DEPARTMENT OF ELECTRONICS

Curriculum for MS/Ph.D

UNIVERSITY OF PESHAWAR

Layout for MS/M.Phil Electronics

MS/M.Phil Electronics

Major Courses

ELEC 711	Advanced Engineering Mathematics	(3+0)
ELEC 712	Semiconductor Devices and Technology	(3+0)
ELEC 713	Modeling and Simulation of Semiconductor Devices	(3+0)
ELEC 714	Microprocessor-Based System Design	(3+0)
ELEC 715	Advanced Computer Architecture	(3+0)
ELEC 716	Digital Integrated Circuits for Communication	(3+0)
ELEC 717	Fiber Optics and Integrated Optics	(3+0)
ELEC 718	Digital Control Systems	(3+0)
ELEC 719	Advanced Computer and Communication Networks	(3+0)
ELEC 721	Advanced Communication Systems	(3+0)
ELEC 722	Advanced Digital Signal Processing	(3+0)
ELEC 723	Multi-rate Systems and Filter Banks	(3+0)
ELEC 724	Power Electronic Devices	(3+0)
ELEC 725	Optoelectronic Devices	(3+0)
ELEC 726	Digital System Design	(3+0)
ELEC 727	Cellular and Mobile Communication	(3+0)
ELEC 728	Wireless Sensor Networks Hardware	(3+0)
ELEC 729	Bio-Electric Signal Analyses and Interpretation	(3+0)
ELEC 731	Digital Image Processing	(3+0)
ELEC 732	Pattern Matching and Recognition	(3+0)
ELEC 733	Cryptography and Network Security	(3+0)
ELEC 734	Advanced VLSI Design	(3+0)
ELEC 735	Advanced FPGA-Based System Design	(3+0)
ELEC 736	Design of Electronics Systems	(3+0)
ELEC 737	Nanotechnologies	(3+0)
ELEC 738	Advanced Digital Control	(3+0)
ELEC 739	Embedded System Design	(3+0)

Minor/Related Courses

ELEC 701	Research Methodology	(2+0)
ELEC 702	Thesis Writing and Presentation Skills	(2+0)
ELEC 703	MATLAB Programming	(2+0)
ELEC 704	Digital Speech Processing	(2+0)
ELEC 705	Power Electronics	(2+0)
ELEC 706	VLSI Design	(2+0)
ELEC 707	PLCs and SCADA Systems	(2+0)
ELEC 708	Integrated Circuit Design	(2+0)
ELEC 709	Linear Integrated Circuits	(2+0)

Layout for Ph.D Electronics

PhD Electronics

Major Courses

ELEC 811	Probability and Stochastic Processes	(3+0)
ELEC 812	Ad hoc and Sensor-based Networks	(3+0)
ELEC 813	Advanced Applied Electronics	(3+0)
ELEC 814	Advanced Digital Communication	(3+0)
ELEC 815	Wireless Networks	(3+0)
ELEC 816	Information Theory and Coding	(3+0)
ELEC 817	Advanced Data and Computer Communications	(3+0)
ELEC 818	Secure Wireless Communications	(3+0)
ELEC 819	Advanced Robotics	(3+0)
ELEC 821	Telecommunication System Modeling and Simulation	(3+0)
ELEC 822	Next Generation Networks	(3+0)
ELEC 823	Advanced Coding Theory	(3+0)
ELEC 824	Advanced Information Theory	(3+0)
ELEC 825	Personnel Area Networks	(3+0)
ELEC 826	Satellite Communication	(3+0)
ELEC 827	Automatic Speech Recognition	(3+0)
ELEC 828	Pattern Recognition and Analysis	(3+0)
ELEC 829	Advanced Power Electronics	(3+0)
ELEC 831	Adaptive Filter Theory	(3+0)
ELEC 832	Biomedical Signal and Image Processing	(3+0)
ELEC 833	Representation and Modeling for Image Analysis	(3+0)
ELEC 834	Complex Digital Systems	(3+0)
ELEC 835	Techniques in Artificial Intelligence	(3+0)
ELEC 836	Signal Detection and Estimation	(3+0)
ELEC 837	Computer Vision	(3+0)
ELEC 838	Image and Video Compression	(3+0)
ELEC 839	Telecommunication Switching and Traffic Networks	(3+0)

Minor/Related Courses

ELEC 801	Advanced Optical Communication and Networks	(2+0)
ELEC 802	High Speed Communication Networks	(2+0)
ELEC 803	RF Design of Wireless Communications	(2+0)
ELEC 804	Multimedia Communications and System Design	(2+0)
ELEC 805	Organic Electronic Devices	(2+0)
ELEC 806	Organic Electronic Materials	(2+0)

MS/M.Phil Course Contents
Major Courses

ELEC 711 Advanced Engineering Mathematics
3(3+0)

Course Outline
First order differential equations, second order linear equations, series solutions of second order linear equations, higher order linear equations, the Laplace transform, system of first order linear equations, partial differential equations and Fourier series, boundary value problems and Strum Liouville Theory, nonlinear differential equations.

Recommended Books
1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons, 2011.
2. George B. Thomas and Ross L. Finney, "Calculus and Analytic Geometry", 9th Edition, Pearson Education, 1996.
3. Irl B. Anton and Stephen D. Howard, "Calculus", 9th Edition, John Wiley & Sons, 2010.
4. Michael Greenberg, "Advanced Engineering Mathematics", 2nd Edition, Pearson, 1998.

ELEC 712 Semiconductor Devices and Technology
3(3+0)

Course Outline
Energy bands and carrier concentrations in semiconductors, motion of charge carriers in solids, p-n junction, junction transistor, light emitting diode, photodiode, junction lasers, MOSFETs, MESFETs, factors limiting the performance of each type of device along with their optimization trends and on-going search for novel device structures, fabrication technology for microelectronic devices, crystal growth, wafer fabrication and characterization, mask fabrication, epitaxy, lithography, etching, diffusion, CVD, ion implantation, packaging.

Recommended Books

1. Simon M. Sze and Kwok K. Ng, "Physics of Semiconductor Devices", 3rd Edition, John Wiley & Sons, 2006.
2. Ben G. Streetman and Sanjay Banerjee, "Solid State Electronic Devices", 6th Edition, Prentice Hall, 2006.
3. Simon M. Sze & Ming-Kwei Lee, "Semiconductor Devices: Physics and Technology", 3rd Edition, John Wiley & Sons, 2012.
4. Papadopoulos**,** Christo, "Solid-State Electronic Devices", 1st Edition, Springer-Verlag New York, 2014.

ELEC 713 Modeling and Simulation of Semiconductor Devices
3(3+0)

Course Outline

Review of semiconductor physics, basic semiconductor equations, numerical methods applied for scaling of variables and parameters, Newton-Raphson method of solving nonlinear algebraic equations, iterative and other methods, error estimation, Monte Carlo simulation, Boltzmann transport equation, electron motion in the momentum space, scattering processes, mean velocity, device modeling and simulation of p-n junctions, potential barriers, static properties, reverse-biased junctions, avalanche and zener breakdowns, Shockley-Hall-Read Model, I-V characteristics, charge storage and transients, numerical simulation of p-n junctions, device modeling and simulation of BJT, Early effect, emitter biases, base transit time-charge control model, simulation of BJTs, device modeling and simulation of MOS, model of charges in gate oxides, modeling of charges in accumulations, depletion, and inversion conditions, capacitance, threshold voltage adjustment, device modeling and simulation of MOSFET, basic theories and models, MOSFET parameters, short and narrow channel effects, hot carriers, simulation of MOSFET characteristics, adjustment of threshold voltage, model design of MOSFET, modeling and simulation of CMOS characteristics, CMOS design, HBT, bandgap engineering, material
parameters, modeling of HBT characteristics.

Recommended Books

1. Richard S. Muller and Theodore I. Kamins, "Electronic Device for Integrated Circuits", 3rd Edition, John Wiley & Sons, 2003.
2. Christopher M. Snowden, "Introduction to Semiconductor Device Modeling", World Scientific Publishing Company, 1987.
3. Siegfried Selberherr, Hannes Stippel, Ernst Strasser, "Simulation of Semiconductor Devices and Processes", Volume-5,Springer Science & Business Media, 1993.

ELEC 714 Microprocessor-Based System Design 3(3+0)

Course Outline

Architecture, instruction cycle, registers and stacks, external interface, register architecture, external interface, addressing modes, branching and conditions, stack commands, subroutines, port I/O, interrupts, internal operation of processor, register transfer logic, instruction formats, microcode, timing diagrams, design techniques such as pipelining, other microprocessors, addressing modes, instruction sets, timing , high-level languages, programming in C, design of systems, memory, static/dynamic RAM, technology and timing, ROM, PROMs, EPROMs, PLAs, DMC chips address decoding, EDAC I/O, parallel and serial I/O, DMA, interrupts and interrupt control circuits, microcomputer buses, system bus, bus interface and arbitration circuits bus standards, peripherals, keyboards, CRT controllers, printers, secondary memory, A/D and D/A conversions, data acquisition systems using microprocessors.

Recommended Books

1. David J. Comer, "Microprocessor-based System Design", Oxford University Press, 1996.
2. Muhammad Ali Mazidi and Janice Gillispie-Mazidi, "80X86 IBM PC and Compatible Computers, Assembly Language, Design, and Interfacing Volumes I & II", 4th Edition, Prentice Hall, 2003.
3. Nikitas A. Alexandridis, "Design of Microprocessor-Based Systems", Prentice Hall, 1993
4. Mohamed Rafiquzzaman, "Microprocessors and microcomputer development systems: Designing microprocessor-based systems", HarperCollins Publishers, 1984

ELEC 715 Advanced Computer Architecture 3(3+0)

Course Outline

Introduction, Reminder on Pipelined Processors, Parallelism and ILP, Memory Hierarchy Design, Multiprocessors, shared memory, distributed memory, synchronization, Implementation Issues in Deep Submicron, power, process variation, Nano-scale Computing Fabrics and Architecture, physical layer including devices and layout, manufacturing constraints, architectures, defect tolerance, variability.

Recommended Books

1. J. L. Hennesy and D. A. Patterson, "Computer Architecture A Quantitative Approach", 5th Edition, Elsevier, 2012.
2. J. P. Shen and M. H. Lipasti, "Modern Processor Design, Fundamentals of Superscalar Processor", 1st Edition, McGraw Hill, 2005.
3. A. Chandrakasan, F. Fox, W. J. Bowhill, "Design of High-Performance Microprocessor Circuits", 1st Edition, John Wiley & Sons, 2001.
4. Jan M. Rabaey, "Digital Integrated Circuits", 2nd Edition, Prentice Hall, 1996.

ELEC 716 Digital Integrated Circuit for Communication 3(3+0)

Course Outline

Dynamic CMOS design, dynamic logic, Basic principles, speed and power dissipation of dynamic logic, issues in dynamic design, cascading dynamic gates. Designing logic for reduced supply voltages, static latches and registers, bi-stability principle, multiplexer-based latches, low-voltage static latches, static SR Flip-Flops – writing data by pure force, dynamic latches and registers, dynamic transmission, C2MOS – clock-skew insensitive approach, true single-phase clocked register (TSPCR), alternative register styles, pulse registers, sense-amplifier based registers, pipelining, an approach to optimize sequential circuits, latch- vs. register-based pipelines, NORA-CMOS – logic style for pipelined structures, non-bistable sequential circuits, Schmitt trigger, mono-stable sequential circuits, stable circuits, memory core, read-only memories, non-volatile read-write memories, read-write memories (RAM), contents-addressable or associative memory (CAM), memory peripheral circuitry, address decoders, sense amplifiers, voltage references, drivers/buffers, timing and control, memory reliability and yield, signal-to-noise ratio, memory yield, power dissipation in memories.

Recommended Books

1. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits", 2nd Edition, Prentice Hall, 2002.
2.Mohab Anis and Mohamed Elmasry, "Multi-Threshold CMOS Digital Circuits, Managing Leakage Power", Springer, 2003.
3. Mark Rodwell, "High Speed Integrated Circuit Technology", Volume 21, World Scientific Publishing Co. 2001
4. Jan M. Rabaey, "Digital Integrated Circuits: A Design Perspective", Prentice-Hall, Inc. 1996

ELEC 717 Fiber Optics and Integrated Optics 3(3+0)

Course Outline

Optical fiber waveguide, ray theory for transmission, electromagnetic mode theory for optical propagation, cylindrical fiber, single mode fiber transmission characteristics of optical fibers, attenuation, material absorption losses in silicon glass fibers, scattering losses, overall fiber dispersion, optical fiber parameter measurement, optical time-domain reflectometry, fiber optic communication systems, optical

fiber sensor technology, modes of optical fiber and coupled mode analysis of passive optical fiber devices, pulse propagation in optical fibers and its application to communication systems.

Recommended Books

1. John M. Senior, "Optical Fiber Communications, Principles and Practice", 2nd Edition, Prentice Hall, 1992.
2. Gerd Keiser, "Optical Fiber Communications", 3rd Edition, McGraw Hill, 2000.
3. Harold Kolimbiris, "Fiber Optics Communications", 1st Edition, Prentice Hall, 2004.
4. Djafar Mynbaev and Lowell Scheiner, "Fiber-Optic Communications Technology", 1st Edition, Prentice Hall, 2001.

ELEC 718 Digital Control System 3(3+0)

Course Outline

Basics of digital control, theory of sampling, sampled data systems, discrete signals and sampling, difference equation, discrete transfer functions, z transform analysis, frequency response methods, state equations, time-discrete representation of time-continuous systems, discrete control algorithms, design methods of digital controllers, stability of digital control systems, discrete equivalents for continuous controllers, pulse transfer functions of feedback systems, digital-to-analog conversion, digital filtering of systems.

Recommended Books

1. Charles L. Phillips and H. Troy Nagle, "Digital Control System Analysis and Design", 3rd Edition, Prentice Hall, 1995.
2. Benjamin C. Kuo, "Digital Control Systems", 2nd Edition, Oxford University Press, 1995.
3. Mohammed S. Santina, Allen R. Stubberud and Gene H. Hostetter, "Digital Control System Design", 2nd Edition, Oxford University Press, 1995.
4. Katsuhiko Ogata, "Discrete-Time Control Systems", 2nd Edition, Prentice Hall, 1995.

ELEC 719 Advanced Computer and Communication Networks 3(3+0)

Course Outline

Advanced TCP/IP and ATM Networks, TCP/IP protocol architecture, OSI model, Internetworking, TCP, UDP, Ipv6, Packet-switching networks, Frame relay networks, ATM logical connections, service categories, ATM Adaptation Layer ,Wireless LANs, Congestion control in data networks and internets, Effects of congestion, Congestion and control, Traffic management, Congestion control in Packet-Switching networks, Frame relay, flow and error control, Link control mechanisms, ARQ performance. TCP flow control, Elementary concepts of graph theory, shortest path length determination, Internet routing principles, Distance-Vector protocol, RIP, Link State protocol, OSPF, Path-Vector protocols, Integrated Services Architecture (ISA), Differentiated services, Real-Time traffic, Resource Reservation , RSVP, Multiprotocol label switching, Real-Time Transport Protocol (RTP).

Recommended Books

1. James F. Kurose and Keith W. Ross, "Computer Networking, A Top-Down Approach Featuring the Internet", 6th Edition, Pearson Education, 2012.
2. Andrew S. Tanenbaum and David J. Wetherall, "Computer Networks", 5th Edition, Pearson Education, 2010.
3. William Stallings, "High Speed Networks and Internets – Performance and Quality of Service", 2nd Edition. Pearson Education, 2002.
4. Nader F. Mir, "Computer and Communication Networks", 1st Edition, Prentice Hall, 2006

ELEC 721 Advanced Communication System 3(3+0)

Course Outline

Introduction to digital communication, Shannon limit for information capacity, digital radio, FSK, PSK, BPSK, QPSK, quadrature amplitude modulation, clock recovery, delta modulation pulse code modulation, adaptive delta modulation PCM, differential PCM, pulse transmission, time division multiplexing, T1 digital carrier system, codecs, frame synchronization, bit interleaving versus word interleaving, history of satellites, orbital satellites, geostationary satellites, orbital patterns, look angles, satellite system link models and parameters, satellite link budget, satellite link equations, satellite multiple access arrangements, FDM/FM satellite systems, multiple accessing, TDM/FM frequency hopping, channel capacity, cellular communication, operation of cellular system, elements of cellular system design specifications, concept of mobility, cell coverage for signal and traffic, cell sites and mobile antennas, trunking theory, blocking probabilities, co-channel interference reduction, handoff strategies, power control, GSM architecture, GSM cell structure, call processing in GSM, 3G mobiles.

Recommended Books

1. Leon W. Couch, "Digital & Analog Communication Systems", 8th Edition, Prentice Hall, 2012.
2. Theodore S. Rappaport, "Wireless Communications, Principles and Practice", 2nd Edition, Prentice Hall, 2002.
3. Jochen Schiller, "Mobile Communications", 2nd Edition, Addison-Wesley, 2003.
4. Timothy Pratt, Charles W. Bostian and Jeremy E. Allnutt, "Satellite Communications", 2nd Edition, John Wiley & Sons, 2002.

ELEC 722 Advanced Digital Signal Processing 3(3+0)

Course Outline

Discrete-time signals and systems, linear time-invariant systems, linear constant-coefficient difference equations, frequency-domain representation of discrete-time signals and systems, Fourier transform, Fourier transform theorems, z-transform, region of convergence for the z-transform, inverse z-transform, z-transform properties, sampling of continuous-time signals, periodic sampling, frequency-domain representation of sampling, reconstruction of a bandlimited signal from its samples, discrete-time processing of continuous-time signals, continuous-time processing of discrete-time signals, changing the sampling rate using discrete-time processing, multirate signal processing, transform analysis of LTI systems, frequency response of LTI systems, system functions, frequency response for rational system functions, All-pass systems, minimum-phase systems. Frequecy-domain sampling, the Discrete Fourier Transform, properties of DFT, linear filtering methods based on the DFT, Frequency analysis of signals using DFT, the Discrete Cosine Transform, Efficient computation of the DFT, FFT algorithms, a linear filtering approach to computation of the DFT, Structures for the realization of Discrete-time systems, Structures for FIR systems, Structures for IIR systems, Design of FIR filters, Design of IIR filters from analog filters, frequency transformation, Periodogram, Filter Bank.

Recommended Books

1. Oppenheim, A. V., R. W. Schafer, and J. R. Buck, "Discrete-Time Signal Processing", 2nd edition, Upper Saddle River, NJ, Prentice Hall, 1999.
2. Proakis, John G., and Dimitris G. Manolakis, "Digital Signal Processing, Principles, Algorithms, and Applications", 4th Edition, Prentice Hall, 2006.
3. Hayes, Monson B., "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, 1996.
4. Lim, Jae S., and Alan V. Oppenheim, eds., "Advanced Topics in Signal Processing", Englewood Cliffs, NJ, Prentice Hall, 1988.

ELEC 723 Multi-rate System and Fiber Banks
3(3+0)

Course Outline

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", Prentice Hall, 2004.
2. N. J. Fliege, "Multirate Digital Signal Processing, Multirate Systems - Filter Banks - Wavelets", John Wiley & Sons,
1999.
3. Gordana Jovanovic-Dolocek, "Multirate Systems, Design & Applications", Idea Group Publishing, 2002.
4. R. E. Crochiere and L. R. Rabiner, "Multirate Digital Signal Processing", Prentice Hall, 1983.

ELEC 724 Power Electronic Devices
3(3+0)

Course Outline

Physical construction, operation and characteristics of power diode, power diode static and dynamic modeling, diode behavior with resistive and inductive loads, fast recovery diodes, physical construction, operation and characteristics of power thyristor, SCR static and dynamic modeling, GTO construction and operation, GTO static and dynamic characteristics, GTO modeling, physical construction and operation of power BJT, static and dynamic characteristics of power BJT, construction and operation of MOSFET, static and dynamic characteristics of IGBT, IGBT modeling, thermal calculations and heat sink designing.

Recommended Books

1. John G. Kassakian, Martin F. Schlecht and George C. Verghese, "Principle of Power Electronics", 1st Edition, Prentice Hall, 1991.
2. B. W. Williams, "Power Electronics, Devices, Drivers, Applications, and Passive Components", 2nd Edition, McGraw Hill, 1992.
3. Erickson, Robert W., Maksimovic, Dragan, "Fundamentals of Power Electronics", 2nd Edition, Springer US, 2001
4. Muhammad Harunur Rashid, "Power Electronics: Circuits, Devices, and Applications", Pearson Education India, 2003

ELEC 725 Optoelectronic Devices
3(3+0)

Course Outline

Fundamentals of semiconductor devices, p-n junctions, hetrojunction and double hetrojunction, basics of laser physics, spontaneous and stimulated emission, Einstein relation, population inversion, optical pumping, light amplification, resonators and modes, light sources, light emitting diodes (LEDs), laser diodes, different types of semiconductor laser sources, optical detectors, p-n junction diodes, PIN diodes, avalanche photodiodes, optical switches, optical fiber couplers, noise considerations and performance parameters, optical modulators, for example, electro-optical and acousto-optic modulators, optical amplifiers, GRI lenses.

Recommended Books

1. Gerd Keiser, "Optical Fiber Communications", 4th Edition, McGraw Hill, 2008
2. John M. Senior, "Optical Fiber Communications, Principles and Practice", 3rd Edition, Prentice Hall, 2009.
3. Joachim Piperk "Semiconductors Optoelectronic Devices", 1st Edition, Elsevier, 2003.
4. S. C. GUPTA, "Optoelectronic Devices and Systems", PHI Learning, 2005

ELEC 726 Digital System Design 3(3+0)

Course Outline

Detailed description and analysis of core digital design block, inverter, implementation of inverter in CMOS, design of more complex combinational gates such as NAND, NOR and EXOR for optimum speed, area, or power, application of learned techniques to more evolved designs such as adders and multipliers, impact of interconnect parasitics on circuit performance and approaches to cope with them, study of sequential circuits, clocking approaches, memories, examination of design methodologies, use of CAD tools for layout, extraction, and simulation for assignments, labs and projects.

Recommended Books

1. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits", 2nd Edition, Prentice Hall, 2002
2. Neil H.E. Weste and David Harris, "CMOS VLSI Design, A Circuits and Systems Perspective", 2nd Edition, Addison Wesley, 2004.
3. D.A.Godse A.P.Godse, "Digital System Design", Technical Publications, 2008

ELEC 727 Cellular and Mobile Communication 3(3+0)

Course Outline

Introduction to Cellular Mobile Systems, basic cellular system, performance criteria, uniqueness of mobile radio environment, operation of cellular systems, planning a cellular system, overview of generations of cellular systems, elements of Cellular Radio Systems Design and interference, general description of the problem, concept of frequency reuse channels, co-channel interference reduction factor, cell splitting, consideration of the components of cellular systems, Introduction to co-channel interference, co-channel measurement design of antenna system, antenna parameter and their effects. Cell Coverage for Signal & antenna structures, General introduction, obtaining the mobile point to point mode, propagation over water or flat open area, foliage loss, propagation near in distance, long distance propagation, point to point prediction model- characteristics, cell site, antenna heights and signal coverage cells, mobile to mobile propagation. Characteristics of basic antenna structures, antenna at cell site, mobile antennas. Frequency Management & Channel Assignment, Hand Off & Dropped Calls, Frequency management, fixed channel assignment, non-fixed channel assignment, traffic & channel assignment, Modulation methods and coding for error detection and correction.

Recommended Books

1. William C. Y. Lee, "Mobile Cellular Telecommunications", 2nd edition, McGraw Hill, 1995.
2. Mischa Schwartz, "Mobile Wireless Communications", Cambridge University Press, UK, 2005.

3. Jerry D. Gibson, "Mobile Communication Handbook", 3rd Edition, CRC Press, 2013.
4. Theodore S. Rappaport, "Wireless Communications, Principles and Practice", 2nd Edition, Pearson Education, 2002.
5. L. Harte, R. Kikta and R. Levine, "3G Wireless Demystified", McGraw Hill, 2002.

ELEC 728 Wireless Sensor Networks Hardware
3(3+0)

Course Outline
WSN Operating System, Gathering Data, Simulations, Dissemination and over the air programming, Encrypted Communication, WSN Applications, Audio Detection, Cloud Integration, Other Operation Systems for WSN.

Recommended Books
1. R. Faludi, "Building Wireless Sensor Networks", 1st Edition, O'Reilly Media, Inc., 2011.
2. H. Karl and A. Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley and Sons, 2005.
3. P. J. Marron, T. Voigt, P. Corke and L. Mottola, "Real-World Wireless Sensor Networks", Springer, 2010.
4. C.S. Raghavendra, Krishna M. Sivalingam, Taieb Znati, "Wireless Sensor Networks", Springer Science & Business
Media, 2004

ELEC 729 Bio-Electric Signal Analysis and Interpretation
3(3+0)

Course Outline
Theoretical concepts and experimental approaches to characterize electric phenomena in live cells and tissues, excitable membrane, action potential generation, cable theory, equivalent dipoles and volume conductor fields, introduction to bio-electric signal processing and analysis, fundamental techniques to analyze and process signals that originate from biological sources such as ECGs, EMGs, EEGs, blood pressure signals, physiological knowledge with the information useful for physiologic investigation, medical diagnosis and processing, biomedical signal characterization in time and frequency domain, deterministic and stochastic signal analysis methods, short-time Fourier transform, spectrogram, wavelet signal decomposition, characterization of signal dynamics, chaotic, stochastic, fractal (self-similar), introduction to simple chaotic models, chaotic time series analysis techniques based on delayed coordinate embedding, concept and measures of signal complexity, statistical analysis techniques, probability density functions, moments, concept of stochastic process and nonstationarity, linear/nonlinear systems identification and modeling, Volterra and Wiener series.

Recommended Books
1. Eugene N. Bruce, "Biomedical Signal Processing and Signal Modeling", John Wiley & Sons, 2001.
2. D. C. Reddy, "Biomedical Signal Processing, Principles and Techniques", Tata McGraw-Hill, 2005.
3. Isak Gath and Gideon F. Inbar, "Advances in Processing and Pattern Analysis of Biological Signals", Springer, 1996.
4. Metin Akay, "Detection and Estimation Methods for Biomedical Signals", Academic Press, 1996.

ELEC 731 Digital Image Processing
3(3+0)

Course Outline
Examples of fields that use digital image processing, fundamental steps in digital image processing, visual perception, electromagnetic spectrum, image sensing and acquisition, image sampling and quantization, basic relationships between pixels, linear and nonlinear operations, gray level transformations, histogram processing, enhancement using arithmetic/logic operations, smoothing spatial filters, sharpening spatial filters, Fourier

transform, smoothing frequency-domain filters, sharpening frequency-domain filters, homomorphic filtering, image restoration, noise models, restoration in the presence of noise only-spatial filtering, periodic noise reduction by frequency domain filtering, estimation of degradation function, inverse filtering, Wiener filtering, Constrained least squares filtering, geometric mean filter, geometric transformations, color models, pseudocolor image processing, color transformations, smoothing and sharpening, color segmentation, wavelets background, multiresolution expansions, wavelet transforms in one dimension, wavelet transforms in two dimensions, fundamentals of image compression, image compression models, elements of information theory, error-free compression, lossy compression.

Recommended Books

1. R. C. Gonzalez and R. E. Woods, "Digital Image Processing", Prentice Hall, Inc., 2002.
2. R. C. Gonzalez, R. E. Woods and S. L. Eddins, "Digital Image Processing Using MATLAB", 2nd Edition, McGraw-Hill 2010.
3. Jayaraman, "Digital Image Processing", Tata McGraw-Hill Education, 2011
4. William K. Pratt, "Digital Image Processing: PIKS Scientific Inside", 4th Edition, Wiley, 2007

ELEC 732 Pattern Matching and Recognition 3(3+0)

Course Outline

Introduction, Bayes decision theory, discriminant functions and decision surfaces, Bayesian classification for normal distributions, estimation of unknown probability density functions, linear discriminant functions and decision hyperplanes, perceptron algorithm, least squares methods, feature selection, preprocessing, feature selection based on statistical hypothesis testing, class separability measures, feature subset selection, optimal feature generation, template matching, similarity measures based on optimal path searching techniques, similarity measures based on correlation.

Recommended Books

1. Sergios Theodoridis and Konstantinos Koutroumbas, "Pattern Recognition", 3rd Edition, Academic Press, 2006.
2. Luc Devroye, Laszlo Gyorfi and Gabor Lugosi, "A Probabilistic Theory of Pattern Recognition", Springer, 1996.
3. Christopher Bishop, "Pattern Recognition and Machine Learning (Information Science and Statistics)", Springer, 2007.

ELEC 733 Advanced Network Security 3(3+0)

Course Outline

Introduction, Web security, Security standards - SSL/TLS and SET, Intruders and viruses, PGP and S/MIME for electronic mail security, Firewalls, Secret Key and Public/Private Key Cryptography, Cryptographic Hashes and Message Digests, Authentication Systems (Kerberos), Digital signatures and certificates, Kerberos and X.509v3 digital certificates,

Recommended Books

1. W. Stalling, "Cryptography and Network Security: Principles and Practice", 6th Edition, Pearson, 2014
2. W. Stalling, "Network Security Essentials: Applications and Standards," 5th Edition, Prentice Hall, 2013.

3. M. Speciner, R. Perlman and C. Kaufman, "Network Security, Private Communications in a Public World", Pearson Education, 2002.
4. B. Jerman-Blažič, W. Schneider and T. Klobučar, "Security and Privacy in Advanced Networking Technologies", IOS Press, 2004.

ELEC 734 Advanced VLSI Design
3(3+0)

Course Outline
Design methodology for ASIC and FPGA implementations, high-level VLSI synthesis and design tools including Mentor Graphics, FPGA hardware structures and fabrics, languages for VLSI synthesis including VHDL, high-level DSP algorithm simulation and code (VHDL) generation using Xilinx State CAD, LabVIEW FPGA, and ModelSim, design and analysis of algorithm-specific VLSI processor architectures, implementation of pipelined and systolic processor structure, techniques for mapping numerical algorithms onto custom processor arrays including application specific instruction processors (ASIPs), design tools for ASIPs including transport triggered architecture, high-level design frameworks for systems containing custom and general-purpose units.

Recommended Books
1. William J. Dally and John W. Poulton, "Digital Systems Engineering", 1st Edition, Cambridge University Press, 2001.
2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", 1st Edition, McGraw-Hill, 2001.
3. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits", 1st Edition, Prentice Hall,
2002.

ELEC 735 Advanced FPGA-Based System Design
3(3+0)

Course Outline
Logic synthesis, implementation, and SoC design concepts, Verilog HDL description to verification using simulation and synthesis, and finally to programmable device implementation on an FPGA development board, culminating in a complete SoC design incorporating an 8-bit microprocessor and peripherals, a simple FSM, serves to introduce students to logic synthesis and FPGA implementation tools and methods, FPGA development board, SoC concepts such as on-chip processor, memory and peripheral interfacing, and hardware-software trade-offs, design results on a CRT monitor, programmable chip architectures, logic synthesis, SoC concepts, and the Verilog synthesizable subset.

Recommended Books
1. Wayne Wolf, "FPGA-Based System Design", Prentice Hall, 2004.
2. Samir Palnitkar, "Verilog HDL, A Guide to Digital Design and Synthesis", 2nd Edition, Prentice Hall, 2003.
3. Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL", 1st Edition, Prentice Hall, 2003.

ELEC 736 Design of Electronics System
3(3+0)

Course Outline

System design based on quantitative performance concepts, design of electronic systems using discrete devices, integrated circuits including analog, digital, and hybrid circuits, linear and nonlinear amplifiers, active filters, signal generators, signal modulators, switched-mode power converters and analog/digital data conversion, sensors and actuators, combinational logic design, design of microprocessor-based and microcomputer-oriented subsystems, design of continuous and digital control systems using modern analytic and computer design tools.

Recommended Books

1. C. D. Motchenbacher and J. A. Connelly, "Low-Noise Electronic System Design", 1st edition, John Wiley & Sons,
1993.
2. Steve Heath, "Embedded Systems Design", 2nd Edition, Newnes, 2002.
3. Rob A. Rutenbar, Georges G. E. Gielen and Brian A. Antao, "Computer-Aided Design of Analog Integrated Circuits and Systems", 1st Edition, Wiley-IEEE Press, 2002.

ELEC 737 Nanotechnologies
3(3+0)

Course Outline

Introduction to the physics of solid state, structure, energy bands, localized particles, methods of measuring properties, microscopy, spectroscopy, properties of individual nanoparticles, nanoclusters, semiconducting nanoparticles, rare gas and molecular clusters, carbon nanostructures, carbon molecules, carbon clusters, carbon nanotubes, applications of carbon nanotubes, bulk nanostructured materials, solid disordered structures, nanostructured crystals, nanostructured ferromagnetism, quantum wells, wires and dots, preparation of quantum nanostructures, size and dimensionality effects, excitons, single-electron tunneling, superconductivity, applications, self-assembly and catalysis, organic compounds and polymers, forming and characterizing polymers, nanocrystals, polymers, supramolecular structures, Nanomachines and nanodevices, Microelectromechanical systems (MEMS), nanoelectromechanical systems (NEMS), molecular and supramolecular switches.

Recommended Books

1. Charles P. Poole Jr. and Frank J. Owens, "Introduction to Nanotechnology", 1st Edition, John Wiley & Sons, 2003.
2. Massimiliano Di Ventra, Stephane Evoy and James R. Heflin, "Introduction to Nanoscale Science and Technology", Kluwer Academic Publishers, 2004.
3. Mark A. Reed and Takhee Lee "Molecular Nanoelectronics", American Scientific Publishers, 2003.

ELEC 738 Advanced Digital Control
3(3+0)

Course Outline

Overview of linear discrete dynamic systems and z-transform theory, design of digital filters, z-plane analysis and design of digital control systems using conventional techniques and state-space methods, stability analysis techniques, parameterization of stable digital control systems, compensator design, digital controller design, quadratic optimal control, pole-assignment design and state estimation, microprocessor implementation of digital filters and controllers, sample-data systems, sampling and reconstruction, quantization effects, computer control of feedback systems, performance of digital control system, overview to multivariable and optimal control, system identification, fuzzy logic, adaptive filtering, non-linear systems, robust control.

Recommended Books

1. Charles L. Phillips and H. Troy Nagle, "Digital Control System Analysis and Design", 4th Edition, Prentice Hall, 2004.
2. Dogan Ibrahim, "Microcontroller Based Applied Digital Control", John Wiley & Sons, 2006.
3. Gene F. Franklin, Michael L. Workman and Dave Powell, "Digital Control of Dynamic Systems", Third Edition, Addison Wesley, 1997.

ELEC 739 Embedded System Design
3(3+0)

Course Outline
Introduction to Embedded Systems, C8051FXXX/ARM series advanced Processors Architecture, Memory Organization and Real World Interfacing, Devices and Communication Buses for Devices Network, Device Drivers and Interrupt Service Mechanisms, Program modeling concepts, Inter process communications and synchronization of processes, threads and tasks, Real time operating systems, case studies, programming with RTOS in Micro C OS-I/RT-Linux/Windows CE.

Recommended Books

1. Kamal, R., "Embedded Systems Architecture, Programming and Design", McGraw Hill, 2008.
2. Tammy N., "Embedded Systems Architecture, A Comprehensive Guide for Engineers and Programmers", Elsevier, 2005.
3. Raghavan, P., Amol, L., "Embedded Linux System Design and Development", Auer Bach Publications, 2006.

MS/M.Phil Course Contents
Minor/Related Courses

ELEC 701 Research Methodology
2(2+0)

Course Outline

Introduction to Research, What is Research?, Research Concepts, Research Ethics and Integrity, Quantitative Research Methods, The Scientific Method, Design of Quantitative Surveys, Quantitative Research Methods, Qualitative Research, Introduction to Qualitative Research and Research Approaches, Qualitative Research Methods--The Toolkit, Data Analysis and Theory in Qualitative Research Articles, Mixed-Methods Design, Introduction to Mixed Methods Research, Design of Mixed Methods Research, Evaluation of Mixed Methods Research.

Recommended Books

1. C. R. Kothari, "Research Methodology, Methods & Techniques", New Age International Publishers, 2004.
2. W. Goddard and S. Melville, "Research Methodology, An Introduction", 2nd Edition, Juta and Co. Ltd., 2007.
3. J. A. Khan, "Research Methodology", A P H Publishing Corporation, 2008.

ELEC 702 Thesis Writing and Presentation Skills
2(2+0)

Course Outline

Systematic preparation/planning, Logical structure, Guiding the reader, Language choice Finishing techniques, What they need to know before preparing the specification, How to plan the process to ensure it meets the required time frame and is fair and within bounds of probity, What clients look for, Practical session on Report writing, What is a report?, Classification of reports, Informal, Formal, Preparation for report writing, Terms of reference, Leadership, Gathering information, Planning the structure, Varieties structure, Grouping and sequence of information, Appendices and illustrations, Practice on writing the report, Accuracy, bravity and clarity, Tabular and graphic presentation, Editing the draft, Issuing the report, Format and style, Reproduction, Distribution and Presentation, Critique of existing reports, Evaluation of Reports.

Recommended Books

1. E. Hildinger, P. B. Kahn and E. Hildinger, "A Practical Guide to Technical Reports and Presentations", 2nd Edition,
Pearson Custom Publishing, 2008.

2. M. Anderson, P. K. Nayar and M. Sen, "Critical Thinking, Academic Writing and Presentation Skills", Pearson Education, 2008.
3. J. A. Hoschette, "The Engineer's Career Guide", John Wiley & Sons, 2010.

ELEC 703 MATLAB Programming
2(2+0)

Course Outline

MATLAB introduction, Main characteristics of MATLAB, Basic elements of MATLAB, The numerical toolbox, The symbolic toolbox, A minimum MATLAB session, Mathematical functions, Basic plotting, Matrix generation, Array operations , Solving linear equations, Differential equations, Programming in MATLAB, Control flow and operators, Debugging MATLAB files, Simulink.

Recommended Books

1. S. J. Chapman, "MATLAB Programming for Engineers". 4th Edition, Cengage Learning, 2007.
2. C. F. Van Loan, "Introduction to Scientific Computing", Prentice Hall, 1997.
3. D. J. Higham and N. J. Higham, "MATLAB Guide". 2nd Edition, SIAM: Society for Industrial and Applied Mathematics, 2005.

ELEC 704 Digital Speech Processing
2(2+0)

Course Outline

Fundamentals of digital speech processing, digital models for the speech signal, time-domain models for speech processing, digital representation of the speech waveform, ahort-time Fourier analysis, homomorphic speech processing, linear predictive coding of speech, digital speech processing for man-machine communication.

Recommended Books

1. L. R. Rabiner and R. W. Schafer, "Digital Processing of Speech Signals", Pearson Education, Inc., 1993.
2. Thomas F. Quatieri , "Discrete-Time Speech Signal Processing, Principles and Practice", Prentice-Hall, 2001.
3. Lawrence Rabiner & Ronald Schafer, "Theory and Applications of Digital Speech Processing", 1st Edition, Prentice Hall, 2001.
4. Lawrence R. Rabiner and Ronald W. Schafer, "Introduction to Digital Speech Processing", Now Publishers Inc. 2007

ELEC 705 Power Electronics
2(2+0)

Course Outline

Modern power semiconductor devices e.g., diodes, thyristors, MOSFETS, and other insulated gate devices such as the IGBT, MCT and the FCT, Static and switching characteristics, gate drive and protection techniques, Various AC-DC and DC-AC converter circuit topologies, their characteristics and control techniques, Application considerations for remote and uninterruptible power supplies, and for computer systems, telecommunications, automobiles, traction and other industrial processes, Utility interaction, harmonic distortion, and power factor, EMI and EMC considerations.

Recommended Books

1. N. Mohan, T. M. Undeland and W. P. Robins, "Power Electronics, Converters, Applications and Design", 2nd Edition, John Wiley & Sons, 1995.
2. J. G. Kassakian, M.F. Schlecht and G.C. Verghese, "Principles of Power Electronics", Addison Wesley, 1991.
3. R. W. Erickson, "Fundamentals of Power Electronics", Kluwer Academic, 1997.

ELEC 706 VLSI Design 2(2+0)

Course Outline

Overview of VLSI systems (complexity, wires and switches), fabrication and layout, MOS transistors, switch and gate logic, CMOS gates, capacitance and switch level simulation, gate logic, logic optimization, high level design, hardware description languages, clocking of VLSI systems, synthesis, implementation constraints and high level planning, cell design issues, Pseudo NMOS and pre-charged logic, MOS memory design, MOS decoders (gate sizing, MOS delay models, distributed RC Tree), Data-path functional units (adders, shifters and multipliers), testing, design for testability, input/output issues, Pads, ESD, low power design.

Recommended Books

1. S. A. Khan, "Digital Design of Signal Processing Systems", John Wiley & Sons, 2011.
2. M. D. Ciletti, "Advanced Digital Design with the Verilog HDL", Prentice Hall, 2011.
3. S. Palnitkar, "Verilog HDL, A Guide to Digital Design and Synthesis", Sun Microsystems, Inc. 2003.
4. Zainalabedin Navabi, "Verilog Computer-Based Training Course", 1st Edition, McGraw Hill, 2002.

ELEC 707 PLCs and SCADA System 2(2+0)

Course Outline

Introduction to Programmable Logic Controllers, Ladder Logic programming, PLC connections, Ladder Logic Inputs and Outputs, PLC Hardware, Input and Output Modules, Relays, Logical Sensors, Sensor wiring, Presence detection of Contact Switches, Reed Switches, Optical Sensors, Capacitive Sensors, Logical Actuators, Solenoids, Valves, Hydraulic and Pneumatic Actuators, Motors, Boolean Logic Design details, PLCs Operation, Latches Timers, Counters, Structured Logic Design, State Based Design, Handling numbers and data, Using PLC memory bits, Data handling using ladder logic functions, Structured Text Programming, Function Block Programming, Analog Inputs and Outputs, Continuous Control, PID Control, Serial Communication, Networking, Human Machine Interface (HMI), SCADA and its use.

Recommended Books

1. Bolton, W., "Programmable Logic Controllers", 4th Edition, Elsevier, 2011.
2. Jack, H., "Automating Manufacturing Systems", 7th Edition, Springer, 2010.
3. Khaled Kamel and Eman Kamel, "Programmable Logic Controllers: Industrial Control", McGraw Hill Professional, 2013

ELEC 708 Integrated Circuit Design 2(2+0)

Course Outline

Different ASIC design styles and technologies, design flow, full-custom/semi-custom circuit techniques, layout of full-custom CMOS ICs, simulation (different types and levels), design-for-test, use of full-custom IC design tools.

Recommended Books

1. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits, A Design Perspective", 2nd Edition, Prentice Hall, 2003.
2. Neil H. E. Weste and David Harris, "CMOS VLSI Design", 3rd Edition, Addison Wesley, 2005.
3. Michael John Sebastian Smith, "Application Specific Integrated Circuits", Addison Wesley, 1997.

ELEC 709 Linear Integrated Circuits 2(2+0)

Course Outline

Design of linear integrated circuits applying modern MOS and BJT integrated circuit technologies, Single-stage amplifiers, current-mirror DC bias and active load circuits, stability and frequency compensation of single-stage and two-stage operational amplifiers, output stages, current and voltage reference circuits, Introduction to linear integrated circuit devices, IC operational amplifier, inverting and non-inverting operational amplifier configurations, Dealing with practical operational amplifiers, Instrumentation amplifiers, isolation amplifiers, non-operational IC linear amplifiers, High frequency, VHF, UHF and microwave linear IC devices, IC waveform generators and wave-shaping circuits, DC power supplies for linear integrated circuits.

Recommended Books

1. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", 1st Edition, McGraw Hill, 2001.
2. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis and Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits", 4th Edition, John Wiley & Sons, 2001.
3. Joseph J. Carr and Joe Carr, "Linear Integrated Circuits", Newnes, 1996.

Ph.D. Course Contents
Major Courses

ELEC 811 Probability and Stochastic Process 3(3+0)

Course Outline

Sets, Probability, Conditional Probability, Bernoulli Trials, Asymptotic Theorems, Poisson Theorem, Random Variables, Distribution and Density Functions, Conditional and Total Probability, Mean, Variance, Moments, Cumulants, Characteristic Functions. Bivariate and Multivariate Random Variables, Joint Moments, Joint Characteristic Functions, Conditional Distributions, Conditional Expected Values, Sequences of Random variables, Mean Square Estimation, Stochastic Convergence and Limit Theorems, Random Numbers, Meaning and Generation, Parameter Estimation, Hypothesis Testing. Systems with Stochastic Inputs, Power Spectrum, Digital Processes, Random Walks, Brownian motion, Thermal Noise, Poisson Point and Shot Noise, Modulation, Cyclostationary Processes, Band limited Processes and Sampling Theory, Spectral Representation. Ergodicity, Spectral Estimation, Extrapolation and System Identification, Prediction, Filtering, Kalman Filters, Entropy, Maximum Entropy Principle, Markov Processes.

Recommended Books

1. A. Leon-Garcia, "Probability, Statistics, and Random Processes for Electrical Engineering", 3rd Edition, Pearson Education, 2011.
2. A. Popoulis and S. U. Pillai, "Probability, Random Variables and Stochastic Processes", 4th Edition, Tata McGraw Hill, 2002.
3. H. C. Tijms, "A First Course in Stochastic Models", Wiley, 2003.
4. D. W. Stroock, "An Introduction to Markov Processes", Springer, 2005.

ELEC 812 Adhoc and Sensor-based Networks (3+0))

Course Outline

AD HOC Wireless, Introduction, Mobile Ad Hoc Networks, Technologies for Ad Hoc Network, Issues in Ad hoc wireless Networks, IEEE 802.11 Architecture and protocols. Protocol for AD HOC Wireless Networks, Issues and classification of MAC protocol, other MAC protocols, Dynamic Source Routing (DBR), Adhoc Distance Vector (AoDV) routing, Routing Protocols, Multicasting Routing issues. Transport layer & Security protocols, Issues in designing transport layer protocols, TCP over Ad Hoc Wireless Networks, Network Security Attacks, and Key management. Wire Sensor Networks, Basic Sensor Network Architectural Elements, Applications of Sensor Networks, Comparison with Ad Hoc Wireless Networks, Challenges and Hurdles. Architecture of WSNs Hardware components, Operating systems and execution environments, some examples of sensor nodes, Network Architecture, Sensor networks scenarios, Optimization goals and figures of merit, Design principles for WSNs. Communication Protocols, Physical Layer and Transceiver design considerations in WSNs, Fundamentals of (wireless) MAC protocol, Address and name management in wireless sensor networks, Localization and positioning, Routing protocols Data Dissemination and Gathering, Routing Challenges and Design Issues in Wireless, Routing Strategies in Wireless Sensor Networks, QoS in wireless sensor networks, Coverage and deployment

Recommended Books

1. C. Siva Ram Murty and B. S. Manoj, "Ad HOC Wireless Networks, Architectures and Protocols", Pearson Education, 2004.
2. F. Adelstein, S. K. S. Gupta, G. G. Richard III and L. Schwiebert, "Fundamentals of Mobile and Pervasive Computing", TMH, 2005
3. M. Ilyas, "The Handbook of Ad Hoc Wireless Networks", CRC Press, 2003.
4. H. Karl and A. Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, 2005.
5. K. Sohraby, D. Minoli and T. Znati, "Wireless Sensor Networks Technology, Protocols and Applications", John Wiley & Sons, 2007.

ELEC813 Advanced Applied Electronics 3(3+0)

Course Outline

Operational amplifier basics, Basic circuits with operational amplifiers, stability issues and dynamic limitations, Comparators, Precision Rectifiers, Instrumentation amplifiers, Voltage regulators and regulated power supplies, voltage references, 3- and 4-terminal regulators, switching regulators, dc-dc converters, Digital and analog electronics interfacing, interfacing between different logic families, interfacing between digital and analog components, Optoelectronics, LED's, displays, Digital/Analog conversion, analog switches, sample and hold, multiplexers, analog to digital converters, digital to analog converters, Analog filter design and active filters, Butterworth, Chebychev, Bessel, elliptic filters, gyrator, Interference, shielding and grounding, signal grounds, grounding between instruments, ground loops, shielding, Data transmission, PCB design techniques,.

Recommended Books

1. Horowitz P. and Hill W., "The Art of Electronics", 2nd Edition, Cambridge University Press, 1989.
2. Doebelin E. O., "Measurement Systems Application and Design", 5th Edition, McGraw-Hill, 2003.
3. Franco S. "Design with Operational Amplifiers and Analog Integrated Circuits", 3rd Edition, McGraw-Hill, 2002.

ELEC814 Advanced Digital Communication 3(3+0)

Course Outline

Analog-to-Digital Conversion, Sampling theorem, Pulse-Amplitude Modulation, Channel bandwidth for PAM signal, Natural sampling, Flat top sampling, Quantization of signals, Quantization error, Pulse-code modulation (PCM), Electrical representation of binary digits, The PCM system, Companding, Multiplexing PCM signals, Differential PCM, Delta modulation, Adaptive delta modulation, Vocoders, Channel Vocoder, Linear Predictive coder. Digital Modulation Techniques, Binary Phase-Shift Keying (BPSK), Differential Phase-Shift Keying, Differentially-Encoded PSK (DEPSK), Quadrature Phase-Shift Keying (QPSK), Quadrature Amplitude Shift Keying (QASK), Binary Frequency-Shift Keying (BFSK), Similarity of BPSK and BFSK, M-ary FSK, Minimum Shift Keying (MSK). Data Transmission, A base band signal receiver, Probability of error, The Optimum Filter, Matched Filter, Probability of error in Matched filter, Coherent reception, Coherent reception of PSK and FSK, Non-Coherent reception of FSK, PSK and QPSK, Calculation of error probability of BPSK and BFSK, Error probability for QPSK] Bit-by-bit encoding versus Symbol-by-Symbol encoding, Relationship between Bit error rate and Symbol Error rate and comparison of modulation systems. Information Theory and Coding, Discrete messages, The concept of amount of information, Entropy, Information rate, Coding to increase average information per bit, Shannon's theorem, Capacity of a Gaussian channel, Bandwidth-S/N tradeoff, use of orthogonal signals to attain Shannon's limit, Efficiency of orthogonal signal transmission, Coding, Parity check bit coding for error detection, Coding for error detection and error correction, Block codes (coding and decoding), Convolution codes (coding and decoding), Comparison of error rates in coded and uncoded transmission.

Recommended Books

1. Wayne Tomasi, "Electronic communications systems", 5th Edition, Pearson Education, 2006.
2. Taub and Schilling, "Principles of Communication Systems", 2nd Edition, TMH, 2006.
3. S. Haykin, "Digital Communication", Wiley, 2006.
4. S. Haykin, "An Introduction to Analog and Digital Communications", Wiley, 2009.

ELEC815 Wireless Networks 3(3+0)

Course Outline

Introduction to Personal Communication Services (PCS), PCS architecture, Mobility management, Networks signaling. Global system for Mobile Communication (GSM) system overview, GSM Architecture, Mobility Management, Network signaling. General Packet Radio Services (GPRS), GPRS architecture, GPRS Network nodes. Mobile Data Communication, WLANs (Wireless LANs) IEEE 802.11 standard, Mobile IP. Wireless Application Protocol (WAP), The Mobile Internet standard, WAP Gateway and Protocols, Wireless Mark-up Languages (WML) Third Generation (3G) Mobile Services, Introduction to International Mobile Telecommunications 2000 (IMT 2000) vision, Wideband Code Division Multiple Access (W-CDMA), and CDMA 2000, Quality of services in 3G, Wireless local Loop (WLL), Introduction to WLL architecture, WLL technologies, Bluetooth technology and Wi-Max.

Recommended Books

1. Yi –Bing Lin and Imrich Chlamatac, "Wireless and Mobile Networks Architecture", John Wiley & Sons, 2008.
2. Raj Pandya, "Mobile & Personnel Communication Systems and Services", Prentice Hall India, 2001.
3. Theodore S. Rappaport, "Wireless Communication, Principles and Practices", 2nd Edition, Pearson Education, 2003.
4. Jochen Schiller, "Mobile Communications", Pearson Education, 2002.

ELEC816 Information Theory and Coding 3(3+0)

Course Outline

Definitions, Uniquely Decodable Codes, Instantaneous Codes, Krafts Inequality, McMillan's Inequality, Optimal Codes, Binary Huffman Codes, r-ary Huffman codes, Information and Entropy, Properties of Entropy Function, Entropy and Average Word-Length, Shannon-Fano Coding, Shannon's First Theorem, Information Channels, Binary Symmetric Channel, System Entropies, System Entropies for Binary Symmetric Channel, Extension of Shannon's First Theorem to Information Channels, Mutual Information, Mutual Information for the Binary Symmetric Channel, Hamming Distance, Shannon's Second (Fundamental) Theorem, Converse of Shannon's Theorems. Review, Algebra, Krawtchouk Polynomials, Combinatorial Theory, Probability Theory. Linear Codes, Block Codes, Linear Codes, Hamming Codes, Majority Logic Coding, Weight Enumerators, The Lee Metric, Hadamard Codes, Golay Codes (Binary and Ternary), Reed Muller Codes, And Kerdock Codes.Bounds on Codes, Gilbert Bound, Upper Bound, Linear Programming Bounds, Hamming's Sphere –Packing Bound, Gilbert Varshamov Bound, Hadamard Matrices and Codes. Cyclic Codes, Generator Matrix, Check polynomial, Zeros of Cyclic Codes, BCH Codes, Reed-Solomon Codes, Quadratic Residue Codes, Generalized Reed-Muller Codes. Perfect Codes and Uniformly Packed Codes, Lloyd's Theorem, Characteristic Polynomial of a Code, Uniformly Packed Codes, Nonexistence Theorems. Quaternary Codes, Binary Codes Derived from codes over Z4, Galois Rings over Z4, Cyclic Codes over Z4. Goppa Codes. Algebraic Curves, Divisors, Differentials on a Curve, Riemann – Roch Theorem, Codes from Algebraic Curves.Arithmetic Codes, AN Codes, Mandelbaum – Barrows Codes, Convolutional Codes.

Recommended Books

1. G. A. Jones and J. M. Jones, "Information and Coding Theory", Springer, 2000.
2. J. H. van Lint, "Introduction to Coding Theory", Springer, 1999.
3. Cover Thomas, "Elements of Information Theory", Wiley, 2006.
4. R. W. Hamming, "Coding and Information Theory", Prentice Hall, 1986.
5. T. K. Moon, "Error Correction Coding, Mathematical Methods and Algorithms", Wiley, 2006.

ELEC817 Advanced Date and Computer Communication 3(3+0)

Course Outline

Introduction to Network models ISO – OSI, SNA, and AppleTalk and TCP/IP models. LAN Standards: Ethernet (IEEE 802.3), Over View of Token ring and Token Bus, Wireless LAN standard (IEEE 802.11 b/a/g); WAN Standards: X.25, Frame Relay, and ATM, Class full and Classless IP Addresses, ARP and RARP, IPv4, and IPv6, RIP, OSPF and BGP; User Datagram Protocol (UDP), Transmission Control Protocol (TCP) and Stream Controlled Transmission Protocol (SCTP) Overview of WWW, DNS, e-mail, SNMP, RMON; Cryptography, Firewalls, Secure Socket Layer (SSL), Security at different layers in application Layer Protocols, and Virtual Private Networks (VPN).

Recommended Books

1. Behrouz A. Forouzan, "TCP/IP Protocol Suit", Tata McGraw-Hill, 2000.
2. Wayne Tomasi, "Introduction to Data Communications and Networking", Pearson Education, 2007.
3. Tananbaum A. S, "Computer Networks", 3rd Edition, Prentice Hall international, 1999.
4. Black U, "Computer Networks-Protocols, Standards and Interfaces", Prentice Hall International , 1996.
5. Stallings W, "Data and Computer Communications", 6th Edition, Prentice Hall International , 2002.
6. Stallings W, "SNMP, SNMPv2, SNMPv3, RMON 1 & 2", 3rd Edition, Addison Wesley, 1999.

ELEC818 Secure Wireless Communication 3(3+0)

Course Outline

Introduction to Wireless Communication, Wireless Network Architecture, Review of Wireless LAN, Review of WPAN, Review of WMAN, Review of WWAN, Wireless Security, Traditional Security Issues, Mobile and Wireless Security Issues, Types of Attacks, Approaches to Security, Physical Limitations, Encryption, Integrity Codes, IPSEC, AAA, Security in WPAN, Basic security mechanisms, Bluetooth security modes, encryption, Authentication, limitations and problems. Security in WLAN, Security mechanisms, WEP, WPA, Radius, CHAP, EAP, 802.11i, (RF transmission, MAC Address Control, SSID, Authentication), Security in WMAN, Broadband Wireless Access, 802.16 Security, Key Management, Authorization, Security in WWAN, Encryption Security in CDMA, GSM authentication and encryption, Problems with GSM security, Security mechanisms of 3G.

Recommended Books

1. R. K. Nichols, P. C. Lekkas, "Wireless Security, Models, Threats and Solutions", Tata McGraw-Hill, 2006.
2. A. E. Earle, "Wireless Security Handbook", Auerbach Publications, 2006.
3. Adelstein, Gupta, et al, "Fundamentals of Mobile and Pervasive Computing", Tata McGraw-Hill, 2005.
4. Conklin, Williams et al, "Principals of Computer Security", Dreamtech, 2004.
5. Y Xiao, X. Shen and D.-Z. Zu, "Wireless Network Security", Springer, 2007.

ELEC819 Advanced Robotics 3(3+0)

Course Outline

Kinematics, Dynamics, State variable representation and linearization of nonlinear models, motion planning, motion control, trajectory planning, mechanisms and actuation, Sensors, Robotic system architecture and programming, mobile robotics, types and classification, localization and mapping, kinematically redundant manipulators, parallel mechanisms, robots with flexible joints, Programming in player/stage simulator, case studies, PUMA560, RHINO XR3, SCARA, STANDFORD ARM.

Recommended Books

1. Craig, J., "Introduction to Robotics, Mechanics and Control", 3rd Edition, Prentice Hall, 2004.
2. Bruno Siciliano, and Oussama Khatib, "Handbook of Robotics", Springer, 2008.
3. Robert J. Schilling, "Fundamentals of Robotics, Analysis and Control", Prentice Hall, 2007.

ELEC821 Telecommunication System Modeling and Simulation 3(3+0)

Course Outline

Generation of Random numbers and Sequence, Gaussian and Uniform random numbers Correlated random sequences, testing of random numbers generators, Stationary and Uncorrelated Noise, Goodness of fit test. Radio frequency and Optical sources, Analog and Digital signals, Communication channel and Models, Free Space channels, Multipath channel and discrete channel noise and interference. Quality of Estimator, Estimation of SNR, Probability density function and Bit Error Rate, Monte Carlo method, Importance Sampling method, Extreme Value Theory. Simulation Environment, Modeling considerations, Performance Evaluation techniques, Error Source Simulation, Validation. Case Studies, Simulations of QAM Digital Radio link in environment, Light wave communication link and Satellite system.

Recommended Books

1. M. C. Jeruchim, P. Balaban and Sam K. Shanmugam, "Simulation of Communication Systems, Modeling, Methodology and Techniques", Plenum Press, New York, 2001.
2. Averill. M. Law and W. David Kelton, "Simulation Modeling and Analysis", McGraw-Hill, 2000.
3. Geoffrey Garden, "System Simulation", Prentice Hall India, 1992.
4. W. Turin, "Performance Analysis of Digital Communication Systems", Computer Science Press, New York, 1990.

ELEC822 Next Generation Networks 3(3+0)

Course Outline

Communicating in the new Era, New Era of Networking, Technologies influencing change, IP Everywhere, Optical fiber anywhere, wireless access, building blocks for NGN, IP Networks, VOIP, Multi service Flexible Networks architecture. VPNs, Optical Networks, Wire line & Wireless Networks, NGN Services, Network Infrastructure convergence, services convergence, from technology push to service pull. IP past, present and future, IP influence and confluence, IP version 4, I. P. Version 6, IP Network convergence, LAN Technologies, IP Routing, LAN Switching, WAN's, WAN Technologies and Topologies. Wireless IP LANS, Mobility Networks, Global IP Networks, Global capacity, Globally Resilient IP, Internet – A Network of Networks. Beyond IP, Technology Brief – IP Networks, Business Drivers, Success factors, Applications and Service Value. Origin of multi service ATM, Next Generation Multi service Networks, Next Generation Multi service ATM switching, Multi-protocol Label switching, Networks, Frame Based MPLS, Cell based MPLS, MPLS services and their benefits, multi service provisioning platforms (MSPP) & Multi service switching platform (MSSP). Internet connectivity, e-commerce, call center, third party application service provision, UMTS, WAP, WiMAX, integrated billing, security and directory enable networks.

Recommended Books

1. N. Wilkinson, "Next Generation Network Services, Technologies and Strategies", Wiley, 2002.
2. R. Wood "Next-Generation Network Services", Cisco Press, 2005.
3. Jingming Li Salina, Pascal Salina, "Next Generation Networks: Perspectives and Potentials", John Wiley & Sons, 2008
4. Robert Wood, "Next-Generation Network Services", Cisco Press, 2005

ELEC823 Advanced Coding Theory 3(3+0)

Course Outline

Basic Digital Communication, Signal Detection, Memoryless Channels, Hamming Codes, Overview of Information Theory (Random variables, Entropy, Conditional Entropy, Relative Entropy, Mutual Entropy, Channel Capacity, Channel Coding Theorem (without proof) and its implication). Groups (Definition and properties, Subgroups, Cyclic groups and order, Cosets, Lagrange's theorem, Isomorphism, Homomorphism), Linear Algebra (Vector Spaces, Independence, Basis, dimension, inner product, dual space, orthogonality), Rings (Definition, Polynomials, Quotient Rings, Ideals), Number Theory and Algebra (Divisibility, Euclidean Algorithm, Sugiyama Algorithm, Congruences, function, Chinese Remainder Theorem, Fields over R and C, Galois Fields, Galois Field Arithmetic, Irreducible and Primitive Polynomials, Krawtchouk Polynomials). Linear Block Codes (Generator Matrix, Parity Check Matrix, Dual Codes, Weight Distribution, Hamming Codes and their Dual, Erasure Decoding), Cyclic Codes (Cyclic Encoding, Syndrome Decoding, Binary CRC Codes), BCH, Reed Solomon Codes, Goppa Codes, Peterson's Algorithm, Belekamp – Massey Algorithm, Forney's Algorithm. Welch – Berlekamp Key Equation, Guruswami –Sudan Decoding Algorithm and Soft RS decoding, Hadamard Matrices and Codes, Reed Muller Codes, Quadratic Residue Codes, Golay Codes, Gilbert – Varshamov Bound, Plotkin Bound, Griesmer Bound, Linear Programming and Related Bounds, McEliece – Rodemich – Rumsey – Welch Bound, Bursty Channels, Interleavers and Concatenation, Soft Decision Decoding Algorithms, Convolutional Codes, Viterbi Algorithm, Error Analysis, Puncturing, Suboptimal decoding algorithm for Convolutional codes, convolutional codes as block codes, Trellis representation of Block and Cyclic Codes, Trellis Coded Modulation. Turbo Codes – Encoding parallel concatenated codes, decoding algorithms, Error Floor and Weight Distribution. Low Density Parity Check Codes – Construction, Tanner graphs, Decoding.
Space Time Coding – Fading Channels, Rayleigh Fading, MIMO Channel, Space Time Block Codes, Space – Time Trellis Codes.

Recommended Books

1. T. K. Moon, "Error Correction Coding, Mathematical Methods and Algorithms", Wiley, 2006.
2. W. C. Huffman and V. Pless, "Fundamentals of Error – Correcting Codes", Cambridge University Press, 2003.
3. S. Lin and D. J. Costello, "Error Control Coding, Fundamentals and Application", Pearson Education 1983.
4. R. H. Morelos-Zaragoza, "The Art of Error Correcting Codes", John Wiley & Sons, 2002.

ELEC824 Advanced Information Theory 3(3+0)

Course Outline

Discrete Entropy, Entropy, Uniqueness of Entropy Function, Joint Entropy, Conditional Entropy, Relative Entropy and Mutual Information, Chain rules (for Entropy, Relative Entropy and Mutual Information), Jensen's Inequality, Log sum inequality, Fano's inequality, Asymptotic Equipartition Property (AEP), High probability and the typical set, Markov Chains, Entropy rate, Hidden Markov Model. Codes, Kraft's inequality, Optimal Codes, Bounds on optimal codes, Kraft inequality for uniquely decodable codes, Huffman Codes, Optimality of Huffman Codes, Shannon – Fano – Elias coding, Arithmetic Coding, Competitive optimality of Shannon code. Channels, Channel Capacity, Symmetric Channels, Jointly Typical Sequences, Channel Coding Theorem, Zero – Error Codes, Fano's inequality and the converse to the coding theorem, Equality in the converse to the channel coding theorem, Hamming codes, Feedback capacity, Joint Source Channel Coding Theorem. Differential Entropy, AEP for Continuous Random Variables, Differential Entropy, Joint, Conditional, Relative, and Mutual Differential Entropy, Differential Entropy Bounds on Discrete Entropy, Gaussian Channel, Maximum Entropy and Spectral Estimation. Kolmogorov's Entropy, Models of Computation, Kolmogorov Complexity and Entropy, Kolmogorov complexity of integers, Algorithmically random and incompressible sequences, Universal Probability, Halting problem and Kolmogorov Complexity, The number, Occam's Razor, Kolmogorov Sufficient Statistic. Informatioon Theory and Statistics, The method of types, the law of large numbers, universal source coding large deviation theory, Sanov's theorem, Conditional Limit Theorem, Hypothesis Testing, Stein's Lemma, Chernoff Bound, Lempel – Ziv Coding, Fisher information and Cramer – Rao inequality. Rate Distortion Theory and Network Information Theory, Quantization, Rate Distribution Function, Rate Distribution Theorem, Strongly Typical Sequences, Channel Capacity and the Rate Distortion Function. Gaussian Multiple User Channels, Jointly Typical Sequences, Multiple Access Channel, Encoding of Correlated Sources, Duality between Slepian – Wolf encoding and Multiple Access Channels, Broadcast Channel, Relay Channel, Source Encoding with side information, Rate Distortion with Side Information.

Recommended Books

1. T. M. Cover and J. A. Thomas, "Elements of Information Theory", Wiley, 1991.
2. A. I. Khinchin, "Mathematical Foundations of Information Theory", Dover, 1957.
3. F. M. Reza, "An Introduction to Information Theory", Dover, 1994.
4. R. B. Ash, "Information Theory", Dover, 1990.
5. R. M. Gray, "Entropy and Information Theory", Springer-Verlag, 1990.

ELEC825 Personnel Area Networks 3(3+0)

Course Outline

Over view of all technologies, IEEE 802.15 WPAN, Home RF, Blue tooth, interface between blue tooth and WLAN, standards, major telecommunications standards organizations, the radio frequency spectrum, interoperability issues. Infrared Standards, Differences between the OSI communications model and the IEEE 802 of a radio system, describe how different factors effect communications, standards, infrared WLAN, features of IrDA. Bluetooth Technology, Bluetooth protocol architecture, Link management, Logical Link control, Blue tooth profiles and Blue tooth security. WLANs, Historical overview of LAN industry, evolution, wireless home networking, Versions of 802.11b, 802.11g, IEEE 802.11a, The Phy layer, MAC layer, Mobility in WLAN, Deploying WLAN, Managing Wi-fi Networks.

Recommended Books

1. Kaven Pahlavan, "Principles of Wireless Networks", Pearson Education, 2002.
2. Nathan J Muller, "Blue Tooth Demystified", Tata McGraw-Hill, 2007.
3. William Stallings, "Wireless Communications and Networks", Prentice Hall International, 2007.

4. Jochen Schiller, “Mobile Communications”, Pearson Education, 2003
5. Martyr Mallick, “Mobile and Wireless Design Essentials”, John Wiley & Sons, 2004.
6. Asoke Talukder, Yavagal, “Mobile Computing”, Tata McGraw Hill, 2005.

ELEC826 Satellite Communication 3(3+0)

Course Outline

Introduction, origin and brief history of satellite communications, an overview of satellite system engineering, satellite frequency bands for communication, orbital theory, Orbital mechanics, locating the satellite in the orbit w.r.t. earth look angle determination, azimuth & elevation calculations. Spacecraft systems, Attitude and orbit control system, telemetry, tracking and command (TT&C), communications subsystems, transponders, spacecraft antennas, satellite link design, Basic transmission theory, noise figure and noise temperature, C/N ratio, satellite down link design, satellite uplink design. Modulation, Multiplexing, Multiple access Techniques, Analog telephone transmission, Fm theory, FM Detector theory, analog TV transmission, S/N ratio Calculation for satellite TV linking, Digital transmission, base band and band pass transmission of digital data, BPSK, QPSK , FDM, TDM, Access techniques, FDMA, TDMA, CDMA, Encoding & FEC for Digital satellite links, Channel capacity, error detection coding, linear block, binary cyclic codes, and convolution codes. Satellite Systems, Satellite Earth station Technology, satellite mobile communication, VSAT technology, Direct Broadcast by satellite (DBS).

Recommended Books

1. Timothy Pratt, Charles W. Bostian, “Satellite communication”, John Wiley & Sons, 2003.
2. J.J. Spilker, “Digital Communication by Satellite”, Prentice Hall International, 1997.
3. J. Martin, “Communication Satellite Systems”, Prentice Hall International, 2001.

ELEC827 Automatic Speech Recognition 3(3+0)

Course Outline

Background material in the acoustic theory of speech production, acoustic-phonetics, and signal representation, algorithmic aspects of speech recognition systems including pattern classification, search algorithms, stochastic modelling, and language modelling techniques, compares and contrasts the various approaches to speech recognition, and describes advanced techniques used for acoustic-phonetic modelling, robust speech recognition, speaker adaptation, processing paralinguistic information, speech understanding, and multimodal processing.

Recommended Books

1. Huang, Acero, and Hon, “Spoken Language Processing”, Upper Saddle River, NJ, Prentice-Hall, 2001.
2. Jelinek, “Statistical Methods for Speech Recognition”, Cambridge, MA, MIT Press, 1998.
3. Rabiner and Juang, “Fundamentals of Speech Recognition”, Upper Saddle River, NJ, Prentice-Hall, 1993.
4. Duda, Hart, and Stork, “Pattern Classification”, New York, John Wiley & Sons, 2000.

ELEC828 Pattern Recognition and Analysis 3(3+0)

Course Outline

Introduction to Pattern Recognition, Feature Detection, Classification, Review of Probability Theory, Conditional Probability and Bayes Rule, Random Vectors, Expectation, Correlation, Covariance, Review of Linear Algebra, Linear Transformations, Decision Theory, ROC Curves, Likelihood Ratio Test, Linear and Quadratic Discriminants, Fisher Discriminant, Sufficient Statistics, Coping with Missing or Noisy Features, Template-based Recognition, Feature Extraction, Eigenvector and Multilinear Analysis, Training Methods, Maximum Likelihood and Bayesian Parameter Estimation, Linear Discriminant/Perceptron Learning, Optimization by Gradient Descent, Support Vector Machines. K-Nearest-Neighbor Classification, Non-parametric Classification, Density Estimation, Parzen Estimation, Unsupervised Learning, Clustering, Vector Quantization, K-means, Mixture Modeling, Expectation-Maximization, Hidden Markov Models, Viterbi Algorithm, Baum-Welch Algorithm, Linear Dynamical Systems, Kalman Filtering, Bayesian Networks, Decision Trees, Multi-layer Perceptrons, Reinforcement Learning with Human Interaction, Genetic Algorithms, Combination of Multiple Classifiers "Committee Machines".

Recommended Books

1. Duda, Richard O., Peter E. Hart, and David G. Stork, "Pattern Classification", John Wiley & Sons, 2000.
2. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
3. Hastie, T., R. Tibshirani, and J. H. Friedman, "The Elements of Statistical Learning, Data Mining, Inference and Prediction", New York, Springer, 2001.
4. MacKay, David, "Information Theory, Inference, and Learning Algorithms", Cambridge, UK, Cambridge University Press, 2003.

ELEC829 Advanced Power Electronics 3(3+0)

Course Outline

DC-DC converters and power supplies, Review of assumed knowledge and switching devices, Review of steady-state characteristics of DC-DC converter circuits, SEPIC and Cuk converters, PSIM models. Analysis of non-ideal switches and circuit elements in DC-DC converters, efficiency calculation, voltage transfer characteristics with continuous and discontinuous inductor current, PSIM models. Representation of dynamics of buck, boost and forward converters, state-space averaging, PWM controller, control loop design, voltage control, current mode control, Limiting of inrush current, Inductor and capacitor components.

DC-AC Inverters, Review of assumed knowledge on DC-AC inverter circuits, advanced modulation techniques, SVM, Compensation for dead time and device voltage drops, PSIM Models, Current source inverters, multi-level and Z-source inverters, Rectifier/inverter with bi-directional power flow. Resonant converters, Zero-current switched (ZCS) DC-DC converter, Zero-voltage switched (ZVS) DC-DC converter, Series-resonant converter/inverter, Parallel-resonant converter/inverter, Series-parallel resonant converter, and Resonant DC-link inverter/converter, AC-DC and AC-AC converters, Effect of source inductance in diode rectifier circuits, Effect of source inductance in controlled rectifier circuits, Single- and three-phase Cycloconverter circuits, Matrix converter.

Recommended Books

1. N. Mohan, T. M. Undeland and W. P. Robins, "Power Electronics, Converters, Applications and Design", 2nd Edition, John Wiley & Sons, 1995.
2. J. G. Kassakian, M.F. Schlecht and G.C. Verghese, "Principles of Power Electronics", Addison Wesley, 1991.
3. R. W. Erickson, "Fundamentals of Power Electronics", Kluwer Academic Publications, 1997.
4. D. W. Hart, "Introduction to Power Electronics", Prentice Hall, 1997.

ELEC831 Adaptive Filter Theory
3(3+0)

Course Outline
Stochastic processes and models, Wiener filters, linear prediction, method of steepest descent, least-mean-square adaptive filters, frequency-domain and subband adaptive filters, method of least squares, recursive least-squares adaptive filters, Kalman filters, square-root adaptive filters, order-recursive adaptive filters, blind deconvolution.

Recommended Books

1. S. Haykin, "Adaptive Filter Theory", 4th Edition, Pearson Education, 2002.
2. B. Farhang-Boroujeny, "Adaptive Filters, Theory and Applications", Wiley, 2013.
3. Ali H. Sayed, "Fundamentals of Adaptive Filtering", John Wiley & Sons, 2003.

ELEC832 Biomedical Signal and Imagine Processing
3(3+0)

Course Outline
Biomedical Signals and Images, ECG, Speech Signals, Speech Coding, Imaging Modalities, MRI, Surgical Applications. Fundamentals of Deterministic Signal and Image Processing , Data Acquisition, Digital Filtering, DTFT, DFT, Sampling, Image processing. Probability and Random Signals, PDFs, Classification, Estimating PDFs, Random signals, Blind source separation. Image Segmentation and Registration.

Recommended Books

1. Oppenheim, A. V., and R. W. Schafer, and J. R. Buck, "Discrete-Time Signal Processing", 2nd edition Upper Saddle
River, NJ, Prentice-Hall, 1999.
2. Papoulis, A., and S. U. Pillai, "Probability, Random Variables, and Stochastic Processes", New York, McGraw Hill,
2001.
3. Duda, R., P. Hart, and D. Stork, "Pattern Classification", 2nd edition, New York, John Wiley & Sons, 2000.
4. Bishop, C., "Neural Networks for Pattern Recognition", New York, Oxford University Press, 1996.

ELEC833 Representation and Modeling for Image Analysis
3(3+0)

Course Outline
Subspace (Manifold) learning Theory, PCA Applications, Eigen faces, Active Shape & Active Appearance Models, Additional topics, kernel PCA, LLE, Boundary Detection Theory, Calculus of variations Applications, Mumford-Shah functional, snakes, level sets, EM Theory, EM algorithm Applications, segmentation, tracking, Graph algorithms Theory, Graph cut algorithms Applications, segmentation, stereo, Clustering Theory, hierarchical, k-means, spectral Applications, grouping in images, Graphical Models Theory, MRFs, inference in graphical models Applications, regularization, part/layer models. Shape descriptors Shape context, SIFT Medial axis, skeletons, Transformations and their manipulation Theory, diffeomorphisms, splines Applications, shape representation, registration, Information Theoretic Methods Theory, entropy and mutual information Application, alignment,

segmentation, Classification Theory, nearest neighbor, perceptron, Fisher Linear Discriminant, SVMs, Ada Boosting Applications, object detection/recognition.

Recommended Books

1. T. F. Chan and J. Shen, "Image Processing and Analysis, Variational, PDE, Wavelet, and Stochastic Methods", SIAM, 2005.
2 L. Florack, R. Duits, G. Jongbloed, M.-C. van Lieshout and L. Davies, "Mathematical Methods for Signal and Image
Analysis and Representation", Springer, 2012.
3. R. P. Barneva, V. E. Brimkov, H. A. Hauptman, R. M. N. Jorge, J. M. R. S. Tavares, "Computational Modeling of Objects Represented in Images", Springer, 2010.

ELEC834 Complex Digital Systems 3(3+0)

Course Outline

Digital Design Using Verilog, CMOS Technology and Logic Gates, T1 Verilog Simulation, Wires, Synthesis, Clocking, Bluespec, Motivation, Bluespec, Designing with Rules, Bluespec, Modules and Interfaces, Bluespec, Rule Scheduling and Synthesis, Bluespec, Power, Bluespec, Processors, Bluespec, Modularity and Performance, Transaction Level Design and Verification, Testing.

Recommended Books

1. Palnitkar, Samir, "Verilog HDL, A Guide to Digital Design and Synthesis", 2nd edition, Upper Saddle River, NJ, Prentice Hall, 2003.
2. Smith, Douglas, "HDL Chip Design", Madison, AL, Doone Publishing, 2001.
3. Weste, Neil, and Kamran Eshraghian, "Principles of CMOS VLSI Design, A System Perspective", 2nd edition, Reading, MA, Addison Wesley, 1994.
4. Rabaey, Jan, Anantha Chandrakasan, and Borivoje Nikolic, "Digital Integrated Circuits, A Design Perspective", Upper Saddle River, NJ, Prentice Hall, 2002.

ELEC835 Techniques in Artificial Intelligence 3(3+0)

Course Outline

Introduction, Search, Stochastic Methods, Propositional Logic, Syntax, Semantics, Propositional Satisfiability, First-Order Logic, Introduction, FOL, Knowledge Representation, FOL, Resolution, Equality, Other Logics, Planning, Situation Calculus and POP, Planning, GraphPlan and SATPlan, Probability, Bayesian Networks, Bayesian Networks, General Inference, Learning, Bayes Nets, Observable, Learning, Bayes Nets, Hidden, Decision Theory, Markov Decision Processes, Probabilistic Planning, Reinforcement Learning, Supervised Learning, Philosophy.

Recommended Books

1. S. Russell and P. Norvig, "Artificial Intelligence, A Modern Approach", Pearson Education, 2014.
2. D. Plemenos and G. Miaoulis, "Artificial Intelligence Techniques for Computer Graphics", Springer, 2008.
3. G. A. Vouros and T. Panayiotopoulos, "Methods and Applications of Artificial Intelligence", Springer, 2004.
4. H. Papadopoulos, A. S. Andreou and M. Bramer, "Artificial Intelligence Applications and Innovations", Springer, 2010.

ELEC836 Signal Detection and Estimation 3(3+0)

Course Outline

Signal detection, Hypothesis testing, Likelihood ratios, Probability of detection and false alarms, Receiver operator characteristics, the matched filter, Bayes theorem and maximum a-posteriori methods, Introduction of prior knowledge, Derivation of Bayes theorem, Joint and Marginal estimators, Effects of different priors, Model selection using evidence and other methods, Parameter estimation, Kalman Filters and tracking, Maximum entropy, How to assign probabilities, Maximum entropy and Fisher Information, Spectral estimation, Image recovery and Inverse problems, Non-linear methods, Examples of non-linear systems, Linear in the Parameters models, Volterra expansion and NARMAX models.

Recommended Books

1. Oruanaidh J. J. K. and Fitzgerald, W. J., "Numerical Bayesian Methods Applied to Signal Processing", Springer, 1996.
2. Therrien, C.W, "Discrete Random Signals and Statistical Signal Processing", Addison- Wesley, 1992.
3. Scharf, L.L., "Statistical Signal Processing", Addison-Wesley, 1991.

ELEC837 Computer Vision 3(3+0)

Course Outline

Introduction to Computer Vision, Image Formation and Representation, Image Filtering, Mask-based, Smoothing, Sharpening, Edge Detection, Interest Point Detection, Moravec, Segmentation, Edge-based, Pixel-based, Feature Extraction Description and Matching, Geometric features, Blobs, Examples, SIFT, SURF, HOG, WLD, LBP, Recognition, Geometry-based, Appearance-based, Applications, Camera Calibration, Stereo Vision.

Recommended Books

1. R. Szeliski, "Computer Vision, Algorithms and Applications", Springer-Verlag, 2011.
2. David Forsyth and Jean Ponce, "Computer Vision, A Modern Approach", Prentice Hall, 2002.
3. Cipolla, R and Giblin, P.J., "Visual Motion of Curves and Surfaces", Cambridge University Press, 2000.
4. Hartley, R. and Zisserman, A., "Multiple View Geometry", Cambridge University Press, 2003.

ELEC838 Image and Video Compression 3(3+0)

Course Outline

Basic Processing Tools, Filtering, Histogram, Edge Detection and Segmentation, Motion estimation, Hough transform, mathematical morphology, colours, image and video compression, Still Images, Fax and JBIG included techniques, Huffmann, RLC GIF and JPEG included techniques , LZW and DPCM, DCT, SQ. Video H.261 and H.263 included techniques, Block Matching MPEG-1, MPEG-2 and MPEG-4, Emerging Techniques, Vector Quantization (DVI), Introduction to Fractal Coding Introduction to Subband Coding and Wavelets (JPEG 2000) Implementations, applications and uses of compression systems, Introduction to multimedia signal processing on compressed image data.

Recommended Books

1. V. Bhaskaran, K. Konstantinides, "Image and Video Compression Standards", 2nd Edition, Kluwer Academic Publishers, 1997.
2. A. N. Netravali, B.G. Haskell, "Digital Pictures - Representation and Compression", 2nd Edition, New York, Plenum Press, 1995.
3. W. Pennebaker, J. Mitchell, "JPEG Still Image Data Compression Standard", Van Nostrand Reinhold, New York, 1993.
4. J. Mitchell, W. Pennebaker, C. Fogg, D. LeGall, "MPEG Video Compression Standard", Chapman & Hall, New

York, 1996.

ELEC839	Telecommunication Switching and Traffic Networks 3(3+0)

Course Outline

Multiplexing, Transmission Systems, FDM Multiplexing and modulation, Time Division Multiplexing, Digital Transmission and Multiplexing, Pulse Transmission, Line Coding, Binary N – Zero Substitution, Digital Biphase, Differential Encoding, Time Division Multiplexing, Time Division Multiplex Loops and Rings. SONET/SDH, SONET Multiplexing Overview, SONET Frame Formats SONET Operations, Administration and Maintenance, Payload Framing and Frequency Justification, Virtual Tributaries, DS3 Payload Mapping, E4 Payload Mapping, SONET Optical Standards, SONET Networks. SONET Rings, Unidirectional Path-Switching Ring, Bidirectional Line-Switched Ring. Digital Switching, Switching Functions, Space Division Switching, Time Division Switching, two-dimensional switching, STS Switching, TST Switching, No.4 ESS Toll Switch, Digital Gross-Connect Systems, and Digital Switching in an Analog Environment. Elements of SSNO7 Signaling. Network Synchronization Control and Management, Timing, Timing Recovery, Phase-Locked Loop, Clock Instability, Jitter Measurements, Systematic Jitter. Timing Inaccuracies, Slips, Asynchronous Multiplexing, Network Synchronization, U.S. Network Synchronization, Network Control, Network Management. Digital Subscriber Access and traffic analysis, ISDN, ISDN Basic Rate Access Architecture, ISDN U Interface, ISDN D Channel Protocol. High-Data-Rate Digital Subscriber Loops, Asymmetric Digital Subscriber Line, VDSL. Digital Loop Carrier Systems, Universal Digital Loop Carrier Systems, Integrated Digital Loop Carrier Systems, Next-Generation Digital Loop Carrier, Fiber in the Loop, Hybrid Fiber Coax Systems, and Voice band Modems, PCM Modems, Local microwave Distribution Service, Digital Satellite Services. Traffic Characterization, Arrival Distributions, Holding Time Distributions, Loss Systems, And Network Blocking Probabilities, End-to-End Blocking Probabilities, Overflow Traffic, And Delay Systems, Exponential Service Times, Constant Service Times, Finite Queues.

Recommended Books

1. Bellamy John, “Digital Telephony”, John Wiley & Sons, 2000.
2. Viswanathan, “Telecommunication Switching System and Networks”, Prentice Hall International, 1994.
3. Robert G. Winch, “Telecommunication Transmission Systems”, Tata McGraw-Hill, 2004.
4. Marion Cole, “Introduction to Telecommunications”, Pearson Education, 2008.
5. Tom Sheldon, “Encyclopaedia of Networking and Telecom”, Tata McGraw-Hill, 2006.

Ph.D. Course Contents
Minor/Related Courses

ELEC801	Advanced Optical Communication and Networks 2(2+0)

Course Outline

Wave Nature of Light, Polarization, Interference, Diffraction, Light Source, Review of Quantum Mechanical Concept, Review of Solid State Physics, Review of Semiconductor Physics and Semiconductor Junction Device, Introduction, Photo Luminescence, Cathode Luminescence, Electro Luminescence, Injection Luminescence, LED, Plasma Display, Liquid Crystal Display, Numeric Displays, Laser Emission, Absorption, Radiation, Population Inversion, Optical Feedback, Threshold condition, Laser Modes, Classes of Lasers, Mode Locking, Laser Applications. Photo Detector, Thermal Detector, Photo Devices, Photo Conductors, Photo Diodes, Detector performance, Fiber optic networks,

Transceivers for fiber optic networks, Semiconductor optical amplifiers (SOA), general considerations and principles of operation of SOA, Erbium doped fiber amplifiers (EDFA), Gain and noise considerations, couplers / splitters, Wavelength division multiplexers and demultiplexers, Telephone networks, Computer networks, element of the architecture of fiber optic networks, Networks protocols and services, OSI reference models, SONET networks and layers, Layered architecture of fiber optic networks, Network management and the future of fiber optic networks.

Recommended Books

1. John Gowar, "Optical Communication Systems", 2nd Edition, PHI, 1999.
2. Djafar K. Mynbaev and Lowell L. Scheiner, "Fiber-Optic Communications Technology", Prentice Hall, 2001.
3. Gerd Keiser, "Optical Fiber Communications", McGraw Hill, 2010.
4. Walter Goralski, "Optical Networking and WDM", Tata McGraw-Hill, 2001.

ELEC802 High Speed Communication Networks 2(2+0)

Course Outline

High Speed Networks, Frame Relay Networks – Asynchronous transfer mode – ATM Protocol Architecture, ATM logical Connection, ATM Cell – ATM Service Categories – AAL. High Speed LAN's, Fast Ethernet, Gigabit Ethernet, Fiber Channel – Wireless LAN's, applications, requirements – Architecture of 802.11. Congestion and Traffic Management, Queuing Analysis – queuing Models – Single Server Queues – Effects of Congestion – Congestion Control – Traffic Management – Congestion Control in Packet Switching Networks – Frame Relay Congestion Control. TCP and ATM Congestion Control, TCP Flow Control – TCP Congestion Control – Retransmission – Timer Management – Exponential RTO back off – KARN's Algorithm – Window Management – Performance of TCP over ATM, Traffic and Congestion control in ATM – Requirements – Attributes – Traffic Management Frame work, Traffic control – ABR traffic Management - ABR rate control, RM cell formats ABR Capacity allocations – GFR traffic management. Integrated and Differentiated Services, Integrated Services Architecture – Approach, Components, Services – Queuing Discipline, FQ, PS, BRFQ, GPS, WFQ – Random Early Detection, Differentiated Services, Protocols for QOS Support, RSVP – Goals & Characteristics, Data Flow, RSVP operations, Protocol Mechanisms – Multiprotocol Label. Switching – Operations, Label Stacking, Protocol details – RTP – Protocol Architecture, Data Transfer Protocol, RTCP.

Recommended Books

1. William Stallings, "High Speed Networks and Internets, Performance and Quality of Service", Pearson Education, 2002.
2. Irvan Pepelnjk, Jim Guichard and Jeff Apcar, "MPLS and VPN Architecture", Volume 1-2 Cisco Press, 2003.
3. Tom Sheldon, "Encyclopedia of Networking and Telecommunications", Tata McGraw-Hill, 2001.

ELEC803 RF Design of Wireless Communication 2(2+0)

Course Outline

RF Filter design, Basic resonator and filter configurations-special filter realization-filter implementation-coupled filter, Active RF Components, RF diodes-bipolar junction transistor –RF field effect transistor-high electron mobility transistors-diode models-transistor models-measurement of active devices-

scattering parameter device characterization, Matching and biasing networks, Impedance matching using discrete components-micro strip line matching networks-amplifier classes of operation and biasing networks, RF Transistor amplifier design, Characteristics of amplifier-amplifier power relations-stability consideration-constant gain-broadband, high power, and multistage amplifiers, Oscillators and mixers, Basic oscillator model-high frequency oscillator configuration-basic characteristics of mixer.

Recommended Books

1. Reinhold Ludwig, "RF Circuit Design, Theory and Applications", Pearson Education, 2001.
2. D. Pozar, "Microwave Engineering", John Wiley & Sons, 1998.
3. Bahil and P. Bhartia, "Microwave Solid State Circuit Design", John Wiley & Sons, 1998.

ELEC804 Multimedia Communication and System Design 2(2+0)

Course Outline

Multimedia Communication, Introduction, Network requirements, multimedia terminals, multimedia Requirement for ATM networks, Multimedia terminals, Audio visual Integration. Audio to visual mapping, Multimedia Processing in Communications, Introduction, Digital Media, Signal processing elements, Challenges in multimedia information processing, Perceptual coding of Digital audio signals, Transform audio coders, Image coding, Video Coding. Distributed multimedia systems, Resource management of DMS, IP networking, Multimedia operating systems, distributed multimedia servers, Distributed multimedia applications, Multimedia File Formats, Multimedia communication standards, MPEG-1, MPEG-2, MPEG-4Audio/Video, MPEG-4 Visual Texture coding (VTC), Multimedia communication across networks. Compression Techniques, JPEG, MPEG.

Recommended Books

1. K. R. Rao, Z. S. Bojkovic and D. A. Milovanovic, "Multimedia Communication Systems, Techniques, Standards, and Networks", PHI, 2002.
2. P. K. Andleigh and K. Thakrar, "Multimedia System Design", Prentice Hall International, 1996.
3. N. K. Sharda, "Multimedia Information Networking", Prentice Hall International, 1999.
4. T. Vaughan, "Multimedia, Making it Work", Tata McGraw-Hill, 2008.

ELEC805 Organic Electronic Devices 2(2+0)

Course Outline

Introduction to OLEDs, OLED Operation Mechanism, injection, transport and emission of light, Organic heteojunction, General comparison of inorganic versus organic devices Electronic Structure of Organic Molecules, Electronic structure of atoms, Atomic and Molecular Orbitals, LCAO, Bonding and antibondig orbitals, Orbital hybridization, HOMO and LUMO levels, Conjugated Molecules Photophysics of Organic Molecules, Excited states, (Absorption and emission, Singlet and triplet states), Rates of electronic transitions, Transition moment, Frank Condon Principle, Radiative and non-radiative transitions, Excited state kinetics Exciton Processes in Organic Solids, The Solid State, Excitons, Forester and Dexter energy transfer, Exciton quenching processes Electronic Conduction in Organic Solids, Conductivity, Carrier generation, Hopping transport, Mobility measurements, Traps. Aspects of OLED Physics and Technology, Charge injection from metal contacts, Charge transport and device characteristics, Exciton formation and luminescence, Stability and aging, Contrast, RGP patterning approaches, Quantum dot OLEDs. Organic Light Harvesting Devices, Photoreceptor Devices,

Photodetector Devices, Photovoltaic Devices, General background, device operation mechanism and characteristics, important phenomena, current challenges, recent developments.

Recommended Books

1. Pope and Swenberg, "Electronic Processes of Organic Crystals and Polymers", Oxford University Press, 1999.
2. H. Meier, "Organic Semiconductors", Verlag Chemie GmbH, 1974.
3. Wolfgang Brütting, "Physics of Organic Semiconductors", John Wiley & Sons, 2005.
4. Hagen Klauk, "Organic Electronics, Materials, Manufacturing, and Applications", John Wiley & Sons, 2006.

ELEC806	Organic Electronic Materials 2(2+0)

Course Outline

Introduction, Motivation, and Overview, Research in Materials Related to Energy Conversion, Basic Terms and Concepts in Polymer Science, Charge Transport in Organic Molecules and Materials, Chemical Bonding in Organic Molecules, Electron Delocalization in Molecules with π-Conjugated Systems, Charge Generation and Transport in Molecules and Bulk Materials, Synthesis and Properties of Conjugated Molecules and Polymers, General Strategies for the Synthesis of Conjugated Oligomers and Polymers, Synthesis and Properties of Pentacenes, Tetrathiafulvalenes, Porphyrins, Fullerenes, Carbon Nanotubes, Graphene, and other Examples of Carbonaceous, Nanostructures, Fabrication and Characterization of Organic Electronic Devices, Organic Field-Effect Transistors (OFET), Organic Light-Emitting Diodes (OLED), Organic Solar Cells (OSC).

Recommended Books

1. M. Hornby and J. Peach, "Foundations of Organic Chemistry", Oxford Chemistry Primers, 1993.
2. D. J. Walton and J. P. Lorimer, "Polymers", Oxford Chemistry Primers, 2001.
3. P. D. Beer, P. A. Gale, and D. K. Smith, "Supra Molecular Chemistry", Oxford Chemistry Primers, 1999.
4. Hagen Klauk (Editor), "Organic Electronics: Materials, Manufacturing, and Applications", 1st Edition, John Wiley & Sons 2006