Edition, CRC Press, 2009.
2. J. G. Proakis and D. G. Manolakis, “Introduction to Digital Signal Processing”, 4th Edition, Prentice Hall, 2007.
3. John G. Proakis, Dimitris Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", 4th ed, Pearson, April 2006,
4. Stergios Stergiopoulos, "Advanced Signal Processing Handbook; Theory and Implementation for Radar, Sonar, and Medical Imaging Real Time Systems", CRC, New York, 2000

Course Number	Course Title	Units
802648	**TIME-FREQUENCY AND MULTI-RATE SIGNAL PROCESSING**	**3**

Objectives

To provide graduate students with advanced knowledge of Time-Frequency, Time-scale analysis of signals to enable them to perform research on approximation, estimation, compression, and Target Identification. General mathematical formulation permits extensions of concepts to diverse applications, such as speech, imaging, video, and synthetic aperture radar. Establish the theory necessary to understand and use wavelets and related constructions. The course has computer and research projects involving independent study.

Description

Advanced topics in signal processing including time-frequency analysis, multiscale edge detection, wavelet bases and filter banks, and techniques for approximation, estimation, and compression using wavelets. Basic building blocks of multirate signal processing; fundamentals of multidimensional multirate signal processing; multirate filter banks; lossless lattice structures; introduction to wavelet signal processing. Applications in signal processing, communications, and sensing where time-frequency transforms like wavelets play an important role.

Pre-requisite Knowledge (Subject to Department Consent)

Advanced Digital Signal processing and Filter Design.

Keywords

Time-Frequency Analysis, Multiscale Edge Detection, Wavelets.

References

1. Martin Vetterli, Jelena Kovacevic, “Wavelets and Sub Band Coding", Prentice Hall, Englewood Cliffs, New Jersey, 2007.
2. S.G. Mallat, “A Wavelet Tour of Signal Processing”, 2nd Edition, Academic Press, 1999.
3. Bruce W. Suter, "Multirate and Wavelet Signal Processing", 1st Edition, Elsevier, 1997.
4. M. Vetterli and J. Kovacevic, "Wavelets and Subband Coding," Prentice Hall, 1995

Course Number	Course Title	Units
802649	**SPEECH PROCESSING**	**3**

Objectives

This course provides students with knowledge of speech signal analysis and synthesis to perform research on digital speech, speech features extraction, recognition of speech and speakers, parametric speech analysis by using computer algorithms.

Description

Covers the main aspects of speech processing by computer. Topics include: models of the vocal tract; identification and extraction of speech features; the recognition of speech and speakers by computer; and control of speech synthesizers. Analysis and synthesis of Pole-Zero Speech Models. Computer projects are required.

Pre-requisite Knowledge (Subject to Department Consent)

Digital signal processing and filter design.

Keywords

Vocal Tract, Identification, Extraction, Recognition, Synthesizers.

References

1. Ben Gold, Nelson Morgan, Dan Ellis, "Speech and Audio Signal Processing: Processing and Perception of Speech and Music", Wiley, 2011.
2. Thomas F. Quatieri, "Discrete-Time Speech Signal Processing, Principles and Practice", Prentice Hall, Upper saddle River, NJ 2001.
3. Lawrence R. Rabiner and B.-H. Juang, “Fundamentals of Speech Recognition”, Prentice Hall, 1993.
4. Frank J. Owens, "Signal Processing of Speech", McGraw-Hill, 1993
5. Lawrence R. Rabiner, Ronald W. Schafer, "Digital Processing of Speech Signals", Prentice Hall, 1978.

Course Number	Course Title	Units
802650	**ELECTROMAGNETIC RADIATION AND ANTENNAS**	**3**

Objectives

This course is dedicated to give the student a solid background concerning the following topics, broadband dipole, travelling waves and broadband antennas, fractal antennas, aperture antennas, horn antennas, microstrip antennas, to be able to design various antennas and perform research in this field.

Description

Analysis of some kinds of broadband dipoles such as biconical antennas, travelling waves antennas, the theory of frequency independent antennas, Analysis fractal antennas, the Field Equivalence Principle: Huygens' Principle, Analysis of aperture antennas microstrip antennas

Pre-requisite Knowledge (Subject to Department Consent)

Undergraduate course on electromagnetics.

Keywords

Broadband Dipole, Antenna, Travelling Waves, Fractal Antennas.

References

1. Joseph J. Carr, "Practical Antenna Handbook", Mc Graw-Hill., New York, 5th edition, 2011.
2. Balanis, C. A, "Antenna Theory and Analysis", John Wiley & Sons, Inc., New York, 2005.
3. Thomas A. Milligan, "Modern Antenna Design", John Wiley & Sons, Inc., New York, 2nd edition, 2005.

Course Number	Course Title	Units
802651	**RF CIRCUIT DESIGN**	**3**

Objectives

This course provides the student a solid background knowledge reaghrding noise and active RF circuits, microwave amplifier design, oscillator and mixer design.

Description

Calculate of noise, dynamic range and intermodulation distortion in microwave circuits. The two port power gains and stability concepts, Design of single stage transistor RF amplifier, Design of broad band amplifier, RF oscillator, frequency multipliers, and Mixers

Pre-Requisite Course(s)

Electromagnetic Radiation and Antennas (802650)

Keywords

RF circuits, Amplifiers, Mixers, Oscillators.

References

1. D. M. Pozar, “Microwave Engineering”, John Wiley & Sons, Inc., New York, 2005.
2. W. Alan Davis, Krishna Agarwal, “Radio Frequency Circuit Design”, John Wiley & Sons, Inc., New York, 2003.
3. Collin, R. E., “Foundations for Microwave Engineering”, McGraw Hill Book Co., New York, 2000

Course Number	Course Title	Units
802652	**RADIO WAVE PROPAGATION**	**3**

Objectives

To provide the student with a foundation of the concepts of propagation in free space, point to point transmission, effect of obstacles, reflection and scattering, atmospheric effects to be able to perform system design.

Description

This course covers topics on propagation in free space for point-to-point and point-to-area transmission, respectively. The effect of obstacles, whether buildings or mountains. Investigate the nature of reflections and the effect that reflections have on the nature of a received signal. Predict the level of the received signal considering the propagation mechanism. The effects of atmosphere on radio waves. Design of various communication systems such as point to point communications, broadcast, and earth-space systems.

Pre-Requisite Course(s)

Electromagnetic Radiation and Antennas (802650)

Keywords

Wave propagation, Antenna, Scattering.

References

1. Christopher Haslett, Essential of radio wave propagation, Cambridge University Press, 2008.
2. Nathan Blaunstein and Christos Christodoulou, Radio Propagation and Adaptive Antennas for Wireless Communication Links Terrestrial, Atmospheric and Ionospheric, John Wiley & Sons, Inc., New York, 2007.
3. H. Sizun, Radio wave propagation for telecommunication applications, Springer, 2005.

Course Number	Course Title	Units
802653	**MODERN TELECOMMUNICATION SYSTEMS**	**3**

Objectives

To provide the student with an introduction to modern communication networks and satellite Communication system and related topics. Familiarize the student with cellular communication systems and related concepts including; frequency reuse, hand-off, Cellular Telephone System Structure, Cellular System Radio Interface, and roaming. To provide the student with an introduction to other modern telecommunication systems such as radar communications, under-water communications, and fiber optical communications. The student will become aware of the current wireless systems standards.

Description

Discussion of modern telecommunication systems, including cellular systems, satellite communications, radar communications, under-water communications, and fiber optical communications.

Pre-requisite Knowledge (Subject to Department Consent)

Digital communication systems.

Keywords

Telecommunication systems, Cellular, Satellite communication.

References

1. T. Rappaport, “Wireless Communications: Principles and Practice”, Prentice Hall, 2 edition, 2002.
2. L.M. Correia, “Wireless Flexible Personalized Communications”, 'COST 259: European Co-operation in Mobile Research', Chester, England: John Wiley, 2001.
3. M.I. Skolnik, “Introduction to Radar Systems”, NY: McGraw-Hill, 2001.
4. M. Schwartz, “Mobile Wireless Communications”, Cambridge University Press, 2005. G.D. Gordon and W.L. Morgan, “Principles of Communications Satellites”, NY: John Wiley, 1993.

Course Number	Course Title	Units
802654	**SATELLITE COMMUNICATIONS**	**3**

Objectives

To introduce the student to the parameters of link budget, satellite communication sub-system and orbits, radio frequency bands and antennas used in satellites.

Description

Historic perspective, orbital mechanics and constellations, Propagation considerations. Function of communication satellites, parameters of link budget, communication satellite subsystems, orbits, antennas. Modulation and Multiplexing Techniques for Satellite Links. Interference issues and other obstacles, existing and proposed mobile satellite systems.

Pre-requisite Knowledge (Subject to Department Consent)

Modern telecommunication systems and digital communication systems.

Keywords

Satellite communication, Satellite orbit, Link budget.

References

1. K.N. Raja Rao. Satellite Communication: Concepts and Applications, Prentice-Hall, 2013.
2. G. Maral, M. Bousquet, and Z. Sun. Satellite Communications Systems: Systems, Techniques and Technology, John Wiley, 2009.
3. G.D. Gordon and W.L. Morgan. Principles of Communications Satellites, NY: John Wiley, 1993.

Course Number	Course Title	Units
802655	**SPREAD SPECTRUM COMMUNICATION**	**3**

Objectives

To provide graduate students with the ability to analyze spread spectrum modulation and demodulation procedures. To familiarize the students with the design of synchronization and detection circuits for spread spectrum communication. To provide an understanding of pseudo random shift register.

Description

Concepts of spread spectrum systems, frequency hopping and direct sequence systems. Anti-jamming performance analysis, synchronization schemes, and systems with forward error correction.

Pre-requisite Knowledge (Subject to Department Consent)

Advanced communication systems.

Keywords

Spread Spectrum, Synchronization, Anti Jamming.

References

1. V. P. Ipatov, "Spread Spectrum and CDMA: Principles and Applications", NJ: John Wiley and Sons Inc., 2005.
2. D. Torrieri, "Principles of Spread-Spectrum Communication Systems", NY: Springer 2005.
3. O. Berg, T. Berg, S. Haavic, and R. Skaug, "Spread Spectrum in Mobile Communication", The Institution of Electrical Engineers, London: UK, 1998.
4. A.J. Viterbi, "CDMA- Principles of Spread Spectrum Communication", MA: Addison- Wesley Longman, 1995.
5. R.L. Peterson., R.E. Ziemer., and D.E. Borth, "Digital Communication and Spread Spectrum System", NJ: Prentice Hall, 1995.

Course Number	Course Title	Units
802656	**ADVANCED WIRELESS COMMUNICATION**	**3**

Objectives

To introduce the students to some of the latest advances in wireless communications.
To familiarize the students with the design of wireless systems employing advanced diversity techniques, including MIMO, STBC, and STTC. To familiarize the students with the concept of spatial multiplexing and the trade-off with diversity schemes. To provide an understanding of beamforming and cooperative communication techniques.

Description

Advanced diversity techniques, multiple-input multiple-output (MIMO) systems, space-time block codes (STBC), space-time trellis codes (STTC), spatial multiplexing and Bell laboratories layered space-time (BLAST) systems, diversity-multiplexing tradeoff, beamforming, cooperative communications.

Pre-requisite Knowledge (Subject to Department Consent)

Spread spectrum communication and modern telecommunication systems.

Keywords

Diversity Techniques, MIMO, STBC, STTC, BLAST, Spatial Multiplexing, Beamforming, Cooperative Communications.

References

1. L. Hanzo, T. H. Liew, B. L. Yeap, R. Y. S. Tee, and S. X. Ng, Turbo Coding, Turbo Equalisation and Space-Time Coding: EXIT-Chart-Aided Near-Capacity Designs for Wireless Channels, Wiley-IEEE Press, 2 edition 2011.
2. E. Biglieri, R. Calderbank, A. Constantinides, A. Goldsmith, A. Paulraj, and H. Vincent Poor, MIMO Wireless Communications, Cambridge: Cambridge University Press, 2010.
3. Paulraj, R. Nabar and D. Gore, Introduction to space-time wireless communications, Cambridge: Cambridge University Press, 2008.
4. D. Tse and P. Viswanath, Fundamentals of Wireless Communication, Cambridge: Cambridge University Press, 2005.
5. A. Goldsmith, Wireless Communications, Cambridge: Cambridge University Press, 2005.
6. Vucetic and J. Yuan, Space-time coding, John Wiley and Sons, 2003.

Course Number	Course Title	Units
802657	**REGULATIONS AND POLICIES IN THE TELECOMMUNICATIONS INDUSTRY**	**3**

Objectives

To introduced students to the key events in the history of telecommunications. To provide the student with the market models and the role of regulation in natural monopoly. The student is made aware of the fundamental objectives of telecom policy and the organizations involved in telecom policy process. The student will learn to be able to identify the current policy issues in the development of VoIP and broadband

Description

This course covers the policy issues in the telecommunications industry. It provides the knowledge of and reinforces the implications of the telecommunications Policy for mangers in the telecom and IT industry. Students will be provided with a framework to analyze and interpret governmental policies on telecommunications at the national .and international levels. We review the history of telecommunication evolution and the objectives of the telecom policy.

Pre-Requisite Course(s)

Modern Telecommunication Systems (802653)

Keywords

Telecommunications industry, policy, regulations, history.

References

1. S. Papathanassopoulos and R. Negrine, Palgrave Macmillan, “Communications Policy: Theories and Issues”, 2010.
2. R. J. May, “New Directions in Communications Policy”, Carolina Academic Press, 2009.
3. J. E. Nuechterlein and P. J. Weiser, “Digital Crossroads: American Telecommunications Policy in the Internet Age”, the MIT Press, 2007.
4. S. M. Benjamin, D. G. Lichtman, H. A. Shelanski, and P. J. Weiser, “Telecommunications Law and Policy”, Carolina Academic Press, 2006.
5. P. Aufderheide, “Communications Policy and the Public Interest”, Guilford Press, 1999.
6. G. W. Brock, “Telecommunication Policy for the Information Age: From Monopoly to Competition”, Harvard University Press, 1998.

Course Number	Course Title	Units
802658	ERROR CONTROL CODING	3

Objectives

To introduce the students to the fundamentals of error control coding. Familiarize the students with the design of linear block codes and convolutional codes. Provide an understanding of the design of advanced error correction codes, including turbo codes, LDPC and BICM schemes. Students learn the codes and decoding methods required for the detection and correction of the errors and erasures which inevitably occur in digital information during transmission, storage and processing because of noise, interference and other imperfections.

Description

Introduction to algebraic codes and advanced error correction techniques; linear block codes, Detailed coverage of Block, Cyclic, BCH, Reed-Solomon, Convolutional, Turbo, and Low Density Parity Check (LDPC) codes, together with relevant aspects of Information Theory, and bit-interleaved coded modulation (BICM). A practical engineering and information technology emphasis, as well as relevant background material and fundamental theoretical aspects, provides an in-depth guide to the essentials of Error-Control Coding. Detailed coverage of Block, Cyclic, BCH, Reed-Solomon, Convolutional, Turbo, and Low Density Parity Check (LDPC) codes, together with relevant aspects of Information Theory.

Pre-requisite Knowledge (Subject to Department Consent)

Random variables and signals, digital communication systems.

Keywords

Algebraic Codes, Linear Block Codes, Cyclic Codes, BHC Codes, Reed-Solomon Codes, LDPC, Convolution Codes, Turbo Codes, BICM.

References

1. C. Heegard and S. Wicker, Turbo Coding, Springer, 2010.
2. J. Proakis and M. Salehi, Digital Communications, McGraw-Hill Prentice-Hall, 5th edition, 2008.
3. T. Richardson and R. Urbanke, Modern Coding Theory, Cambridge University Press, 2008.
4. Jorge Castiñeira Moreira, Patrick Guy Farrell, " Essentials of Error-Control Coding", Wiley 2006.
5. R. H. Morelos-Zaragoza, The Art of Error Correction Coding, Wiley, 2nd edition, 2006.
6. Lin Shu, Shu Lin and Daniel J. Costello, Error Control Coding: Fundamentals and Applications, Prentice Hall, 2nd edition, 2004.
7. S. Benedetto and E. Biglieri Principles of Transmission with Wireless Applications Kluwer Academic, 1999.
8. R. W. Hamming, Coding and Information Theory, 2nd Ed., Prentice-Hall Inc.,1986.

Course Number	Course Title	Units
802659	WIRELESS COMMUNICATION NETWORKS	3

Objectives

To introduce the students to the essentials of wireless communications and wireless networking, including Wireless Personal Area Networks (WPAN), Wireless Local Area Networks (WLAN), and Wireless Wide Area Networks (WWAN). Students are introduced to the fundamentals that are required to study mobile data networking and mobile communications.

Description

Introduction to fundamental concepts of mobile networking aspects. The discussion of WPAN, WLAN, WWAN, and internetworking between WLAN and WWAN. Other aspects of mobile communications such as mobility management, security, cellular network planning, and 4G systems. An Overview of Wireless Systems, Teletraffic Engineering, Radio Propagation and Propagation Path-Loss Models, An Overview of Digital Communication and Transmission, Fundamentals of Cellular Communications, Multiple Access Techniques, Architecture of a Wireless Wide Area Network (WWAN), Spread-Spectrum (SS) and CDMA Systems. Mobility Management in Wireless Networks, Security in Wireless Systems, Mobile Network and Transport Layer: Planning and Design of Wide Area Wireless Networks, Wireless Application Protocol (WAP).

Pre-Requisite Course(s)

Advanced Wireless Communication (802656)

Keywords

WLAN, WPAN, WWAN, CDMA, WAP.

References

1. Ali Eksim, "Wireless Communications and Networks - Recent Advances". InTech, 2012.
2. Vijay Garg, "Wireless Communication and Networking", Morgan Kaufman, 2007
3. William Stallings, "Wireless Communications and Networks", 2nd, Ed. Pearson, Prentice Hall, Upper Saddle River, NJ 2004.
4. Alberto Leon-Garcia), Indra Widjaja, "Communication Networks; Fundamental Concepts and architecture", 2nd, Ed. McGraw-Hill, 2003

Course Number	Course Title	Units
802694	**ADVANCED TOPICS IN COMMUNICATIONS ENGINEERING**	**3**

Objectives

This course is intended to cover any advanced topics in communications engineering which not included in the program and the student require it to compete his study.

Description

To be provided by the supervisor and the communications sequence committee.

Pre-requisite Knowledge (Subject to Department Consent)

To be provided by the instructor.

Keywords

To be provided by the instructor.

References

To be provided by the instructor.

Courses’ Descriptions (Power)

Course Number	Course Title	Units
802660	APPLICATIONS OF POWER SYSTEM PROTECTION	3

Objectives

This course is intended to cover deeply the application of real protection systems in the field including the generators, transformers, motors, lines ……etc. This specifically help to expand the knowledge of the students about the essential art of protection engineering as well as to integrate with other fundamental course(s) in the area.

Description

100% covering methods for generator winding protection, Out of step relaying for generator protection, protection methods for field winding of power generators, Interturn fault detection in transformer winding, integrated motor protection, Communication-based relaying system of transmission systems, wide area monitoring an fault detection in distribution Systems, Modern communication systems and SCADA for improving the performance of relaying systems, current sensors and fault location techniques in power systems.

Pre-requisite Knowledge (Subject to Department Consent)

Each Student should have the basic knowledge of power system protection core including main protection functions, basic procedures for relaying setting and coordination, relays classifications and types, and power system analysis fundamentals (particularly, symmetrical components).

Keywords

Protective relay, Relaying coordination, Relay setting, SCADA, Pilot Relaying

References

1. J. Lewis Blackburn, "Protective Relaying: Principles and Applications", CRC Press, Third Edition (Power Engineering, 2006.
2. Stanley H. Horowitz and Arun G. Phadke, "Power System Relaying", Wiley, 2008.
3. Leslie Hewitson, Mark Brown and Ramesh Balakrishnan, "Practical Power System Protection", Elsevier, 2005.
4. Paul M. Anderson, "Power System Protection", IEEE Press Series on Power Engineering, 1998.

Course Number	Course Title	Units
802661	INTELLIGENT PROTECTIVE RELAYING	3

Objectives

This course is intended to cover the benefits of artificial intelligence tools in power system protection applications such as ANNs, Fuzzy Logic and Genetic Computations. Some applications of such tools in power system protection are covered.

Description

Common features of AI techniques, Advantages of AI tools as compared with the conventional methods for protection purposes. Applications of AI tools for transmission protection, Applications of AI tools for machine protection, wide area monitoring and intelligent management systems, realization of AI techniques in power system protection. Challenges of AI tools as compared with the conventional methods for protection purposes.

Pre-Requisite Course(s)

Applications of Power System Protection (802660)

Keywords

Digital protection, Artificial Intelligence, ANNs, Fuzzy Logic and Genetic algorithms.

References

1. Muthiah Geethanjali, "Artificial Intelligence for power system protection", Lambert, 2012.
2. K. Warwick, R. Aggarwal and A. Ekwue, "Artficial Intelligence Techniques in Power Systems (Power & Energy Series), 1997.
3. Arun G. Phadke and James S. Thor, “computer relaying for power system”, Wiley & Sons Publications, 2009.
4. Wolfgang Ertel, "Introduction to Artificial Intelligence (Undergraduate Topics in Computer Science), Springer, 2011.

Course Number	Course Title	Units
802662	**DIGITAL SIGNAL PROCESSING FOR NUMERICAL PROTECTION**	**3**

Objectives

This course is intended to cover the applications of digital signal processing techniques for power system protection purposes. Phasor estimation methods with digital techniques are covered. Each student should implement some selected algorithms into MATLAB.

Description

Review of fundamentals of digital signal theory and sampling techniques, Phasor estimation requirements for relaying applications. Phasor estimation with two samples and three samples methods, Phasor estimation with Fourier transform theory including DFT, SDFT and FFT. Phasor estimation with other techniques including (Least squares, Walsh functions and FIR filtering), Implementation issues of digital signal processing applications.

Pre-Requisite Course(s)

Applications of Power System Protection (802660)

Keywords

Digital protection, Sampling theory, Digital Fourier Transform, Numerical relaying.

References

1. Waldemar Rebizant and Waldemar Rebizant, "Digital Signal Processing in Power System Protection and Control", Springer, 2011.
2. Arun G. Phadke and James S. Thor, “computer relaying for power system”, Wiley & Sons Publications, 2009.
3. A.T.Johns, “Digital Protection for Power Systems”, Power & energy service, 2000.
4. A. Sleva, “ Digital relay principles”, CRC Press, 2009.

Course Number	Course Title	Units
802663	**ADVANCED POWER ELECTRONICS**	**3**

Objectives

The course provides the students with the practical knowledge in Power Electronics, study the important topics in the recent industrial applications such as PWM inverter, PWM rectifiers, Uninterruptible power supply(UPS), Multilevel converters and matrix converter.

Description

Review about the power electronics converters, advanced topics in power electronics: switching mode regulators, switching DC power supplies, AC power supplies and uninterruptible power supply, phase-controlled cycloconverter, Principle of pulse width modulation PWM, space vector pulse width modulation (SVPWM), multilevel converter, matrix converter, and Harmonics studies.

Pre-requisite Knowledge (Subject to Department Consent)

Fundamentals of industrial electronics.

Keywords

DC power supply, AC power supplies, UPS, cycloconverter, PWM, Multilevel converter, Matrix converter, Harmonics studies.

References

1. Mohan N., Tore M. Underand, William P. Robbins, “Power Electronics: converters, Applications, and Design”, John Wiley & Sons, Inc, third Edition, 2003.
2. M. H. Rashid, “Power Electronics Handbook”, 2^{nd} Ed., Academic Press, 2006.
3. B. K. Bose, "Modern Power Electronics and AC Drives", Prentice, 2001.
4. Bimal K. Bose, " Power Electronics and Motor Drives: Advances and Trends", Elsevier, 2006.

Course Number	Course Title	Units
802664	**POWER ELECTRONICS APPLICATIONS**	**3**

Objectives

The course provides the students with the new applications of power electronics, the application of multi-level converter, scalar control, vector control and direct torque control. Those applications used in the renewable energy, speed control of DC and AC machines, UPS systems.

Description

Advanced topics include: scalar control of induction motor, direct and indirect field orientation control of AC machines, direct torque control "DTC" of induction motor, UPS: construction, types, applications and some applications in renewable energy and speed control.

Pre-Requisite Course(s)

Advanced Power Electronics (802663)

Keywords

DTC, Matrix converter, Inverter, Field orientation control, Multi-level converter, Electrical Machines.

References

1. Bimal K. Bose," Power Electronics and Motor Drives: Advances and Trends ", Elsevier Inc, 2006.
2. Krause, P. C., "Analysis of Electric machinery", McGraw-Hill, 2001.
3. Bimal K. Bose, "Modern Power Electronics and AC Drives", Prentice, 2001
4. Mohan N., Tore M. Underand, William P. Robbins, “Power Electronics: converters, Applications , and Design”, John Wiley & Sons, Inc , third Edition, 2003.
5. M. H. Rashid, “Power Electronics Handbook”, 2nd Ed., Academic Press, 2006.

Course Number	Course Title	Units
802665	ELECTRIC MACHINES AND MOTOR DRIVES	3

Objectives

By the end of this course a wide range of topics in electrical machines and motor drives will be covered including modeling and analysis of DC and induction motor drives. Students will be able to understand the concept, theory, and operation of common electrical drives utilized in industrial applications.

Description

Introduction to Electrical Drives: Elements of Modern Electrical Drives, Components of Load Torque, Load and Motor Torque-Speed Characteristics, Quadrants of Operations, Power Electronic Converters in Electrical Drives: Modeling and Control of Controlled Rectifier and DC choppers. DC Motor Drives: Construction, Modeling and Transfer Function of the DC Machine, Converters for DC drives, Closed-loop Control of DC drives. Induction motor drives: Steady State Equivalent Circuit of Induction Motor, Dynamic Modeling of Induction Motor and Vector control.

Pre-Requisite Course(s)

Advanced Power Electronics (802663)

Keywords

Induction machines, Electrical Drives, DC Machines, Motor, Control of machines.

References

1. Bimal K. Bose, " Power Electronics and Motor Drives: Advances and Trends", Elsevier, 2006
2. Krause, P. C., "Analysis of Electric machinery", McGraw-Hill, 2001.
3. Austin Hughes, "Electric Motors and Drives: Fundamentals, Types and Applications", 3rd Edition, Newnes, 2006.
4. Ned Mohan, Tore M. Undeland and Willam P. Robbins, "Power Electronics: Converters, Applications, and Design", John Wiley & Sons, 2003.
5. Bimal K. Bose, “Modern Power Electronics and AC Drives ", Prentice Hall, 2002.
6. Ramu Krishnan, " Electric motor drives: modeling, analysis, and control ", Prentice Hall, 2001.

Course Number	Course Title	Units
802666	**SPECIAL ELECTRICAL MACHINES**	**3**

Objectives

This course provides in-depth coverage of special machines including synchronous reluctance, motors, stepping motors, switched reluctance motors, permanent magnet brushless D.C. motors, and permanent magnet synchronous motors.

Description

Synchronous Reluctance Motors; Construction, Operation, Axial and radial air gap motors, Reluctance, Phasor diagram, Vernier motor. Stepping Motors; Construction, Operation, Theory of torque predictions, Linear and non-linear analysis, Characteristics, Requirements of Driving circuits. Switched Reluctance Motors; Construction, Principle of operation, Torque prediction, Power controllers, Non-linear analysis, and Characteristics. Permanent Magnet Brushless D.C. Motors; Operation, Types, Magnetic circuit analysis, EMF and torque equations, Power controllers, Motor characteristics and control. Permanent Magnet Synchronous Motors; Operation, EMF and torque equations, Reactance, Phasor diagram, Power controllers, Converter, Volt-ampere requirements, Torque speed characteristics.

Pre-requisite Knowledge (Subject to Department Consent)

Fundamentals of electrical machines, DC machine operation and control, Induction machine operation and control.

Keywords

Special machines, Synchronous reluctance motors, Stepping motors, Variable reluctance motor, Brushless D.C. motors, Synchronous motors, Permanent magnet brushless D.C. motors.

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References

1. R. Krishnan, “Permanent Magnet Synchronous and Brushless DC Motor Drives ", Publisher: CRC Press, 2009.
2. Takashi Kenjo, Shigenobu Nagamori, " Brushless Motors: Advanced Theory and Modern Applications", Sogo Electronics Press; 3rd edition, 2003.
3. R. Krishnan, "Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design, and Applications", CRC Press, 2001.
4. Austin Hughes, " Electric Motors and Drives: Fundamentals, Types and Applications", 3rd Edition, Newnes, 3rd edition, 2005.
5. Ramu Krishnan, "Electric motor drives: modeling, analysis, and control ", Prentice Hall, 2001.

Course Number	Course Title	Units
802667	**PHOTOVOLTAIC SYSTEMS: ANALYSIS, OPERATION, AND DESIGN**	**3**

Objectives

PV systems utilize a variety of equipment, some of which is manufactured through sophisticated and complex technologies. This course aims to describe the components of PV systems and the basic principles to transform energy from sunlight to electricity. This will include systems that are tied to the utility grid as well as systems that stand alone or include storage backup with batteries. Keys for modern intelligent PV design is introduced. Loading and economic computation for application sites are covered.

Description

PV Applications and electricity, Safety Basics, PV System Components, Efficient Appliances, Solar Site Analysis, PV System Wiring and Over current Protection, Stand-Alone PV System Sizing, Grid-Tie System Sizing, Component Specification, System Costs and Economics, Determining the energy requirements for any desired application and determining the capacity and specifications for each of the components. Finalizing system design and commissioning.

Pre-requisite Knowledge (Subject to Department Consent)

Each Student should have the basic knowledge of power system operation core including: Generation types, Transmission systems fundamentals, Distribution system design fundamentals. Also, basic power electronic knowledge should be gained including converters, inverters and load modeling.

Keywords

Photovoltaic systems, Batteries, Power system economics, power inverters, Power converters.

References

1. Roger A. Messenger and Jerry Ventre, " Photovoltaic Systems Engineering", CRC Press, third Edition, 2010.
2. Heinrich Haeberlin, "Photovoltaics System Design and Practice ", Wiley, First edition, 2012.

Course Number	Course Title	Units
802668	**RENEWABLE ENERGY AND DISTRIBUTED GENERATION**	**3**

Objectives

This is an advanced course in renewable energy that gives students a comprehensive understanding of distributed power generation system and renewable energy technologies. Students will learn practical applications in the field and examples using realistic data.

Description

The course begins with an overview of the development of electric power industry, including an introduction to the technical side of power generation, distributed generation technologies, benefits of distributed generations, challenges with distributed generations, in-depth coverage of renewable and alternative energy technologies such as solar, wind, biomass and hydro are provided. The course also discusses technical and economic analyses of renewable power system, while providing techniques for evaluating the efficiency and cost-effectiveness of the renewable energy technologies.

Pre-requisite Knowledge (Subject to Department Consent)

Each student should have the basic knowledge of power system operation core including: generation types, design and operation of transmission systems, distribution system design fundamentals. Fundamentals of electrical machines is required.

Keywords

Distributed generation, Solar energy, Wind power, Hydroelectric, Biomass, Technical and economic analysis

References

1. Gilbert M. Masters, "Renewable and Efficient Electric Power System", John Wiley and Sons, Inc, 2005.
2. Bollen, Math H., Hassan and Fainan, "Integration of Distributed Generation in the Power System", Wiley – IEEE Press, 2011.
3. B. Sorensen, "Renewable Energy", Academic Press, Fourth Edition, 2010.

Course Number	Course Title	Units
802669	WIND ENERGY GENERATION SYSTEMS	3

Objectives

The course is devoted to develop perspectives regarding the demand for wind power generation system technology and to evaluate the environmental and economic issues associated with wind energy applications.

Description

Introduces wind turbine systems, including wind energy potential and application to power generation. Topics include wind energy principles, wind site assessment, wind turbine components, power generation machinery, control systems, connection to the electric grid and maintenance. Wind turbine cost analysis and environmental impact are also be discussed.

Pre-requisite Knowledge (Subject to Department Consent)

Each Student should have the basic knowledge of power system operation core including: Generation types, Design and operation of transmission systems, Distribution system design fundamentals. Fundamentals of Electrical Machines is required. Electrical Machines and Electrical Power systems.

Keywords

Wind energy potential, Wind energy system and components, Economic analysis and environmental impact.

References

1. S. Heier, R. Waddington, "Grid Integration of Wind Energy Conversion System", John Wiley & Sons, 2006.
2. J. F. Maxwell, J. G. McGowan, and A. L. Rogers, Wind Energy Explained – Theory, Design, and Applications, John Wiley & Sons, 2009.
3. S. M. Muyeen, "Wind Energy Conversion Systems: Technology and Trends", Springer, 2012.

Course Number	Course Title	Units
802670	**INTEGRATION OF ALTERNATIVE ENERGY SOURCES**	**3**

Objectives

The course aims to provide depth knowledge in integration and interconnection of renewable and alternative energy sources. Students will design renewable and alternative energy systems for specific applications.

Description

Emphasis will be placed on the energy flow, storage, power management hybridization, integration and interconnection of renewable and alternative energy sources. Various storage devices used incorporation with renewable and alternative energy systems are discussed and compared. The course will also cover the design and performance analysis of some applications of renewable energy systems in distributed generation, grid connected system and rural electrification.

Pre-Requisite Course(s)

Advanced Power Electronics (802663)

Keywords

Renewable energy systems, Storage devices, Power management hybridization, Integration and interconnection, Distributed generation, Rural electrification.

References

1. F. A. Farret, M.G. Simoes, "Integration of Alternative Sources of Energy", Wiley Interscience, 2006.
2. Gilbert M. Masters, "Renewable and Efficient Electric Power System", John Wiley and Sons, Inc, 2005.
3. B. Sorensen, "Renewable Energy", Academic Press, Fourth Edition, 2010.

Course Number	Course Title	Units
802671	**POWER SYSTEM PLANNING AND RELIABILITY**	**3**

Objectives

To give the engineer more knowledge about load forecasting, power system planning and power system reliability.

Description

Mathematical methods and modern approaches to power system planning. Demand forecasting. Generation system planning: deterministic and probabilistic methods. Transmission system planning: heuristic and stochastic methods. Optimization methods for transmission planning. Route selection: environmental and other considerations. Distribution system planning: system layout, and choice of components. Power system reliability.

Pre-requisite Knowledge (Subject to Department Consent)

Mathematical knowledge related to optimization and planning, transmission and distribution systems simulation.

Keywords

Power system planning, Demand forecasting, Deterministic and probabilistic methods, Transmission system planning, Optimization methods for transmission planning, Route selection, Distribution system planning, Reliability.

References

1. R.L. Sullivan, “Power System Planning”, McGraw Hill Publishing Company Ltd., 2002.
2. T. Gönen, “Electrical Power Distribution Engineering”, McGraw Hill Book Company, 2003.
3. Tom A. Short, “Distribution reliability and power quality”, CRC Press, 2005.
4. Roy Billinton, “Reliability evaluation of power systems”, Plenum Press, 2000.

Course Number	Course Title	Units
802672	**POWER SYSTEM MODELING AND CONTROL**	**3**

Objectives

The objective of this course is to provide the students with comprehensive knowledge on power system modeling and control. This would include modeling of power networks, generating units and loads, the fundamental concept of power system stability and methods of analysis along with control techniques for stability enhancement. It also aims to facilitate the students understanding of the practical issues related to the control of power systems and an awareness of the advanced modeling, analysis and control techniques applicable to power systems.

Description

Introduction to Power System Stability, Review of Equipment Characteristics and Modeling, Generator Model, Load Model, Prime Mover Model, Governor Model, Tie Line Model, Control of Active Power and Frequency, Control of Reactive Power and Voltage, Transient (angle) Stability, Small-Signal (angle) Stability, Sub synchronous Oscillations, Voltage Stability, Frequency Stability, Major Power Grid Blackouts, Power System Security, Power System Control Functions, Major Elements of an Energy Management System, Automation and Control of Distribution Systems.

Pre-requisite Knowledge (Subject to Department Consent)

Power system stability, power system security, load flow studies.

Keywords

Steady-state power system networks, Network components, Stability analysis, Power system control, Power system modeling, SCADA system, EMS / AGC subsystem, FCATS devices.

References

1. Kundur P, "Power System Stability and Control", McGraw-Hill, New York, 1994.
2. Mathur R M, and Varma R K,"Thyristor-Based FACTS Controllers for Electrical Transmission Systems", IEEE Press, Wiley-InterScience, 2002.
3. Anderson P M, and Fouad A A, "Power System Control and Stability", IEEE Press, New York, 1994.

Course Number	Course Title	Units
802673	**ELECTRIC POWER QUALITY**	**3**

Objectives

This course is designed to give the engineers full details about the power Quality problems and their effect on the load/system equipment.

Description

The course addresses all dimensions of Power Quality (PQ) issues including mitigation strategies. The focus is mainly on qualitative concepts and comprehensive coverage. The course introduces PQ definitions, limitations, related international standards and mathematical techniques for PQ analysis of power systems. Different identification, localization and classification techniques for PQ problems will be investigated. The various kinds of PQ problems and their effect on the load/system equipment will be looked at in detail. The mitigation strategies such as passive filtering, active and hybrid power filtering, static VAR compensation, DVR, UPQC, etc. will be investigated. Areas covered include voltage sags, interruptions, transients, flickers, harmonics and modeling and simulation of utility systems.

Pre-requisite Knowledge (Subject to Department Consent)

Each student should have the basic knowledge of power system fundamentals and power system analysis.

Keywords

Power Quality (PQ), VAR, Harmonics, Transients, Filters and grounding.

References

1. A.M. Muñoz "Power Quality: Mitigation Technologies in a Distributed Environment", Springer, London, 2010
2. Kusko and M.T. Thompson, "Power Quality in Electrical Systems", McGraw Hill, 2007.
3. R.M. Strzelecki, "Power Electronics in Smart Electrical Energy Networks", Springer, 2010.
4. H.J. Bollen, "Understanding Power Quality Problems: Voltage Sags and Interruptions", IEEE Press, 1999.

Course Number	Course Title	Units
802674	**FACTS: MODELS, CONTROL AND APPLICATIONS**	**3**

Objectives

This course give basic FACTS controller concepts and applications, explain the operating principles, modeling and control systems of different FACTS Controllers, study in detail the most popular FACTS controller structures and their functionality, introduce detailed and approximate models and their use for these controllers and discuss practical control strategies and applications of these FACTS controllers.

Description

FACTS: controllers, structural, modeling, control and applications viewpoint, Study the most common thyristor-controlled FACTS controllers: in particular Static Var Compensators (SVC), Thyristor-Controlled Series Compensators (TCSC), Thyristor Controlled Voltage and Phase Regulators (TCVR) and (TCPAR), and voltage-sourced converter controllers, Static Compensator (STATCOM): Static Synchronous Series Compensator (SSSC) and the Unified Power Flow Controller (UPFC), Detailed and approximate models for various control strategies, Practical applications of these controllers.

Pre-Requisite Course(s)

Advanced Power Electronics (802663)

Keywords

SVC, TCSC, TCVR, TCPAR, STATCOM, SSSC and UPFC.

References

1. Vijay K. Sood, "HVDC and FACTs Controllers: Applications of static converters in power systems", Kluwer Academic Publishers, 2004.
2. E. Acha, C. R. Fuerte-Esquivel, H. Ambriz-Perez, C. Angeles-Camacho, " FACTS Modeling and Simulation in Power Networks", John Wiley & Sons Ltd, 2004
3. R.M. Mathur and R.K. Varma, “Thyristor-Based FACTS Controllers for Electrical Transmission Systems”, IEEE Press and John Wiley & Sons, New York, USA, Feb. 2002, ISBN: 978-0-471-20643-9
4. N. G. Hingorani and L. Gyugi, “Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems”, IEEE Press, 2000.
5. N. G. Hingorani and L. Gyugyi, "Understanding FACTS, the Institute of Electrical and Electronics Engineers", New York, 2000.

Course Number	Course Title	Units
802675	**SMART GRIDS IN POWER SYSTEMS**	**3**

Objectives

Smart grid is the integration of numerous technologies, systems and processes with the aim to modernize and fully automate the entire electricity grid covering generation, transmission, distribution, utilization plus conservation. This course will provide the required knowledge required to engineers and professionals to deliver the smart grid concepts. The course will mainly focus on intelligent electricity distribution networks, present the latest technologies and analyze the impact of these technologies on system design, operation, management and maintenance, Optimizing power generation and utilizing nonconventional power plants in modern power grids.

Description

Smart grid benefits and rules in power systems, Introduction to the technologies and policies associated with the Smart Grid, Communications/measurement and management tools to monitoring and managing changing loads, Intelligent control/intelligent agents and grids technology used in Smart Grids, Smart grid construction and design, Smart grid security, Grid integration of wind power plants and solar power systems into power grids, Modern power transmission and distribution networks for smart grids requirements. Load monitoring and forecasting systems.

Pre-Requisite Course(s)

Power System Modeling and Control (802672)

Keywords

SMART grids, Load management, Intelligent agents, SCADA systems, Renewable energy systems.

References

1. James Momoh, "Smart Grid: Fundamentals of Design and Analysis", IEEE Press Series on Power Engineering, Wiley-IEEE Press, First edition, 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage Jianzhong Wu and Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley, First edition, 2012.
3. Claudio Lima, "Smart Grid: An Introduction", Wiley, First edition, 2013.

Course Number	Course Title	Units
802676	ELECTRIC SAFETY AND GROUNDING SYSTEM DESIGN	3

Objectives

This course is intended to cover the grounding of power systems and its effect of the system performance. The course, also cover the types of protective grounding. The course discuss the safety management and organizational structure and the human factor that affect electric safety.

Description

Grounding of power systems and equipment has great impact on system performance, system equipment integrity, safety of personnel as well as safety of the public at large. It acquires special relevance for distribution systems where grounding directly affects the reliability of supply to the customer, survivability of end-use equipment and safety of individuals, Discuss in detail the basic safety issues for low, medium and high voltage systems, Designing a reliable grounding system, the different types of protective grounding. Discuss the safety management and organizational structure and the human factor that affect electric safety.

Pre-requisite Knowledge (Subject to Department Consent)

Fundamentals of electric power engineering.

Keywords

Grounding, Electric safety, Protective grounding, Human factor.

References

1. Gouda, "Optimum Design of Grounding System of High Voltage Substations: Grounding System Design of High Voltage Substations", Lambert Academic Publisher, 2011.
2. J. He, R. Zeng and B. Zhang, "Methodology and Technology for Power System Grounding", Wiley & Sons, 2013.
3. P.K. Sen, "System Grounding, Ground Fault Protection and Electrical Safety", IEEE Press, 2010.

Course Number	Course Title	Units
802677	**HIGH AND EXTRA HIGH VOLTAGE ENGINEERING APPLICATIONS**	**3**

Objectives

This course is intended to cover the applications of High Voltage Engineering, Potential divider and high voltage tests for the apparatuses and system equipment.

Description

This course deals with generation and measurement aspects of high voltages and industrial applications of high voltage engineering. The first part concentrates on generation of high voltage ac, dc and impulse voltages of both switching and lightning surges. Measurements techniques based on different types of potential dividers and spark gaps for ac, dc, and impulse measurements will be covered. The second part deals with generation and measurements of special types of high voltages needed for industrial applications. The course also covers non-destructive measurements like surface and internal discharges, capacitance and loss factor and some optical techniques. Voltage Control and Overvoltage EHV Testing. Design of EHV Lines Based upon Steady-State Limit and Transient Over voltages. Surge Arresters and surge over voltage protection.

Pre-requisite Knowledge (Subject to Department Consent)

High voltage engineering.

Keywords

Impulse voltage, Potential divider, Spark gaps non-destructive tests, Extra high voltage.

References

1. M.S. Naidu, "High Voltage Engineering", McGraw – Hill, 2010.
2. V. Gurevich, "Protection Devices and Systems for High-Voltage Applications", Marcel Dekker, Inc., 2003.
3. M. Abdsalam, H, Anis and R. Radwan, "High-Voltage Engineering: Theory and Practice", Marcel Dekker, Inc., 2000.

Course Number	Course Title	Units
802678	**STATISTICAL APPLICATIONS IN HIGH VOLTAGE ENGINEERING**	**3**

Objectives

This course is intended to cover the analysis methods for experiments results of the high stress tests on the insulators and equipment's.

Description

This course deals with Probability fundamentals – Distribution functions- Risk of failure- Correlation between insulation and protection level-Statistical safety factor- Statistical withstand voltage- Statistical approach to insulation coordination-Simulated lightning surges for testing Reliability of high voltage networks.

Pre-Requisite Course(s)

High and Extra High Voltage Engineering Applications (802677)

Keywords

Probability, Risk failure, Safety factor.

References

1. Statistical Techniques for High-Voltage Engineering (I E E Power Engineering Series) English Ed Edition by W. Hauschild (Author), W. Mosch (Author).
2. Application of Statistical Analysis in High Voltage Engineering High Voltage Engineering Farouk A. M. Rizk and Giao N. Trinh CRC Press 2014.

Course Number	Course Title	Units
802679	**STUDY OF POWER SYSTEM TRANSIENTS**	**3**

Objectives

This course is intended to cover the transient phenomenon in power systems, transient types, analysis and protection of power system against them.

Description

This course deals with Modeling of power apparatus for transient studies – principles of digital computation – transmission lines, cables, transformer and rotating machines – Electromagnetic Transient program – typical power system case study: simulation of possible over voltages in a high voltage substation.

Pre-requisite Knowledge (Subject to Department Consent)

High voltage engineering.

Keywords

Transient, Electromagnetic, Over voltages.

References

1. Pritindra Chowdhari, "Electromagnetic transients in Power System", John Wiley and Sons Inc., Second Edition, 2009.
2. Allan Greenwood, "Electrical Transients in Power System", Wiley & Sons Inc. New York, 2012.
3. Naidu M S and Kamaraju V, "High Voltage Engineering", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.

Course Number	Course Title	Units
802680	**HIGH VOLTAGE POWER CABLES**	**3**

Objectives

This course designed to cover the underground cable network, any outages due to their failure will result in considerable service delivery and economic impact on the operation of distribution networks, also the cable tests and diagnostics.

Description

Dielectric theory, material properties and design details of Medium and High Voltage underground cables and their accessories. Understand typical failure modes and their early detection of underground cable and their accessories. High voltage cables for GIS bus designs systems. Type tests and rotten tests for the high voltage cables and the equipment required to do these tests, various off-line and on-line diagnostic tests for condition monitoring of underground cables.

Pre-Requisite Course(s)

High and Extra High Voltage Engineering Applications (802677)

Keywords

Dielectric, Underground cables, Off-line, On-line, Diagnostic tests.

References

1. W.A.Thue, "Electrical Power Cable Engineering", CRC Press, 2011.
2. G.J. Anders, "Rating of Electric Power Cables in Unfavorable Thermal Environment", IEEE Press, 2005.
3. J.Rudman. “Power Cable Maintainer", National Learning Corporation, 2002.
4. O. Gouda and A. Faraskory "Testing of H.V. Power Cables", Lambert Academic Publishing, 2011.

Course Number	Course Title	Units
802696	**ADVANCED TOPICS IN ELECTRICAL POWER ENGINEERING**	**3**

Objectives

This course is intended to cover any advanced topics in electrical power engineering which not included in the program and the student require it to compete his study.

Description

To be provided by the supervisor and the power sequence committee.

Pre-requisite Knowledge (Subject to Department Consent)

To be provided by the instructor.

Keywords

To be provided by the instructor.

References

To be provided by the instructor.