MS/PhD Electrical Engineering Course Description

CSE 801: Stochastic Systems (3-0)

This course will prepare the students to grasp advanced and applied concepts in probability and statistics. Course will cover topics in random variable theory, stochastic processes, correlation and power spectrum, mean-square estimation, filter design, decision theory, Markoff processes, simulation, stochastic calculus and optimal systems for filtering and detection

Recommended Text:

1. Stochastic Systems: Modeling, Identification, and Optimization, By Roger J.-B. Wets, Václav E. Beneš, Contributor Roger J.-B. Wets, Published by North-Holland Pub. Co., 1976.

EE 831: Advanced Digital Signal Processing (3-0)

This course would develop a sound understanding of Digital Signal Processing, its theoretical background as well as its applications and implementation design. This course would elaborate the time domain as well as frequency domain characteristics of discrete time signals and systems. Review of random signals, Multi-D signals. Multirate Signal Processing: Interpolation and Decimation, Sample Rate Conversion, Oversampled Processing (A/D and D/A conversion). Time-Frequency Representations: Filterbanks/Wavelets, Short-Time Fourier Transform, Wigner-Ville Decomposition, 1-D and 2-D Transforms (DCT, DST, KLT). Linear Prediction: Autoregressive Modelling and Least Squares, Modelling Random Signals, Prony's Method. Inverse Problems (Signal Reconstruction): Underdetermined Least Squares, Reconstruction from Projections, Iterative Methods, Reconstruction from Non-uniform Sampling, Optimal Quantization.

Recommended Text:

1. Digital Signal Processing: A Practical Approach. By Emmanuel C. Ifeachor, Barrie W. Jervis. Published by Prentice Hall, 2002
2. J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, Prentice Hall, 4th edition, 2007
3. A.V. Oppenheim and R.W. Schafer, Discrete Time Signal Processing, Prentice Hall, 2nd edition, 1999.

EE 823: Advanced Digital System Design (3-0)

This course introduces logic synthesis, implementation, and SoC design concepts. The course is project oriented where students will take designs from concept to Verilog HDL description to verification using simulation and synthesis, and finally to programmable device implementation on an FPGA development board. This is an advanced level course that will enable the students to realize their DSP algorithms. It will

study components of a digital system design, FPGA designs and state machines, Fixed point arithmetic, adders, multipliers, subtractions in hardware. Register-transfer, behavioural and system-level design and synthesis; resource sharing; scheduling; the use of hardware-description languages; algorithms to logic; hardware/software partitioning; systems-on-chip; component re-usability; reconfigurable systems, low-power systems; case studies (DSP, speech, image and video algorithms implementation).

Recommended Texts:

1. Wayne Wolf, "FPGA-Based System Design," 2004, Prentice Hall, ISBN: 0131424610
2. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis," Second Edition, 2003, Prentice Hall, ISBN: 0130449113.
3. Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL," First Edition, 2003, Prentice Hall, ISBN: 0130891614.

EE 833: DSP Hardware Systems Design (3-0)

This advanced level course provides an in-depth knowledge of hardware concepts required to implement DSP algorithms. It will cover the theory and practice in the design and implementation of DSP algorithms on programmable processors, multiprocessors, and ASICs. Introduction to Programmable DSPs: Skillikorn's taxonomy and classification, Data Path Design for DSP, SISC architectures, Pipeline control, Synchronous data path design and retiming, Arithmetic circuits for DSP, Multiprocessor scheduling theory, Video signal processors, DSP ASIC design and VHDL, DSP Chip Synthesis.

There is no Recommended Text prescribed for this course. The course will be based on classical and contemporary research papers and latest technological developments.

EE 931: DSP Software Systems Design (3-0)

The DSP Software design course deals with challenges related to software design of DSP algorithms and Real Time operating Systems. Topics will encompass latest trends in specification, evaluation, and implementation of realtime DSP applications on embedded DSP-based environments. It will also cover fixed point and floating point issues, Software architecture for DSP boards and systems: Host interfaces, I/O interfaces and Real-time Operating Systems, DSP program framework, APIs, virtual prototyping of DSP applications, DSP application demonstrations (Sample implementations - equalizers, coders), performance measurement and optimization.

There is no Recommended Text prescribed for this course. The course will be based on classical and contemporary research papers and latest technological developments.

EE 834: Applied Signal Processing (3-0)

This course will allow the students to analyze signal processing algorithms, propose solutions for and estimate HW/SW resources needed for the following applications: Adaptive filters, Modulation, Demodulation, Audio signal processing, Video signal, processing . Contents include, Overview of Digital Signal Processing, DSP and FPGA

Basic Computer Arithmetic ,Number representation , Adders, multiplier and dividers, Cordic, Digital Filter Design ,FIR filters ,IIR filters, Multirate Signal Processing , Interpolation ,CIC filters, Error control, Adaptive Filters , Wiener filters.

Recommended Text:

1. Real-Time Digital Signal Processing, S.M.Kuo, B.H. Lee and W. Tian
2. Digital Signal Processing with Field Programmable Gate Arrays, U. Meyer-Baese

EE 836: Advanced Digital Image Processing (3-0)

This graduate level course will provide a holistic view of various topics in image processing and could build the foundations for specialized study in image understanding, video communications, multimedia or medical imaging. Students should have some experience in linear algebra and probability theory. Home-works will be in the form of mathematical problems, computer exercises and reading material from recent literature. Grading will be on the basis of exams and a course project. Introduction to Human Visual System, digital image sensing and basic operations on digital images.2D Systems: 2D spatial and frequency domain operations. Image Restoration. Image Transforms. Image coding and compression. Multi-resolution coding, subbands and wavelets. Medical Imaging Fundamentals. Image analysis: edge detection and segmentation and Video tracking.

Recommended Text:

1. Digital Image Processing by Gonzalez & Woods

CS 867: Computer Vision (3-0)

Computer Vision is an exciting field with applications in modern multimedia, robot and surveillance applications. Topics include imaging geometry, Camera modelling and calibration, Filtering and enhancing

images, region segmentation, colour and texture, line and curve detection, shape analysis, stereopsis, motion and optical flow, video registration and 3D reconstruction.

Recommended Text:

4. Computer Vision, By Linda G. Shapiro, George C. Stockman. Published by Prentice Hall, 2001, ISBN 0130307963, 9780130307965.
5. Multiple View Geometry in Computer Vision, By Richard Hartley, Andrew Zisserman, Contributor Andrew Zisserman, Published by Cambridge University Press, 2003
6. Computer Vision .Algorithms and applications, Richard Sileski, 2008

CSE 811: Advanced Computer Architecture (3-0)

This course will cover latest trends in Computer Architecture, Instruction set architecture RISC, CISC and VLIW, pipelining, vector processors, cache memory, high bandwidth memory design, virtual memory, input and output. Latest research papers related to Computer architecture will also be covered to make the students abreast with the up-to-date knowledge in this area.

Recommended Text:

1. Computer Architecture: A Quantitative Approach, By John L. Hennessy, David A. Patterson, Contributor Andrea C Arpaci-Dusseau, Remzi H Arpaci-Dusseau, Published by Morgan Kaufmann, 2006

EE 821: Advanced Embedded Systems Design (3-0)

Trends and challenges in embedded system design, introduction to the design and use of single-purpose processors (hardware) and general-purpose processors (software), memories and buses, hardware/software tradeoffs, advanced computation models, control systems, chip technologies, modern design tools, embedded processor selection, hardware/firmware partitioning, glue logic, circuit design, circuit layout, circuit debugging, development tools, firmware architecture, firmware design, and firmware debugging

Textbook:

1. Frank Vahid and Tony D. Givargis, "Embedded System Design: A Unified Hardware/Software Introduction," 2001, John Wiley & Sons ISBN: 0471386782.
2. Computers as Components , Wyne Wolf.

EE 822: ASIC Design Methodology (3-0)

The aim of the course is to teach concepts and methods related to design, testing and implementation of digital ASICs. The design process starts from a behavioural or structural description in VHDL. The main

focus lies on synthesis from the register transfer level, but will also discuss latest trends in design for testability, technology mapping and physical synthesis as well as give an introduction to formal verification.
Recommended Text:

1. Application-Specific Integrated Circuits", Michael John och Sebastian Smith, Addison-Wesley, ISBN 0-201-50022-1

EE 922: System on Chip Architectures (3-0)

Advances in process technologies allow integrating more and more components on a single chip, which allows the design of very powerful applications. The course aims to give the student a thorough understanding of the interaction between different components in order to be able to design efficient applications via optimised designs

EE 825: System level Packaging (3-0)

This course provides an introduction to the issues related to the packaging of electronic systems with emphasis on SoC for Digital and Mixed Signal design. As part of this course, the students will work in groups to design packaged sub-systems using the Physical CAD tools from Cadence, parasitic extraction tools, and circuit simulators. Examples are shown in the figures below of a Multi-chip Module (MCM) and Electromagnetic Bandgap structures.

EE 819: Sensors and Transducers (3-0)

The program aims to give students an advanced knowledge of the sensors and sensing processes in modern instrumentation systems, with particular emphasis paid towards commercially available sensors. Sensor terminology: Transducers – input, output, active and passive; Accuracy, precision, resolution, sensitivity (responsivity), linearity, range, relative error, absolute error. Primary and secondary sensors, interference quantity. Displacement measurement: Potentiometric sensors; Linear variable differential transformer; Capacitance sensors; Optical Devices, encoders, moiré fringe devices and laser ranging. Strain gauges, stress, strain, Young's Modulus.Temperature measurement- Thermocouples; Resistance thermometers; Thermistors.
Recommended Text:

1. R Pallas-Areny and J G Webster, Sensors and Signal Conditioning, J Wiley Publishers, 1991
2. W J Tompkins and J G Webster, Interfacing sensors to the IBM PC, Prentice Hall, 1988
3. A Reader, R Loxton and P Pope, Instrumentation, Open University Press, 1986

EE 892: Instrumentation and Systems (3-0)

Teach the methods for the measurement and control of systems including numeric control systems, programmable controllers, and distributed systems. Study of automatic testing of electronic devices, physical properties and their measurement, different types of field instrumentation, industrial electronic circuit applications, interfacing process variables, motor control and servo systems, servo amplifiers and drives, numeric control systems, programmable controllers and distributed control systems.

Recommended Books:

1. Chester L. Nachtigal, "Instrumentation and Control: Fundamentals and Applications," 1990, John Wiley & Sons, ISBN: 0471880450.
2. Mike Tooley, "PC Based Instrumentation and Control," Third Edition, 2005, Newnes, ISBN: 0750647167.
3. W. Bolton, "Programmable Logic Controllers," Third Edition, 2003, Newnes, ISBN: 0750659866.
4. Thomas E. Kissell, "Industrial Electronics: Applications for Programmable Controllers, Instrumentation and Process Control, and Electrical Machines and Motor Controls," Third Edition, 2003, Prentice Hall, ISBN: 0130602418.

EE 893: Data Acquisition and mixed signal design (3-0)

This course is designed for those students who intend to work as an instrumentation engineer with confidence of designing data acquisition systems and to understand principles of data acquisition and fundamentals of signal and information capture applied to sensing and instrumentation. Topics include; Fundamentals: linearity, sensitivity, offset, gain, etc, System dynamics - 1st order and 2nd order systems, settling time and temporal response. Multiplexing and multi-channel signal capture - reed relay, FET CMOS, cross-talk. Controlling aperture - Sample and hold - applications, circuits, practical issues, DAC - reference voltage, coding, internal structure, user guide, ADC - principal methods, Integration types and Σ-Δ (noise effects); Non-integrating types - successive approximation, sub-ranging and flash. System design & practice - quantization error, sampling frequency, aliasing frequency, design practice. Interface issues - unit signals, micro-controller I/O, PC I/O.

There is no Recommended Text prescribed for this course. The course will be based on classical and contemporary research papers and latest technological developments.

EE 851: Advanced Digital Communications Systems (3-0)

Introduction to source coding, Quantization, Prediction, Redundancy removals, Time and frequency domain speech coding, Transform coding of Image/video, Entropy coding of image/video, Standards, Future Research area, Error Control Coding: Introduction, Implementation, Convolutational codes, Simple Linear block Codes, Serial Concatenation, Modulation: Introduction to digital modulations, Phase Shift Keying, FSK, Bandwidth- efficient modulations, Spectrally controlled modulation.

Recommended Text:

1. Digital Communications: Fundamentals and Applications, By Bernard Sklar, Published by Prentice Hall PTR, 2001
2. Digital Communications, By John G. Proakis, Published by McGraw-Hill, 1995

EE 852: Information and Coding Theory (3-0)

This course will provide the students an introduction to classical Information Theory. The main course objective is to introduce the students to well-known information theoretic tools that can be used to solve engineering problems. The course will begin with information measurement and characterization leading to the Asymptotic Equipartition Property. After that entropy rates of Markov chains will be discussed. Fundamentals of noiseless source coding will be taught next. Finally, information capacity of some well-known channel will be studied.

Recommended Text:

1. Information and Coding Theory, By Gareth A. Jones, Josephine Mary Jones, Published by Springer, 2000, ISBN 1852336226, 9781852336226

CSE 820: Advanced Computer Networks (3-0)

The focus of the course is on the protocols, algorithms and tools needed to support the development and delivery of advanced network services over networks. We will also examining the capabilities provided by emerging ultra-fast network technologies. The course begins with a brief survey of the state of the art in networking technology, examines a collection of new and emerging services and applications, and then examines the algorithms, protocols and software entities involved in delivering new services.

This course will then build upon fundamental computer networking principles to cover advanced techniques used in the design and implementation of next-generation-networks (NGNs). Briefly, the broad topics covered will cover the challenges in design and implementation of future NGNs. There will be specific discussions on protocol mechanisms, algorithmic techniques, and performance analysis tools.

There is no Recommended Text prescribed for this course. The course will be based on classical and contemporary research papers.

EE 883: Wireless sensor and mesh networks (3-0)

The aim of this course is to facilitate learning and understanding of the important concepts relevant to wireless sensor and mesh networks. Students will learn the principles behind designing wireless mesh networks and wireless sensor networks. Topics on wireless sensor networks are: Medium access protocol, routing, data-centric networking, topology control, transport layer, applications.

Recommended Text:

1. Wireless Ad Hoc and Sensor Networks: Protocols, Performance, and Control, By Jagannathan Sarangapani, Published by CRC Press, 2007
2.

EE 855: Error Control Coding (3-0)

The aim of the course is to introduce various channel coding techniques which are deployed in actual communication systems. The course will introduce basic channel coding techniques and progressively delve deeper into the subject, covering some sophisticated modern error correcting codes. Students will learn how to select the most suitable channel coding algorithm for any particular channel, and also be aware of implementation and practical issues of the various channel coding methods.

Recommended Text:

1. Error Control Coding: Fundamentals and Applications, By Shu Lin, Daniel J. Costello

EE 842: Microwave Communication System Design (3-0)

This course covers circuit level design issues of high speed communication systems. Some specific circuit topics include S-parameter techniques for R.F. active circuit design, computer aided design techniques, R.F. integrated circuits, fundamentals of low noise R.F. design, analysis and design of wideband non-linear amplifiers, VCO's, mixers, power amps, high speed digital circuits, and frequency synthesizers. In addition to learning analysis skills for the above items, students will gain a significant amount of experience in simulating RF circuits in SPICE/Matlab and also building RF circuits within a lab project.

Recommended Text:

1. RF system design of transceivers for wireless communications, By Qizheng Gu, Published by Springer, 2005

EE 854: Optical Communication Systems (3-0)

The optical fiber, with its low-loss and high-bandwidth characteristics, has the potential to provide enormous capacity of transmitted data as compared to electronic means. This course will describe the fundamental operation and some recent advances in the exciting area of optical fiber communication systems. The course begins with a description of the basic device technologies and their performance in an optical system. This is followed by discussion on optical system design, including signal, noise, and sensitivity in the context of high-speed and long-distance transmission and multi-user networks.

Recommended Text:

1. Optical Communication Systems By John Gowar, Gowar

EE 853: Advanced Wireless Communication (3-0)

This course covers the theoretical aspects of contemporary and emerging wireless communication paradigms. The objective of the course is to equip the students with a sound foundation in advanced concepts of wireless communication systems. To this end, the course will start with an introduction to wireless communications. This introduction will be followed by in-depth discussions on the challenges and constraints of radio propagation and wireless channels. Modulation, equalization and diversity techniques will be covered next. Finally, the course will conclude with detailed discussions on Multi-Input-Multiple-Output (MIMO) coding and communication.

Recommended Text:

1. Wireless Communication Systems , Wireless Communications Systems and Networks, By Mohsen Guizani, ebrary, Inc, Published by Springer, 2004.

EE 862: Power System Operations and Control (3-0)

This advanced level course covers operation planning of power systems including load flow, unit commitment, production cost methods, on line operation and control including automatic generation. Topics include Introduction to the main techniques currently used in the operation and control of power systems: economic dispatch and optimal power flow, Unit commitment; fuel scheduling and management of storage hydro-electric releases; Production costing, reliability calculations and operations planning ; PLC's, Ladder Logic, Storage Operation, Medium Voltage Distribution , Balanced Fault Calculations and Selection of Protective Equipment , Unbalanced Faults , Raceway Design , Switchgear and Motor Control Centres, Power Quality, Optimization applications in power systems, Economic dispatch and optimal power flow, Unit commitment and energy interchange, Generation control, State estimation, Static security assessment, Dynamic performance analysis and simulation , Voltage stability

Recommended Text:

1. Fehr, RE, Industrial Power Distribution, Prentice Hall International, 2002.
2. Wood, AJ & Wollenberger, BD, Power Generation, Operation, and Control, 2nd edn, John Wiley & Sons, New York, 1996.
3. Power System Analysis: Operation and Control, By Abhijit Chakrabarti, Sunita Halder Published by PHI Learning Pvt. Ltd., 2006

EE 871: Liear Control Systems (3-0)

The course covers topics in linear control systems such as vector spaces, representation, system description, solution to the state equations, stability, controllability and observability. Adjoints of linear maps. Eigenstructure assignment. Partial and full order observers. Disturbance decoupling.

Recommended Text:

1. Control System Engiuneering, Morman Nise
2. Linear Control Systems, By James L. Melsa, Charles E. Rohrs, Donald G. Schultz
3. Contributor Donald Schultz, James Melsa, Charles Rohrs, Published by McGraw-Hill, 1993

EE 872: Optimal Control (3-0)

This course covers static optimization, nonlinear optimal control of discrete and continuous systems, with specialization to the LQ regulator and tracking, extending the deterministic results to the Kalman filter and the LQG regulator. Topics such as Dynamic programming and inequality constraints. Convex optimization and LMI's are also covered.

Recommended Text:

1. Optimal control, By Frank L. Lewis, Vassilis L. Syrmos, Contributor Frank L. Lewis, Vassilis L. Syrmos, Published by Wiley-IEEE, 1995

EE 874: Adaptive Control (3-0)

The course covers model reference adaptive control in continuous and discrete time. Lyapunov and hyperstability approaches, adaptive observers, self-tuning regulators, design using pole-zero assignments. Minimum variance and LQG control.

Recommended Text:

1. Adaptive Control Design and Analysis, By Gang Tao, Contributor Gang Tao, Published by Wiley-IEEE, 2003, ISBN 0471274526, 9780471274520

EE 841: Electromagnetic Theory (3-0)

This course will cover advanced topics in electromagnetism: electrostatics, magnetostatics, magnetic fields of steady currents, motional e.m.f. and electromagnetic induction, Maxwell's equations, propagation and radiation of electromagnetic waves, electric and magnetic properties of matter, and EM laws.

Recommended Text:

1. Electromagnetic Theory, By Stratton Julius Adams, Published by READ BOOKS, 2007, ISBN 1406765473, 9781406765472

EE 844: Antennas and Wave Propagation (3-0)

This course will cover advanced review of ground wave, space wave, sky wave propagation, troposcatter propagation and duct propagation, propagation characteristics of different frequency bands, propagation of E.M. waves in ionosphere, absence and presence of magnetic field. Antennas: Types, Design Parameters, Measurement Parameters and CAD Tools.

Recommended Text:

1. Antenna Theory: Analysis and Design, By Constantine A. Balanis, Published by Wiley, 1982, Original from the University of Michigan, Digitized 7 Dec 2007
2. Radio wave propagation and antennas: An Introduction By John Griffiths. Published by Prentice-Hall, 1987.

EE 845: EMI/EMC (3-0)

This course electromagnetics for electrical systems. Signals and spectra. Regulations. Radiated and conducted emissions. Conducted and radiated immunity. Mitigation techniques.

Recommended Text:

1. Principles of Electromagnetic Compatibility, By Bernhard Keiser, Published by Artech House, 1987, Original from the University of Michigan, Digitized 19 Dec 2006

EE 873: Microwave Transmission Lines & Waveguides (3-0)

This subject will cover advanced topics in frequency domain analysis of radio frequency and microwave transmission circuits including power relations and graphical and computer methods. Electromagnetic waves: planar optical components, pulse dispersion, phase front considerations for optical components, conducting waveguides, dielectric waveguides.

Recommended Text:

1. Transmission Lines and Waveguides, By Lamont V. Blake, Published by Wiley, 1969, Original from the University of Michigan, Digitized 10 Dec 2007

EE 813: Microchip Fabrication Technology (3-0)

This course serves as an introduction to basic processes used in fabricating semiconductor devices and integrated circuits. The objective is to develop the background knowledge necessary to understand the state-of-the-art semiconductor technology associated with the device fabrication processes. Microchip Fabrication Technology major is designed to prepare students to enter into the large variety of positions available in the microchip fabrication industry. In order to support the technical flexibility required by the large variety of industries, the core curriculum provides a solid foundation in the area of semiconductor manufacturing and include the major topics such as Semiconductor Processing Technology: Crystal Growth, Wafer Preparation, Contamination Control, Wafer Fabrication. Microelectronics Fabrication: Oxidation, Photolithography, Doping, Deposition techniques, Metallization processes, Wafer Test and Evaluation, Semiconductor Devices, IC Formation, Chip Packaging.

Recommended Texts:

1. S. A. Campbell: The Science and Engineering of Microelectronics Fabrication, Oxford University Press, Second Edition, 2000 (ISBN: 0195136055)
2. P. V. Zant: Microchip Fabrication: A Practical Guide to Semiconductor Processing, 3rd Edition, Semiconductor Services, 2000 (ISBN: 0071356363)
3. Reference Books
4. R.C. Jaeger:. Introduction To Microelectronics Fabrication, 2nd Edition (ISBN: 0201444941)
5. Marc J. Madou, Fundamentals of Microfabrication: The Science of Miniaturization, 2nd Edition (ISBN: 0849308267)

EE 818: Micro-Electro-Mechanical Systems (3-0)

This course covers Micro-electro-mechanical systems (MEMS) in detail with fundamentals of micromachining and microfabrication techniques. Design and analysis of devices and systems in mechanical, electrical, fluidic, and thermal energy and signal domains. Sensing and transduction mechanisms, including capacitive and piezoresistive techniques. Design and analysis of miniature sensors and actuators.

EE 812: Optoelectronic Materials and Devices (3-0)

This course will address the basic principles of common optoelectronic devices including semiconductor lasers, detectors, imaging tubes and optical fibres to lead the students to understand the operation principles and applications of semiconductor lasers, various photonic detectors, imaging devices, fibre optic systems and some modern optoelectronic devices and appreciate the rapidly expanding optoelectronics technology. This course will cover the main topics like Optoelectronics and Optical Engineering. Optoelectronic Devices. Optoelectronic materials. Electronic and optical properties of materials. Laser Theory. Semiconductor junctions. Light emitting diodes. Photodetectors. Optoelectronic modulators.

Recommended Texts:

1. Pallab Bhattacharya:, Semiconductor Optoelectronic Devices, ISBN: 0134956567, Prentice Hall (1998).
2. Joachim Piprek: Introduction to Physics and Simulation of Semiconductor Optoelectronic Devices, ISBN: 0125571909, Academic Press, Incorporated (2003)
3. Mitsuo Fukuda:, Optical Semiconductor Devices, ISBN: 0471149594, Wiley, John & Sons, Incorporated (1998)
4. Jasprit Singh: Semiconductor Optoelectronics: Physics and Technology, ISBN: 0070576378, McGraw-Hill Companies (1995)
5. Shun Lien Chuang:, Physics of Optoelectronic Devices, ISBN: 0471109398, Wiley-Interscience; (September 1995)

EE 839: Adaptive Filters (3-0)

Topics include basic theory of adaptive filter design and implementation. Steepest descent, LMS algorithm, nonlinear adaptive filters, and neural networks. Analysis of performance and applications. Eigenanalysis, Review of Discrete-time random processes ,FIR Wiener filters ,The Discrete Kalman Filter ,Gradient-based adaptive filters ,Steepest descent, The LMS algorithm, Gradient Adaptive Lattice Filter , Recursive least squares , Tracking of time-varying systems, Adaptive IIR filter, IIR LMS, Nonlinear adaptive filters Blind deconvolution.

Recommended Text:

1. Adaptive Filter Theory, By Simon Haykin, Published by Prentice Hall, 2002 ISBN 0130484342, 9780130484345

EE 832: Pattern Recognition (3-0)

Topics cover decision theory; parameter estimation, density estimation, non-parametric techniques, supervised learning, linear discriminant functions, clustering, unsupervised learning, artificial neural networks, feature extraction, support vector machines, and pattern recognition applications (e.g., face recognition, fingerprint recognition, automatic target recognition, etc.).

Recommended Text:

1. Introduction to Statistical Pattern Recognition, Author: K. Fukunaga, 2nd Edition, 1990 by Boston Academic Press
2. Pattern Classification, Authors: Duda, Hart, and Stork, 2nd Edition, 2001 by New York: Wiley

EE 895: Analysis of Measurement Environment (3-0)

Topics include statistics, Noise Processes and Error Analysis,Electromagnetic Compatibility and Analysis of Measurement Systems. These will encompass topics such as estimation, hypothesis testing and linear regression. The importance of EMC for modern electronics, the physical background to EMC, and the requirements of typical EMC tests for emissions and immunity. The study required to design circuits and equipment to achieve EMC. The course will be augmented by studying methods to provide an overview of metrology, instrument calibration and traceability of measurements and quality standards

Recommended Text:

1. D.C. Montgomery, Design and Analysis of Experiments, Publishers J. Wiley, 2001
2. P D T O'Connor, Practical Reliability Engineering, 3rd Edition, John Wiley & Sons, 1991.
3. S Bell, A Beginner's Guide to Uncertainty of Measurement, NPL Measurement Good Practice guide

CSE 821: Network Performance Analysis (3-0)

This objective of this course is to introduce graduate students to the important fields of performance measurement and evaluation using probabilistic models. The course will start with an introduction to elementary probability theory and its applications in computer networks. This introduction will be followed by in-depth lectures on discrete and continuous random variables and their applications. Students will then be taught important stochastic inequalities. Finally, the course will conclude with coverage of some advanced topics in stochastic systems. This is a largely theoretical course which will allow the students to identify and employ appropriate analytical tools for performance modelling of complex networking phenomena for their MS and PhD theses.

Recommended Text:

1. Performance Analysis of Network Architectures, By Dietmar Tutsch, Published by Springer-Verlag, 2006

EE 886: Photonic Networks

This course starts with the growing demand for bandwidth, optical network architecture, and how the network has evolved over time. It then moves onto properties of optical fiber, first generation, second generation and third generation networks and advance technologies wherein it discusses how DWDM works including a discussion on optical cross-connects and switches and certain emerging areas in photonic networks. The later part of the course has a strong emphasis on design of photonic networks.

Recommended Text:

1. Photonic Networks: Advances in Optical Communications, By Giancarlo Prati, Contributor Giancarlo Prati, Published by Springer, 1997

EE 863: Power Systems Analysis (3-0)

This course will cover the following major modules. Power Factor Improvement Methods, Distribution Network and its Efficiency Calculations, Transmission System Modelling. Short line, Medium line and Long lines, Compensations and Line Parameters (A B C D)., Modelling of Component, Synchronous Machine Models, Transformer Models, Tap Changer models, SVS Models ., Y–Bus, Z-Bus, Load Flow Methods. Optimal Power Flow Methods., Short Circuit Studies.

Reference Text:

1. Power system operation by Robert H Miller, James H Malinovaski

EE 864: Advanced Machines (3-0)

Advanced Machines cover topics such as Sensors, implementation, special computer architectures and Nonlinear drives based on state reconstruction and nonlinear and adaptive control. Topics include Electric

motors : Producing rotation, Magnetic circuits, torque production, power electronic converters for motor drives, conventional dc motors and dc motor drives, induction motors – rotating field slip and torque, operating characteristics of induction motors ,induction motor equivalent circuit, synchronous brushless dc and switched reluctance drives

Recommended Text:

1. Electric Motors and Drives, Second Edition - Austin Hughes
2. Analysis of Electric Machinery and Drive Systems
3. Electric Motor Drives: Modelling, Analysis, and Control - R. Krishnan

EE 865: Power Generation Operation and Control (3-0)

Familiarization of the students with the details and characteristics of power generation systems and their control. Computer solutions of power system scheduling problems require students to become familiar with optimization techniques applied to real situations. Topics include Economics of the operation of power systems. Control of hydro and thermal generating units. Aspects of interconnected operation. Transmission losses and techniques for optimum economic generation. Hydro-thermal coordination problems. Fuel management of nuclear reactors.

Textbook:

1. "Power Generation Operation and Control", A.J. Wood and B.F. Wollenberg, January 1984, John Wiley & Sons.

EE 876: Robotics (3-0)

This course covers advanced level topics in robot modelling, kinematics, dynamics, trajectory planning, programming, sensors, controller design, active robotic sensing, intelligent and integrated manufacturing systems, robotic inspection, observation under uncertainty, multi-sensor feedback control of manipulators and mobile robots, advanced simulation and monitoring of robotic systems, high level modelling and control, and other topics.

Recommended Text:

1. Introduction to Robotics: Mechanics and Control, By John J. Craig, Published by Prentice Hall PTR, 2004

EE 879: Robust Control (3-0)

This course covers linear systems and norms for signals and systems. Investigation of stability and performance of control systems. Model reduction, uncertainty, and robustness. Parameterization of stabilizing controllers, Ricatti equations and related factorizations. Application to H-2, H-infinity, and L-1 control.

Recommended Text:

1. Robust and Optimal Control, By Kemin Zhou, John C. Doyle, Keith Glover., Contributor John C. Doyle, Keith Glover, Published by Prentice Hall, 1996

EE 873: Fuzzy Control (3-0)

This advanced course deals with fuzzy and knowledge-based control methods in systems with uncertain data, prediction, classification, prioritisation, control, uncertainty techniques, fuzzy systems and fuzzy control.

Recommended Text:

1. Fuzzy Control: Theory and Applications, By Kevin M. Passino, Stephen Yurkovich,
2. Contributor Stephen Yurkovich, Published by Addison-Wesley, 1998

EE 846: RF Circuit Design (3-0)

This course covers advanced topics in design of microwave amplifiers including low-noise amplifier, multiple stage amplifiers, power amplifiers, and introduction to broadband amplifiers. The goal is to provide the advanced knowledge for the design of monolithic microwave integrated circuits ranging from wireless system to radar system

Recommended Text:

1. Microwave Integrated Circuits, By Jeffrey Frey, K. B. Bhasin, Contributor K. B. Bhasin Published by Artech House, 1985, Original from the University of Michigan, Digitized 10 Dec 2007

EE 889: Advanced Wireless Networks (3-0)

This course will cover the theoretical and practical aspects of contemporary and emerging wireless networks. The objective of the course is to equip graduate students with a sound foundation in concepts of wireless networks, and to introduce them to the prominent concepts in infrastructure-less wireless networks. This course covers the Physical Layer, MAC layer, Network layer aspect of wireless networks (Infrastructure and Infrastructure less). To this end, the course will start with an introduction to wireless networks and other basic concepts on the representation of signals. Later, this course is followed by in-depth discussions on the challenges and constraints of radio propagation and wireless channels. Interference and link analysis of communication channels will be covered next. Based on this foundation, MAC and Network layer issues and algorithms/protocols will also be discussed in detail, which includes presentations on few recent papers that shaped the wireless networks. Finally, the course will conclude with project demonstrations, in which students will implement any MAC, Network layer algorithm/s in simulator of their choice.

Text Book:

1. Modern Wireless Communications by Simon Haykin, Pearson Education
2. Computer Networks by Andrew. S. Tanenbom

Reference Books/notes: The following books are recommended for supplementary reading:

- William Stallings, Wireless Communications and Networks, Pearson Education, 2002.
- T. S. Rappaport, Wireless Communications, 2nd Edition, Prentice Hall, 2002.
- Wireless Adhoc and Sensor Networks By Paolo Santi
- Online content referenced in the slides

EE 900 Level Courses

EE 991: Detection and Estimation (3-0)

This course will provide the students a comprehensive introduction to well-known concepts in signal detection and estimation theory. The main course objective is to teach statistical signal processing with an emphasis on communication system application. This course will allow the students to model and analyze practical communication problems in a decision-theoretic framework. The course will begin with an introduction to detection theory. This introduction will lead to detection of signals in noise. Detection theory fundamentals will be followed by an introduction to estimation theory, where linear and non-linear estimation will be taught. The course will conclude with discussion on Weiner and Kalman filter based estimation.

Recommended Text:

1. S.M. Kay's Fundamentals of Statistical Signal Processing: Estimation Theory (Vol 1), Detection Theory (Vol 2)

EE 936: Multirate Systems and Filter Banks 3 (3-0)

The objectives of this course are to teach multirate signal processing, multirate filter banks, wavelet transforms, and applications of multirate filter banks. Review of discrete-time systems and digital filters, multirate signal processing, multirate operations, interconnection of building blocks in multirate systems, multirate filter banks and perfect reconstruction systems, polyphase representation, structures for decimation and interpolation filters, paraunitary filter banks, wavelet transforms and relation to multirate filter banks, applications of multirate systems, maximally decimated filter banks, filters of QMF type, Johnston's filters.

Recommended Books:

1. P. P. Vaidyanathan, “Multirate Systems and Filter Banks,” 1993, Prentice Hall, ISBN: 0136057187.
2. N. J. Fliege, “Multirate Digital Signal Processing: Multirate Systems - Filter Banks - Wavelets,” 1999, John Wiley & Sons, ISBN: 0471492043.

EE 932: Speech processing (3-0)

This course will cover advanced topics in speech coding, synthesis, enhancement and recognition. Topics will include detailed treatment of theory and application of digital speech processing, speech enhancement, dynamic time warping, Scalar and vector quantization, Linear predictive coding. Hidden Markov models (HMM) and speaker verification systems.

Recommended Text:

1. X. Huang, A. Acero, H. Hon and R. Reddy. Spoken Language Processing: A Guide to Theory, Algorithm and System Development. Prentice-Hall, 2001

EE 937: Advanced topics in Computer Vision and Image Processing (3-0)

This course will cover latest and advanced topics in Computer Vision and Digital Image Processing. These may include latest development in image synthesis and computer modeling, image enhancement and filtering, medical imaging, Tomographic imaging, computer graphics research, colour theory, image processing, affine and projective geometry, hidden-surface determination, photorealistic image synthesis, advanced curve and surface design, dynamics, realistic character animation.

Textbook:

1. Computer Vision, By Linda G. Shapiro, George C. Stockman. Published by Prentice Hall, 2001, ISBN 0130307963, 9780130307965.
2. Multiple View Geometry in Computer Vision, By Richard Hartley, Andrew Zisserman, Contributor Andrew Zisserman, Published by Cambridge University Press, 2003
3. Computer Vision .Algorithms and applications, Richard Sileski, 2008

EE 924: Advanced VLSI Design (3-0)

This course covers advanced topics in digital integrated circuit design; design specifications, functionality, performance, reliability, manufacturability, testability, design-rule checking, circuit extraction, simulation, verification.

EE 926: System Validation (3-0)

Verification is today the principal component in the development cost of embedded systems and is often the reason for cost overruns and project delays. The EDA(Electronic Design Automation) industry has responded to this challenge by coming with a wide range of methodology components to improve productivity and improve quality of verification. Topics include:Verification and Validation Plan, Verification and Validation Strategies and Environments,Stimuli Generation,Test Bench Structures, Regression Analysis, Simulation Based Verification, Bit True Verification of DSP hardware and software, Constraint Based Verification, Code Coverage, Hardware/Software co-verification, Virtual Prototyping, Formal Methods, Assertion Based Verification, Model Checking, Equivalence Checking , Embedded Software Verification , Reuse aspects of Verification and Validation Environments, Rapid System Prototyping, Emulation, Debugging and Testing Embedded Systems.

Recommended Books

1. Comprehensive Functional Verification by Wile, Goss and Roesner. Published by Morgan Kaufman.
2. Hardware Design Verification by Lam. Published by Prentice Hall.

EE 925: Computerized Tomography Systems (3-0)

This course is designed for students interested in advanced non-invasive imaging techniques and their industrial applications. General introduction to Industrial Process Tomography (IPT). Outline of inverse problems in IPT. Introduction to the mathematical aspects of algorithms for hard-field and soft-field reconstruction. Hard-field IPT: x-ray, gamma-ray, optical and terahertz tomography. Sensing principles. Hardware design: sources, detectors and measurement "train". Software design. State-of-the-art in hard-field IPT. Microwave tomography. Soft-field IPT: electrical impedance and capacitance tomography, electromagnetic tomography. Sensing techniques. Hardware design: sensors, measuring circuits and calibration. Software design. State-of-the-art in soft-field IPT. Sonic tomography. Synergy between industrial and medical tomography.

Recommended Text

1. A C Kak and M Slaney, Principles of Computerised Tomographic Imaging. IEEE Press, New York, 1987.
2. W A Kallender, Computed Tomography, Publicis MCD Verlag 2000.

EE 953: Advanced data communication systems (3-0)

This course covers the course from a system perspective (i.e., relating to the OSI lower layers, e.g., newer coding, modulation, transmission, etc. techniques) rather than from the routing/transport/applications-layers perspective.. Fundamental concepts, principles and issues of data communication systems. The ISO/OSI reference model is used as a vehicle for discussion and emphasizes lower layer of the model. Specific topics include: motivation and objectives, layered architectures, physical layer principles and protocols, data link and medium access control principles and protocols, circuit, packet and cell switching, local area network design principles and performance comparisons, high speed networking, introduction to wide area network architectures.

Recommended Text:

1. Advanced Data Communications and Networks. By W. Buchanan. Published by CRC Press, 1997

EE 976: Optimal & Multivariable Control (3-0)

The course covers linear optimal regulator problem – finite-time horizon. Principle of optimality, Hamilton-Jacobi equation, Riccati equation. Steady state solution (LQR), algebraic Riccati equation. Properties: gain and phase margin, sensitivity, nonlinearities. Optimal state estimation (Kalman filter), output feedback control.

Multivariable system representations and equivalent systems. Controllability and observability. Poles and zeros of multivariable systems.Pole placement using state and output feedback.

Recommended Text:

1. Multivariable Control for Industrial Applications, By John O'Reilly, Contributor John O'Reilly

EE 947: Microwave Devices & Systems (3-0)

This advanced level course introduces microwave circuits by examining advanced microwave design and operation principles and emphasizes the operation of various high-frequency circuit families. Applications of these circuits range from communication systems to satellite transceivers and sophisticated high-speed/high-frequency commercial and defence systems. System considerations of microwave circuits are also addressed in the area of wireless applications. The course contents will include: Active Microwave device theory such as tubes and transistors, Design and fabrication of matched microwave amplifiers, Design and fabrication of microwave oscillators. Radar & EW Systems

Recommended Text:

Microwave Engineering, By David M. Pozar, Published by John Wiley, 2004

EE 903: Advanced Semiconductor Device Theory (3-0)

The purpose of this course is to explore in detail the behavior of CMOS and bipolar transistors with emphasis on those parameters and performance factors that are particularly important for VLSI devices of deep-submicron dimensions. The major topic this cover are Introduction, Evolution of VLSI Device Technology, Modern VLSI Devices, Basic Device Physics, MOSFET Devices , CMOS Devices Design, CMOS Performance factors, Performance Factors of Advanced CMOS Devices, Bipolar Devices Design, Bipolar Performance factors Bipolar Device Optimization for Digital Circuits Bipolar Device Scaling for ECL Circuits, Bipolar Device Optimization and Scaling for Analog Circuits

EE 902: Nanoelectronics (3-0)

Nanoelectronics is a new and exciting field, which on the main deals with the question of what happens to an (electronic) device when one or more of its dimensions is in the nano-range, say in the range of 100 nm down to 1 nm. Much is known for devices with sizes larger than that (Microelectronics) and the atomic physics deals very successfully with atomic sizes (less than 1 nm). This course presents the design and analysis of a variety of nano-devices (also referred to as "mesoscopic" devices), and briefly examines some notable applications. The emphasis is on a deep understanding of the fundamental concepts and principles which apply to small devices and the challenges and opportunities ahead. This course is needed in order to provide students with exposure to the special physical processes that are operative in nanoelectronic devices. Novel concepts and their implementation in nanodevices are

presented. Introduces basic elements of nanoelectronic structures, including quantum layers, quantum wires and quantum dots. Covers sub-band structure; transport in quantum layers; behavior in the presence of magnetic fields; Coulomb blockades; CMOS nanodevices and nanoelectronics; and SOI multi-gate device physics and modeling. Students learn the novel physical phenomena that are present in the nanoregime and how they are implemented in the operation of nanoelectronic devices. Schrodinger's equation, Tunneling, Resonant Tunneling Diodes, Single Electron Transistors, Quantum Dots, Molecular Electronics, Nano-scale Fabrication Techniques, Scanning Probe Techniques Nanotechnology, nanomaterials, atoms, molecules & clusters, colloids, top down approach, bottom up approach, property changes with size scaling, synthesis of nanomaterials, applications of nanomaterials, sensors

Recommended Text:

No specific Text Books but the following reference books may help.

1. Lectures on the Electrical Properties of Materials, by L. Solymar and D. Walsh (Oxford Science Publications, 7th Edition).
2. Quantum Mechanics, by D.K. Ferry (Institute of Physics Publishing)
3. The Physics of Low Dimensional Semiconductors, by J.H. Davies (Cambridge)
4. Mesoscopic Electronics

EE 977: Nonlinear Control System (3-0)

This course provides an intensive knowledge of Nonlinear Systems and Control. Topics include: Second-order systems. Fundamental properties of solutions. Lyapunov stability. Input-output stability. Passivity. Absolute stability. Linearization. Integral control. Feedback linearization. Sliding mode control. Lyapunov redesign. Passivity-based control. Recursive methods. Applications to electrical and mechanical systems.

Recommended Text:

1. Stochastic Systems: Modeling, Identification, and Optimization, By Roger J.-B. Wets, Václav E. Beneš Contributor Roger J.-B. Wets, Published by North-Holland Pub. Co., 1976
2. Stochastic systems: estimation, identification, and adaptive control by P. R. Kumar, Pravin Varaiya - Science - 1986 - 358
3. Nonlinear Systems: Analysis, Stability, and Control By Shankar Sastry. Published by Springer, 1999

EE 901 Power Electronics and Electric Drives

This subject is aimed at studying the characteristics of modern semiconductor power electronic devices for best selection to a certain application. To study the application of power electronic circuits in the fields of AC and DC drives, power generation and transmission and energy conservation.

Topics include Driver and trigger circuits for power devices; Protection of power semiconductor devices; Calculation of component ratings, power factor, utilisation factor, retrieval of energy etc. for a given

application, Principle of regenerative braking, Application and implementation of closed loop control to machine drives, Power generation and transmission. ,The superposition of information transmission on power lines, Energy conservation, Solar energy and other sources of energy. Battery technology as applied to the storage of electrical energy. The application of semiconductor inverters including uninterruptible power supplies to battery sources.

Reading Materials:

1. Mohan, et al., Power Electronics, 2nd edn, Wiley, 1995.
2. Leonhard, W, Control of Electrical Drives, Springer-Verlag, 1985.

Math Courses

The following list is identified as the desirable mathematics courses:

MTH 401 Numerical Methods (3-0)

Course designed to familiarize the student with analytical techniques as well as classical finite difference techniques in the numerical solution of partial differential equations. In addition to learning applicable algorithms, the student will be required to do programming. Topics covered may include: Implicit, Explicit, and Semi-Implicit methods in the solution of Elliptic and Parabolic PDE's, iterative methods for solving Elliptic PDEs (SOR, Gauss-Seidel, Jacobi), the Lax-Wendroff and Explicit methods in the solution of 1st and 2nd order Hyperbolic PDEs.

Recommended Text:

1. Numerical Analysis: A Second Course, By James M. Ortega,Published by SIAM, 1990, ISBN 0898712505, 9780898712506
2. Numerical recipes in C

MTH 402 Linear Algebra (3-0)

Linear algebra is the study of abstract vector spaces and linear transformations. The subject is rich in mathematical structures, supports many applications in engineering, science, statistics, and operations research, and is a core area in numerical mathematics. The goal of this course is to master the fundamentals of abstract linear algebra by emphasizing concepts and proofs. Topics include Finite dimensional vector spaces, inner products, dual spaces, transformations, projections, adjoints, norms, eigenvalues, eigenvectors

Recommended Text:

1. Horn and Johnson, Matrix Analysis.
2. Seymour Lipschutz and Marc Lipson, Schaum's Outline of Theory and Problems of Linear Algebra, Shaum's Outline.
3. K. Hoffman and R. Kunze, Linear Algebra, Second Edition, Prentice Hall 1971.
4. Paul R. Halmos, Finite Dimensional Vector Spaces, Springer-Verlag, 1974

Compulsory Professional Development Workshops

The following list is identified as the desirable courses:

Technical Writing Workshop

On completing the workshop, the student should be able to identify and critically analyze the most important text types represented in engineering and academic texts, write short texts based on these text types, apply the Process Writing method to his/her own writing whereby constructive criticism from others (peers/teachers) is used to improve texts from first to final draft, summarize texts and integrate them into scientific reports , write a short report, adapted to a less specialized reader, on a topic from his/her own area of specialization, write clearly, correctly and concisely in the formal English style that is typical of engineering or specialized texts from his/her own area and formulate his/her ideas in English logically, coherently, precisely and persuasively. Course contents included topics like Writing strategies ,Typical features of technical writing , Genre analysis, Report structure, Referencing, Integrating illustrations in a text, Summary techniques, Manual of style and Language study.

Recommended Text:

Academic Writing by Björk/Räisänen

Philosophy & Methodology of Scientific Research Workshop

The student upon completion of the workshop will be able explain the (ideal and factual) requirements on scientific work, describe his or her own view on science, and compare this to his or her view on engineering, apply scientific theory to practical problems, give an account of fundamental concepts of philosophy of science, and of ethics in science, survey and present original texts in the area of philosophy of science, instrumentalise scientific problems. The contents of the course will follow the main book closely, and deal with the following topics in the natural sciences: Science and Pseudoscience, Rationality, Objectivity, and Values in Science, The Duhem-Quine Thesis and Under determination, Induction, Prediction, and Evidence, Confirmation and Relevance: Bayesian Approaches, Mode ls of Explanation, Laws of Nature

Recommended Text:

1. Curd & Cover: Philosophy of Science: The Central Issues (Edition: 1), W W Norton & Co Ltd, 1998, 0393971759
2. Garry Potter: The Philosophy of Social Science (Edition: 1), Pearson Education (Print on Demand), 1999, 0582369746