Approved Ph.D. Courses for the Department of Electronic Engineering

A. Courses with EL-code

S#	Course Code	Course Title
1	EL-601	Technology of Power Semiconductor Devices
2	EL-602	Application of Power Semiconductor Devices
3	EL-603	Challenges and Opportunities in CMOS beyond 45 and 53 nm Technology
4	EL-604	Light Emitting Diodes
5	EL-605	Photovoltaic Materials
6	EL-606	Solar Cell Design
7	EL-607	Electronics Transport in Semiconductors
8	EL-608	Advanced Solid State Device
9	EL-609	Microwave Circuit
10	EL-610	Radio Frequency Circuit and Architecture for Mobile Communication System
11	EL-611	VLSI Architecture
12	EL-612	Selected Topic in Advanced Analog Integrated Circuit
13	EL-613	Advanced concepts in Analog Circuit Synthesis and Design
14	EL-614	Implementation of Analog IC's on PSPICE Software
15	EL-615	CMOS RF IC's
16	EL-616	RF Transceiver Design
17	EL-617	Advanced RF System Design
18	EL-618	Linearization and Efficiency Techniques in RF Circuit
19	EL-619	Stochastic Methods in Autonomous Systems
20	EL-620	Modern Control System
21	EL-621	Solar Power & Integration
22	EL-622	Distributed Generation
23	EL-623	Modeling and Control of Renewable Power Sources
24	EL-624	Nanotechnology
25	EL-625	Power Converter
26	EL-626	Advanced Power Converter
27	EL-627	Advanced Digital Signal Processing and Algorithms
28	EL-628	Modeling and Simulation of Biometric Systems
29	EL-629	Advanced Digital Image Processing
30	EL-630	Advanced Robotics
31	EL-631	Control, Modeling and Simulation in Power Electronics
32	EL-632	Characterization Techniques for Semiconductor Materials
33	EL-633	Electrical Characterization of Semiconductor Devices
34	EL-634	Modern Trends in Solar Cell Design
35	EL-635	Estimation Techniques in Pattern Recognition
36	EL-636	Computational Intelligence

B. Courses with TC- code

1	TC-601	Detection and Estimation Theory
2	TC-602	Advanced Topics in Wireless Communications
3	TC-603	Advanced Topics in Digital Communications
4	TC-604	Adaptive Signal Filtering
5	TC-605	Game Theory in Wireless Communication
6	TC-606	Cognitive Radios
7	TC-611	Cognitive Wireless Systems
8	TC-612	Wireless Systems modeling Techniques
9	TC-613	Detection and Estimation theory
10	TC-614	Advanced Electromagnetic
11	TC-615	Nano photonics
12	TC-616	Optoelectronics and Optical Communications
13	TC-617	Modeling of Large Wireless Network using Advanced Stochastic Processes
14	TC-618	Heterogeneous Cellular Networks
15	TC-619	Advanced Topics in Random Wireless Networks
16	TC-620	High Frequency Simulation Design
17	TC-621	Antenna Theory & Design – I
18	TC-622	Antenna Theory & Design – II
19	TC-623	Conformal Antennas
20	TC-624	Advanced Microwave Systems

Detailed Course Contents

EL-601 Technology of Power Semiconductor Devices

Semiconductor properties, introduction of Power Devices, Semiconductor properties important for power devices. High-speed power devices HEMT, MESFET in III-V semiconductors (GaAs and AlGaAs) used in communication technology, The scope of future technology in wide-bandgap (SiC and GaN) materials. Power MOSFETs for DC and RF applications, Very high current rating devices like Thyristors and Inverted gate bipolar transistors (IGBT) used in electrical transmission and traction.
II-VI semiconductor for power devices, the importance and application of ZnO for optical and electronic devices. Power devices in high frequency applications.Transistors for electric power distributed systems.Silicon LD-MOSFET transistor for mobile telephone base stations. Application of power devices in motors and hybrid machines.

EL-602 Applications of Power Semiconductor Devices

Wide band gap II – VI semiconductors. New growth techniques. Future electronic and opto-electronic power devices and their applications.. The advantages of wide bandgap semiconductors over conventional semiconductors like Si and GaAs. Current problems in wide bandgap semiconductor materials, hindering the commercialisation of these devices.
Power devices in home appliances such as air condition, refrigerators etc. High voltage DC transmission (HVDC)Industrial applications and control systems like RoboticsHigh power traction, Electric cars, motors, high power and temperature sensors Power supplies, uninterrupted power supplies, DC and RF plasma generationsHigh power applications in communication and microwave

EL-603 Challenges and Opportunities in CMOS beyond 45 and 32 nm Technology

The CMOS technology is scaling down every two years and now reached to the limit of 32 nm. The course will address the various issues related to the advantages, challenges and problems in material issues such as gate dielectrics.
Technological issues will be discusses such as lithography and ion-implantation, etching etc.
In the nano-meter scale material stress is playing an important role in CMOS device performance. Utilizing the stress in a positive way, stress engineering.
Beyond Moore's law, Finfet, Carbon nanowire or tube.

EL-604 Light Emitting Diodes

Operating principles, device requirements, development history, commercial and in-development device structures, fabrication, and applications of Light Emitting Diodes (LEDs)
LED Operating Principles, Minimum Device Requirements, and Characterization Units, First Generation LEDs, Basic Fabrication, Packaging, and Light Extraction Considerations ,Advanced Fabrication, Packaging, and Light Extraction Considerations, Elements of Human Vision and colorimetry, White-Light LEDs, IR, UV, and Organic LEDs ,Light from Si and Carbon Nanotubes Applications and Projections of Future.

EL-605 Photovoltaic Materials

Characteristics of II-VI Binary and Ternary Alloys, Criteria for Choice of Window and Absorber Materials, Different Deposition Techniques for Single Crystal & Polycrystalline Materials, Effect of Annealing in Different Environment, Some Characterization Techniques such as EBIC, DLTS, Rutherford Back Scattering etc. Interface Configurations used in Solar Cells, Selection of Optimum Band gap for Photovoltaic Devices, Formation of Ohmic Contacts and their

EL-606 Solar Cells Design

Interaction of Light with Semiconductors, Recombination Processes, Dark and Illuminated Characteristics, Metal-Semiconductor Heterojunctions, Low-Resistance Contacts, MIS Solar Cells, Photo electrochemical Cells, Materials and Structural Characteristics affecting Cell Performance, Short-Circuit Current Limits & Losses, Open-Circuit Voltage Limits & Losses, Effect of Temperature, Fill Factor Losses, Efficiency Measurement and its Improvements.
Design of Solar Cells and Modules, Optimal Cell Design Consideration, Collection Probability of Generated Carriers, Junction Depth, Lateral resistance of Top Layer, Doping of Substrates, Back Surface Fields, Top-Layer Limitations, Dead Layers, High Doping Effects, Contribution to Saturation Current Density, Top-Contact Design, Optical Design, Antireflection coating Textured Surfaces, Spectral Response, Solar Cell Modules.
Solar Cell Materials & Applications, Amorphous-Silicon Solar Cells, Cadmium Sulphide-Copper Sulphide, Cadmium Telluride, Gallium Arsenide, copper Temary and Quaternary Chalcopyrite Solar Cells, Advanced Concentrator Solar Cells, Energy Storage, Uses of Solar Cells.

EL-607 Electronic Transport in Semiconductors

Focus on ballistic (and quasi-ballistic) transport – both semi classical and quantum. Focuses on traditional low-field transport theory based on the Boltzmann Transport Equation, drift-diffusion charge transport, thermoelectric effects (heat flow and temperature gradients) and Galvano-magnetic effects (magnetic and electric fields), high-field transport – first in bulk semiconductors ,velocity saturation, velocity overshoot in small devices.
Balance Equations, Monte Carlo Simulation, Carrier Scattering, High-field transport in bulk semiconductors, Off-equilibrium transport in devices.

EL-608 Advanced Solid State Devices

Semiconductor fundamentals required in the operational analysis of microelectronic devices, Semiconductor Properties, Elements of Quantum Mechanics, Energy Band Theory Equilibrium Carrier Statistics, Recombination-Generation, Carrier Transport, p-n junctions.MS Contacts and Diodes.
Heterojunction, Bipolar Transistors, Metal-Oxide-Semiconductor (MOS) Fundamentals, MOS Capacitor C-V Characteristics, Non-ideal MOS, Small-Dimension MOS

Charge storage and charge transfer in deep-depletion MOS devices (CCDs and DRAMs) Optical processes in semiconductor devices, including absorption (photodiodes), spontaneous emission (LEDs), and stimulated emission (semiconductor lasers) Transferred-electron and transit-time effects in microwave oscillators (Gunn and IMPATT diodes, Power MOSFETs and high-level injection in PIN diodes and IGBTs.

EL 609 Microwave Circuits

The limitations of electrical network theory, advanced Microwave circuit theory, Scattering parameters (S-parameters), Smith-Chart and signal-flow charts, Technology of integrated microwave circuits (HMICs/MMICs), Planar circuit components, quasi-lumped and distributed components, Concepts of layout-oriented design (CAD), hierarchy of network- and EM-oriented simulation, Short discussion of design-oriented EM-simulation methods (quasi-static and dynamic), Design of planar filters, dividers, couplers, transformers, and matching networks, Passive and active electrical components and corresponding models (diode, bipolar transistors, MESFETs and FETs) applicable at RF and microwave frequencies; modeling and parameter extraction, design example discussion of small signal amplifier design with respect to linear gain, power, stability, and noise (design example), Discussion of power amplifier design, large-signal modeling of transistors and harmonic-balance simulations, Design of circuits and subsystems commonly used in communication technology switches, oscillators, mixers, and frequency multipliers, demonstration of layout-oriented CAD design examples.

EL610 Radio Frequency Circuits and Architectures for Mobile Communication Systems

High Speed Broadband Amplifiers, Enhancement of Broadband Amplifiers, Narrowband Amplifiers, Noise Modeling in Amplifiers, Noise Figure, Impact of Amplifier Nonlinearities, Low Noise Amplifiers Mixers, Voltage Controlled Oscillators, Noise in Voltage Controlled Oscillators, High Speed Digital Logic, High Speed Frequency Dividers, Integer-N Frequency Synthesizers, Noise in Integer-N Frequency Synthesizers
Advanced Frequency Synthesizers, Design and Simulation of Synthesizers, Basics of Wireless Communication, Performance Measures of Wireless Communication.

EL 611 VLSI Architectures

MOS transistor features, Short channel transistor characteristics, Parasitic and interconnect elements estimation techniques, CMOS circuit techniques, Static and dynamic power features of basic building blocks, Basics of quantitative optimization. Resume on digital signal processing, frequently used examples and their properties. Common architectures of adders and multipliers

EL-612 Selected Topic in Advanced Analog integrated circuits

This course will cover the study of current mode building blocks that will be used in optimizing the filters and oscillators circuit. Basic Current Conveyor including CCI, CCII, CCIII and modified CC. Dual output Current Conveyor (DO-CCII), Negative Impedance Converter (NIC),

perational Transconductance amplifier (OTA), Current feedback operational amplifier (CFOA), and some others described in literature.

EL-613 Advanced concepts in Analog Circuit Synthesis and Design

Cascade Design, Biquad Circuits, Butterworth Low pass/band pass, Chebyshav Response, Sensitivity of single and multi-parameter, Stability analysis, Frequency transformation, Frequency transformation ladder, Ladder design and leapfrog simulation, Switched capacitor filter, Op-amp Oscillator, Better Op-amp models

EL-614 Implementation of Analog ICs on PSPICE Software

All the building blocks that are studied for the optimizing filters and oscillators will be implemented on transistor level using PSPICE and different responses will be obtained. List of topics for PSPICE simulations are: Basic Current Conveyor including CCI, CCII, CCIII and modified CC. Dual output Current Conveyor (DO-CCII), Negative Impedance Converter (NIC), Operational Transconductance amplifier (OTA), Current feedback operational amplifier (CFOA), and some others described in literature.

EL-615 CMOS RF ICs

Nonlinear history of Radio, overview of wireless principles, passive RLC networks, characteristics of passive IC components, a review of MOS device physics, distributed systems, the smith chart and s-parameters, bandwidth estimation techniques, high frequency amplifier design, voltage references and biasing, noise, feedback systems.

EL-616 RF Transceiver Design

Practical knowledge on RF transceiver system design for wireless communications, systematic design methods of receivers and transmitters used in communication systems like GSM, WLAN or Bluetooth on a System-level, design principles of RF system, analyze an RF system in its physical layer given specifications defined by standard , design an RF front-end for the required performance using professional software tools, Fundamentals of RF system design, Basic design considerations in different radio architectures, Receiver system analysis and design, Transmitter system analysis and design, Performance evaluation, Case studies, Design work with professional tools.

EL-617 Advanced RF System Design

Introduction, Basic Issues in RF Electronics, Modulation Techniques, Analog Transmitters and Receivers, Demodulation Techniques, Transmission Lines, Matching techniques, Oscillators and Frequency Synthesizers, RF Power Amplifiers, Digital transmitters and receivers.

EL-618 Linearization and Efficiency Techniques in RF Circuits

Techniques including Feedback, Harmonic Termination, Optimal biasing, feedforward, Derivative Superposition, IM2 Injection, Noise Distortion Cancellation, Post Distortion, Impact of technology scaling on linearity.

EL – 619 Stochastic Methods in Autonomous Systems

Introduction to Stochastic Methods, Noises & Randomness, Mean Filter, Analysis & Design, Kalman Filtering (KF), Gaussian Assumption, Extended Kalman Filter, Implementation of KF on Matlab, Simultaneous Localization and Mapping (SLAM) , Rao-Blackwellised Particle Filter, Environment Modeling, 2D SLAM using Range-Bearing Information, Partial 3D SLAM using Range/Bearing Information, Modeling on Simulator, Review of Articles/Case Studies

EL – 620 Modern Control Systems

Review of Control Systems (CS) , Modeling and Analysis of Control System, Feedback Control, Analysis and Design, Analog & Digital PID Designing & Implementation, State-Space Method in CS, Signal Flow Graph State Models, Controllability and Observability, Pole Placement Technique, Optimal Control Technique, Analysis and Design, Stochastic Process & State, Estimation , Gaussian Assumption, Kalman Filtering, Modeling & Implementation on Matlab, Review of Articles/Case Studies

EL – 621 Solar Power & Integration

Solar: The course is aimed at Solar Technologies; Physics of PV Cell; PV Inverters; MPPT;PV, Batteries and Charge Controllers; Sizing a PV system; PV System Control; Grid requirements for PV generators; Grid connected PV plants; Case Studies; Lead-Acid Battery for PV Stand-Alone Systems; Hybrid power systems; RES based Hybrid systems; Smart Grids and Distributed networks.
Integration: The integration through smart electrical grids and microgrids with renewable energy sources and of distributed generation systems.
The course content covers the following main issues: The concept of smart grid and microgrid; Interfacing with renewable energy sources; Power quality issues in a microgrid interfacing; Voltage and frequency control in a microgrid through interfacing; Protections in a microgrid. PV Interfaces Wind System Interfaces
It will also focus on fundamentals of solar energy conversion, photovoltaic and photothermal engineering. Design and installation of solar panels for residential and industrial applications and connections to the national grid and cost analysis will be discussed.
In addition, basic manufacturing processes for the production of solar panels, environmental impacts, and the related system engineering aspects will be included to provide a comprehensive state-of-the art approach to solar energy utilization.

EL – 622 Distributed Generation

The course will cover the distributed generation, Generation and storing technologies, Control techniques and renewable energy integration systems, power grid analysis and studies, smart grids, standards and electric markets. The details are: Distributed Generation: introduction, Effects of distributed generation on the grid, Boundaries of the actual grid configuration, Consumption models and patterns. Demand Side Management, Distributed, generation advantages and needs Other Distributed Generators: Microturbines; ICE based generators; Fuel Cells; Control structures of power electronics for DPGS; Grid supporting converters; HDVC Power Transmission systems EV interests. Random generation forecast corrections, EV needs according to users and grid exigencies, Dimension and security according to EV needs, Batteries and chargers, Standard UNE 61851. EV conductive system, Introduction to basic analysis and operation techniques on power electronic systems.
This course will introduce basic methodologies for dynamic analysis, control system design, system coordination, and optimization for renewable power sources such as solar cell systems, power electronics, and power systems.

EL – 623 Modeling and Control of Renewable Power Sources

Modeling and simulation of electric systems: Introduction, Simulation on grid studies and used tools. Per unit systems. Steady state Simulation studies. Load flow : Steady state simulation studies. Short-circuit Electric systems, modeling for permanent regime studies, Dynamic regime simulation studies, Electric systems modeling for simulation in dynamic state, Transient regime simulation studies, Transient regime electric systems modeling, Generation systems modeling, Integral planning of primary-secondary distribution systems using mixed integer linear programming, A probabilistic methodology for distribution substation location , A linear programming methodology for the optimization of electric power-generation schemes

EL – 624 Nanotechnology

The Promise of Nanotechnology and Nanoscience, Molecular and Nano-Electronics: Concepts, Challenges, and Designs, Engineering Challenges in Molecular Electronics, Molecular Electronic Computing Architectures, Nanoelectronic Circuit Architectures, Spintronics — Spin-Based Electronics, Biologically Mediated Assembly of Artificial Nanostructures and Microstructures

EL – 625 Power Converter

Introduction to power electronics and its applications DC-DC converters:, Buck Converter, Boost Converter, Buck-Boost converter. Flyback converters, Forward converter, Full bridge and Half bridge converters. DC-AC Inverters: Single phase and three phase bridge inverters, Pulse-width modulation strategies. Sinusoidal and space vector modulation.Resonant converters. AC-DC Phase Controlled Thyristor Converters. Closed loop control of DC Motor Drives. Introduction to AC motor drives and systems, Examples: Industrial. Transportation, Renewable Energy Applications.

EL – 626 Advanced Power Converter

Pulse width modulation of converters and inverters. Space vector PWM strategies. Soft switching converters. High frequency resonant converters. Power factor correction rectifiers and distributed power systems. Active rectifiers. Multi-level converters. Matrix converters. Multiple input converters.

EL – 627 Advanced Digital Signal Processing and Algorithms

Review of basic digital signal processing. Bio-Sensing Processing. Time and Frequency domain analysis. Signal compression. Engineering design for VLSI implementations in implantable devices. Bio/digital signal processing algorithms. Bio-system based devices. Algorithms used in bio-system devices. High speed processors for real time controlling of multi-model biometric system. High accuracy bio-sensors

EL – 628 Modeling and Simulation of Biometric Systems

Modeling of biometric systems. Computer tools for simulating biometric systems. Software implementation of digital image processing algorithms. Using computer tools for time and frequency domain analysis. Computer aided design of biometric systems. Feature extraction and enhancement.

EL – 629 Advanced Digital Image Processing

Review of basic digital image processing. Image transforms, image segmentation, enhancement, edge detection, texture analysis, image restoration, image compression, filtering, distance measurement and feature extraction. Filters used in image processing. Algorithms for image processing. Image Database maintenance and matching of extracted features. Devices used for capturing of finger-vein images.

EL – 630 Advanced Robotics

Introduction to Advanced Robotic Systems, Transformations and its Analysis, Kinematics and its Types, D-H Parameterization, Review of Industrial Manipulators, SCARA Manipulators, Delta Manipulators, Power Flow Analysis, Dynamics and its Analysis , Trajectory Planning, Cartesian Analysis, Sensors in Autonomous Systems, Actuators in Autonomous Systems, Modeling on Simulator, Review of Articles

EL – 631 Control, Modeling and Simulation in Power Electronics

Principles of modeling and fundamentals of controller design for inverters, and switching dc-dc power converters will be discussed with an emphasis on generalized averaging methods. Special attention will be given to analysis and design of regulated power supplies for low power and medium power level supplies. An introduction to nonlinear phenomenon in power electronic systems and adjustable speed motor drives will be included. Finally, analysis and design of

multi-converter systems will be discussed and the use of advanced control methods such as Feedback linearization and sliding mode control in such systems will be explored.

EL – 632 Characterization Techniques for Semiconductor Materials

Modern characterization techniques routinely employed to study the properties of semiconductor materials. Concepts and theory underlying these techniques.
Spectroscopy techniques such as Atomic Absorption. Diffraction Methods: X-Ray Powder Diffraction, X-Ray Diffraction. Electron Microscopy Methods: Analytical transmission Electron Microscopy, Scanning Electron Microscopy, Electron Probe X-Ray Microanalysis, Low-Energy Electron Diffraction. Scanning Probe Microscopy (SPM), Scanning Tunneling Microscopy (STM) and Atomic Force Microscopy (AFM), photoluminescence (PL), Electroluminescence (EL).
Semiconductor doping measurements and profiling, Deep-level parameter measurements, Carrier mobility measurements, Defects and electronic structures, Raman spectroscopy and absorption technique, studies of Thickness, morphology, doping, Uniformity.

EL – 633 Electrical Characterization of Semiconductor Devices

Electrical measurements of semiconductor devices using source-measure units, nanovoltmeters, picoampmeters and impedance meters collectively available in Keithley Semiconductor characterization system SCS-4200.
Electrical Characterization of semiconductor devices like pn diodes, schottky diodes and MOS devices.
Low level measurements of current, voltage, capacitance and conductance at various frequencies. Lab grade DC and pulse device characterization, real-time plotting, and analysis with high precision and sub-femto amp resolution.Temperature and voltage dependence of current conduction mechanisms. Resistivity measurements, Barrier height and contact resistance measurements, Series resistance and related measurements, , Measurement of oxide and interface parameters in MOS devices.

EL – 634 Modern Trends in Solar Cell Design

Schottky junction based solar cells, Comparison of traditional indium-tin-oxide (ITO) based Schottky junction solar cells and graphene based solar cells, merits and material universalities for designing low cost and easy to fabricate, graphene - based solar cell, their light harvesting and conversion capabilities.
Organic Solar cells: Fabrication and characterization of Organic Solar cells. Dye Sensitized Solar cells(DSSC), Polymer solar cells etc.
Inorganic Solar cells: fabrication methods and characterization of inorganic solar cells. Comparison of organic and inorganic solar cells. Nanoscale Organic – inorganic hybrid solar cells. Alternative structures for solar cells/Nanocomposites.

EL – 635 Estimation Techniques in Pattern Recognition

Concepts of Pattern Recognition theory, Supervised learning and Unsupervised Learning, Generative and discriminative learning, Linear models for regression, Linear models for classification, Learning Classifiers, Linear Classifiers, non-linear classifiers, Bayesian Estimation, Dimensionally Reduction, Kernel Methods, Linear and non-linear kernels, Mixture models and the Estimated Method algorithm, Parametric Estimation Methods, Non-Parametric Estimation Methods.

EL – 636 Computational Intelligence

Structured & Unstructured Learning: Supervised & Unsupervised Learning Neural Networks, Reinforcement Learning; Evolutionary Learning: Genetic Algorithm & Programming, Evolutionary programming & strategy; Swarm Intelligence: Particle Swarm Optimization, Ant Colony Optimization; Fuzzy logic: Fuzzy Set, Fuzzy Logic & Bayesian Reasoning; Artificial Neural Network: Deep Neural Networks, Probability and Learning, Radial Basis Function (RBF) Network, Naive Bayes, k-Nearest Neighbor

TC - 601 Detection and Estimation Theory

Binary and M-ary hypothesis testing. Detection theory: Neyman-Pearson, ROC, Bayesian criteria, Estimation theory: classical estimation, maximum likelihood, Cramer Rao lower bound, Bayesian estimation, MMSE. Composite hypothesis testing, model order selection, General Gaussian models, Representation of continuous-time Waveforms and noise (Karhunen-Loeve expansion), Detection and parameter estimation of signals in additive Gaussian noise.

TC - 602 Advanced Topics in Wireless Communications

Wireless channel and system models; fading and diversity; resource management and power control; multiple-antenna and MIMO systems; space-time codes and decoding algorithms; multiple-access techniques and multiuser detection. Broadcast codes and precoding; cellular and ad-hoc network topologies; OFDM and ultrawideband systems; and architectural issues, Cooperative Communication in Wireless networks.

TC - 603 Advanced Topics in Digital Communications

Sampling Theorem and Orthonormal PAM/QAM. Capacity of AWGN Channels, Performance of Small Signal Constellations, Hard-decision and Soft-decision Decoding, Introduction to Binary Block Codes, Introduction to Finite Fields, Reed-Solomon Codes, Introduction to Convolutional Codes, Trellis Representations of Binary Linear Block Codes, Codes on Graphs, The Sum-Product Algorithm, Turbo, LDPC, and RA Codes, Lattice and Trellis Codes, Linear Gaussian Channels

TC - 604 Adaptive Signal Filtering

Adaptive least-mean-square and recursive-least-square algorithms, adaptive lattice structures, fast finite-precision implementations, and behavioral analysis

TC - 605 Game Theory in Wireless Communication

Static Games, Dynamic Games, Statistical Inference versus Game theory, Information theory versus Game theory, Some wireless communication metrics for Game theory, Application to Power Allocation, Application to Access Control, Application to Routing Protocols, Application to Cognitive Radio Systems, Application to Scheduling.

TC - 606 Cognitive Radios

Introduction to Cognitive Radios, Cognitive Networks, Cognitive Radio Architecture. Software Defined Radio Architectures for Cognitive Radios, Codes and Games for Dynamic Spectrum Access, Efficiency and Coexistence Strategies for Cognitive Radio, Cognitive Radio Sensing, Measurements, Spectrum Sensing, Location Information Management Systems for Cognitive Wireless Networks, OFDM for Cognitive Radio: Merits and Challenges, UWB Cognitive Radio, Applications of Cognitive Radio, Cross Layer Adaptation and Optimization for Cognitive Radio.

TC - 611 Cognitive Wireless Systems

Fundamental challenges and issues in designing cognitive radio. Architectures and protocols for cognitive wireless networks. Distributed adaptation and optimization methods for cognitive wireless networks. Real-time spectrum sensing and medium access control. Spectrum sharing, management and pricing. Cognitive machine learning techniques. Interoperability and co-existence issues. Spectrum awareness and dynamic channel selection. Cognitive radio test-beds and hardware prototypes. Regulatory issues on spectrum sharing and standardization activities. Applications of cognitive radio networks

TC - 612 Wireless Systems modeling Techniques

Introduction to Matlab and Simulink. Functions and elements of ideal wireless system. Effects of additive noise. Channel modeling and effects. Modulation and demodulation techniques. Interference effects. Wireless system range calculations. Spread Spectrum techniques. Cognitive wireless systems.

TC - 613 Detection and Estimation Theory

Classical detection theory including maximum likelihood. Neyman-Pearson, Bayes and minimax criteria. Estimation theory concepts and criteria, Linear estimators. Kalman filters. Maximum likelihood and least-squares estimator. Matched filters. Cramer-Rao bounds. Introduction to pattern recognition.

TC - 614 Advanced Electromagnetic

Review of Electromagnetic fields, Maxwell's equations, Boundary conditions, Displacement current and Maxwell's equations, Conservation of energy and momentum, Poynting's theorem, Propagation of plane wave, propagation of spherical waves, wave polarization, Power reflectance and transmittance, TE and TM modes of wave propagations, Fields in conductors, Resonant cavities.

TC - 615 Nano photonics

Photonics: Nature of light, optical properties of materials, Dispersive media. Photonic Crystals: Light propagation in periodic medium, 1-, 2-, 3-D photonic crystal structures, Photonic crystal waveguides and cavities, Photonic crystal fibers. Plasmonics: Surface plasmon polariton, Localized surface plasmon. Metamaterials: Effective medium theory, Negative refraction,
Nanotechnology: Behavior of materials at nanoscale. Software packages for photonic modeling.

TC - 616 Optoelectronics and Optical Communications

Components of Optical system, Optical fiber, Holey fibers, Optical sources, Optical detectors, Optical couplers, Optical switches, Optical amplifiers. Light wave transmission systems, Optical system optimization, Optoelectronics integrated circuits, Optical networks, Free space optical systems.

TC - 617 Modeling of Large Wireless Network using Advanced Stochastic Processes

Introduction to stochastic process In wireless system, wireless channel model, path loss model, fading mode, point process theory, stochastic geometry, point process spatial model for wireless network, properties of point process, role of point process in wireless heterogeneous network, interference in random wireless network.

TC - 618 Heterogeneous Cellular Networks

Fundamentals of heterogeneous network, Challenges and issues in HetNets, Mobile data explosion and capacity need, radio propagation modeling, Femto cell deployments, Interference modeling, Downlink performance analysis, Co-operative relaying, Energy-efficient architectures and techniques

TC - 619 Advanced Topics in Random Wireless Networks

Performance evaluation at system level, Probabilistic methods to analyze through put, coverage and capacity with and without energy harvesting technique, Power control strategies for cooperative wireless systems, energy-efficient architectures and techniques, Fundamental tradeoffs: capacity and energy

TC - 620 High Frequency Simulation Design

High Frequency Structures. EM Modeling Software Overview. Solution Type selection. Parametric Model Creation. Selection & Assigning of Materials. Assigning Co-ordinate systems. Types of Boundary Conditions. Types of Excitation ports. Modes generation. Analysis Setup. Adaptive Meshing Techniques. Assigning Parametric Solution. 2D & 3D Data Plotting. Exporting Data Points. Demonstrating some industrial examples. Such as Microstrip Patch Antenna, Helical Antenna, Pyramidal Horn Antenna, Hybrid Coupler, Passive Phased Array Antenna.

TC - 621 Antenna Theory & Design – I

Introduction to Antennas for Wireless & Space Communication. Electromagnetic Theory review. Antennas: Types of Antennas., Radiation Mechanism., Current distribution .Historical development. Fundamental Parameters of Antennas: Gain , Directivity, Radiation Pattern. Radiation Intensity. Efficiency, beamwidth & bandwidth. Polarization. Impedance. Wire Antennas: Short Wire. Finite Length Dipole. Ground effects. Loop Antennas: Small circular loops. Large circular loops. Ground effects. Polygonal loops. Arrays: Linear Array. Broadside. Endfire. Scanning. Planar Array. Circular Array. Applications in wireless and space industry

TC - 622 Antenna Theory & Design – II

Aperture Antennas Theory: Equivalence principle, Physical optics approximation, Rectangular Aperture, Gain calculations for aperture Antennas, E plane, H plane and Pyramidal Horn design theory, Rectangular Horn Antennas, analytical and computer design. Reflector Antenna Fundamentals: Circular Apertures, Feeds for reflectors, Corrugated Horn Antennas, Shaped Beam Reflectors, Spillover & Taper Efficiency, Aperture Blockage. Numerical Methods for antenna design: Finite Element Analysis (FEM), Finite Difference Time Domain (FDTD), Geometrical & Physical Optics (GO &PO), Geometric Theory of Diffraction (GTD), Method of Moments (MoM).Antenna Measurement Techniques: Antenna Ranges, Radiation Pattern, Gain Measurement, Impedance Measurement, Polarization Measurement. Link Budget Equation & Radar Range Equation

TC - 623 Conformal Antennas

Conformal Antennas and their types. Microstrip Antenna: Rectangular Patch, Circular Patch, Quality factor, bandwidth & efficiency, Input impedance, Coupling. Probe Fed Microstrip Antenna. Aperture Coupled Multilayer Microstrip Antennas. Microstrip Arrays: Analysis, Design & Applications. Dual & Circularly polarized microstrip antennas. Multifunction Conformal Antennas. Superconducting Conformal Antennas. Active Conformal Antennas. Tapered Slot Antennas. Phased Array Antenna Systems.

TC - 624 Advanced Microwave Systems

Transmission-line Theory: Lumped element model, Field theory of transmission-lines, TEM/TE/TM modes, Terminated lines, SWR, impedance mismatches, The Smith chart and impedance matching, Transient Analysis. Planar Transmission-lines: Stripline, Microstrip, Coplanar-line, and discontinuities. Waveguides: Rectangular waveguide, Circular and Dielectric waveguide concepts, Waveguide excitation. Matching Networks for Distributed Networks: Stub tuning, Quarter-wave transformers, Multi-section and tapered transformers. Microwave Network Analysis: Scattering parameters, multi-port networks, Signal flow graphs, Resonators, Couplers, Power Dividers, and Filters. T-junctions, Magic Tees, and Wilkinson power dividers, Hybrid couplers, Coupled line and Lange couplers, Circulators, Isolators. Periodic structures, Filter design by the insertion loss method, Planar filter circuit implementations. Microwave Amplifier Design. Microwave Integrated Circuits (MIC): RF Microelectromechanical System (MEMS) Components. Microwave Systems: RF Components for Wireless Systems, RF Components for Ultra Wideband Systems.