Department of Electronics and Communication Engineering, VNIT

Nagpur

M.Tech. (Communication System Engineering) Scheme

PEOs (Program Educational Objectives)

1. To cater the needs of industry, R&D organizations and academia through utilizing the fundamental principles of communication system engineering.
2. To develop the courage, integrity, awareness, imbibing concern for eco-system, and an attitude to serve society and humanity in large.
3. To develop capacity for free and objective enquiry pertaining to original research in communication system engineering at international competence level with ethical professionalism.
4. To develop an ability to contribute to development of next set of standards.

PSOs (Program Specific Outcomes)

1. An ability to apply knowledge of mathematics and engineering to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, health and safety.
2. To understand fundamental theory and mathematical tools used in communication system engineering.
3. Understand the process of standardization and the standards that are developed by various organizations such as ISO, ITU, IEEE, IETF, ANSI, ETSI, ISI etc.
4. To be able to pursue further research and contribute to academics.

CREDIT REQUIREMENTS FOR M.TECH. (COMMUNICATION SYSTEMS)

Program Core (PC)		**Program Elective (PE)**	
Category	Credit	Category	Credit
Departmental Core (DC)	33-39	Departmental Electives (DE)	19-13
		Grand Total PC + PE	**52**

Details of credits:

I Semester				**II Semester**			
CORE				**CORE**			
Code	Course	L-T-P	Cr	Code	Course	L-T-P	Cr
ECP518	Communication System Lab-I	0-0-2	1	ECL409	Radio Frequency Circuit Design	3-0-0	3
ECL520	Computational Electromagnetics	3-0-0	3	ECL516	Converged Communication Networks	3-0-0	3
ECL521	Information Theory and Coding	3-0-0	3	ECP519	Communication System Lab-II	0-0-2	1
ECL523	Wireless Channels	3-0-0	3	ECL528	Detection and Estimation in Wireless Systems	3-0-0	3
ECL524	Statistical Signal Analysis	3-0-0	3				
ECL525	Signal Processing for Communication Systems	3-0-0	3				
ECP525	Signal Processing for Communication Systems Lab.	0-0-2	1				
	Total No. of Credits		17		Total No. of Credits		10
I Semester				**II Semester**			
ELECTIVE (Theory: maximum one Lab: maximum two)				**ELECTIVE (Theory: Maximum three Lab: Maximum one)**			
Code	Course	L-T-P	Cr	Code	Course	L-T-P	Cr
ECL402	Comm. Net. & Network Applications	3-0-0	3	ECL406	Mobile Communication Systems	3-0-0	3
ECP402	Comm. Net. & Network Applications Lab	0-0-2	1	ECP409	Radio Frequency Circuit Design Lab	0-0-2	1
ECL416	Fuzzy Logic and Neural Networks	3-0-0	3	ECL410	Satellite Communication	3-0-0	3
ECL418	Network Planning and Management	3-0-0	3	ECL411	Digital Image Processing	3-0-0	3
ECL424	Optical Communication	3-0-0	3	ECL413	Adaptive Signal Processing	3-0-0	3
ECP424	Optical Communication Lab	0-0-2	1	ECL419	Wireless Sensor Networks	3-0-0	3
ECL428	Industrial Communication Systems	3-0-0	3	ECL420	Smart Antennas	3-0-0	3
ECP440	Cyber Laws and Telecom Regulation Workshop	0-0-2	1	ECL427	Broadband Communication	3-0-0	3
ECP441	Network Standards Workshop	0-0-2	1	ECL511	Non-linear System Modelling	3-0-0	3
ECP442	Software Engineering Workshop	0-0-2	1	ECL515	Intelligent System Design	3-0-0	3
ECL513	Synchronization and Tracking	3-0-0	3	ECL527	Spectrum Management	3-0-0	3
ECL526	Computer Vision	3-0-0	3	ECL529	Advanced Computer Architecture	3-0-0	3
ECP526	Computer Vision Lab	0-0-2	1	CSL528	Cryptography and Information Security	3-0-0	3

III Semester				IV Semester			
CORE				**CORE**			
Code	Course	L-T-P	Cr	Code	Course	L-T-P	Cr
ECD501	Project Phase I	0-0-0	3	ECD502	Project Phase II	0-0-0	9
		Total No. of Credits	3			Total No. of Credits	9
ELECTIVES (Theory: Max 4)							
Code	Course	L-T-P	Cr				
ECL425	High Power RF Devices and Systems	3-0-0	3				
ECL512	Topics in Communication Systems	3-0-0	3				
ECL514	Electromagnetic Interference and Compatibility	3-0-0	3				
ECL530	Contemporary Embedded Systems	3-0-0	3				
ECL531	Machine Learning and Learning Machines	3-0-0	3				
ECL532	Wavelets and Multi-media Applications	3-0-0	3				
CSL517	Pattern Recognition	3-0-0	3				
MAL503	Optimization Techniques	3-0-0	3				
MAL504	Linear Algebra and Applications	3-0-0	3				

DETAILED COURSE CONTENTS

CORE COURSES

ECP518 Communication System Lab I [(0-0-2); Credit: 1] Back

Course Outcomes

Student will be able to

1. Apply concepts of random variables and random processes to modeling the real-world communication systems.
2. Evaluate the effects of fading and Additive White Gaussian noise in wireless communication, through simulations.
3. Evaluate the performance metrics such as error and outage probabilities for any communication systems.
4. Analyze the achievable channel capacity for Gaussian and non-Gaussian communication channels.
5. Develop their interest in research related to communication systems.

Contents

Introduction to standard random variables, Function of one and two random variables, and plotting and validating their PDFs with simulations.

Analysis and simulation of outage probability in various fading scenarios and AWGN noise. Analysis and simulation of error probability for MPSK and MQAM modulations in various fading scenarios and AWGN noise.

Channel capacity for additive white Gaussian noise channel

Performance analysis of advanced communication architectures such as cooperative communication, cognitive radio and free-space optical communication.

ECL520 Computational Electromagnetics [(3-0-0); Credit: 3] Back

Course Outcomes

Students will

1. Understand ideas behind various simulation concepts used for electromagnetic simulations
2. Be familiar with and able to apply differential based approaches like FDM and FDTD.
3. Be familiar with and able to apply integral based approaches like MoM.
4. Be familiar with and able to apply approaches like FEM.
5. Apply these concepts to simulation of working of various components and systems.

Contents

Introduction to electromagnetic fields: review of vector analysis, electric and magnetic potentials, boundary conditions, Maxwell's equations, diffusion equation, Poynting vector, wave equation.
Finite Difference Method (FDM): Finite Difference schemes, treatment of irregular boundaries, accuracy and stability of FD solutions, Finite-Difference Time-Domain (FDTD) method
Finite Element Method (FEM): Variational and Galerkin Methods, shape functions, lower and higher order elements, vector elements, 2D and 3D finite elements, efficient finite element computations
Method of Moments (MOM): integral formulation, Green's functions and numerical integration, other integral methods: boundary element method, charge simulation method
Applications of these methods for EM simulation of waveguides, micro-striplines and other planar components, antennas, scatterers, radars.

Texts / References Books

1. M. V. K. Chari and S. J. Salon, Numerical methods in electromagnetism, Academic Press.
2. M. N. O. Sadiku, Numerical techniques in electro-magnetics, CRC Press.
3. N. Ida, Numerical modeling for electromagnetic non-destructive evaluation, Chapman and Hall.
4. S. R. H. Hoole, Computer aided analysis and design of electromagnetic devices, Elsevier Science Publishing Co.
5. J. Jin, The Finite Element Method in electromagnetics, 2nd Ed., John Wiley and Sons.
6. P. P. Silvester and R. L. Ferrari, Finite elements for electrical engineers, 3rd Ed., Cambridge University Press.

ECL521 Information Theory and Coding [(3-0-0); Credit: 3] Back

Course Outcomes

Students will

1. Analyze self and mutual information.
2. Evaluate the information rate of various information sources.
3. Design lossless data compression codes for discrete memory-less sources.
4. Evaluate the information capacity of discrete memory-less channels and determine possible code rates achievable on such channels.
5. Design simple linear block error correcting codes, select and design simple convolutional codes.

Contents

Communication processes, Channel matrix, Probability relation in a channel, the measure of information, Entropy function – Properties of entropy function,n Mutual Information, Symmetry of information, Jensen's Inequality, Fano's Inequality.
Channel capacity; Special types of channels and their capacity, Noiseless channels symmetric channel, erasure channels, continuous channels, Shannon's theorem, Shannon Hartley theorem for AWGN channels.
Encoding: Block code, Binary code, Binary Huffman code, Shannon–Fano Encoding procedure, Noiseless coding theorem. Error – correcting codes. Examples of codes, Hadamard matrices and codes, Binary Colay code, Matrix description of linear codes, Equivalence of linear codes, The Hamming codes, The standard array, Syndrome decoding.
Introduction to Rate Distortion Theory, MIMO Information Theory: Concept of diversity, introduction to MIMO systems, space-time coding, MIMO Channels, capacity of MIMO channels, ergodic capacity.

Text Books

1. T.M.Cover and J.A Thomas, "Elements of information theory", John Wiley and Sons.
2. S .Haykins, " Communication Systems" John Wiley and Sons.
3. R Bose, "Information Theory, Coding and Cryptography", 2E, Tata-McGraw Hill, New Delhi.

Reference Books

1. G. A. Jones et. Al, "Information and Coding Theory", Springer – Verlag.
2. J. H. van Lint, " Introduction to Coding Theory", Springer –Verlag.

ECL523 Wireless Channels [(3-0-0); Credit: 3] Back

Course Outcomes

Students will

1. Understand various effects observed in propagation in wireless mobile communication systems.
2. Understand characterization methods and parameters of wireless communication channels.
3. Be able to apply concepts of cellular network engineering in network design.
4. Understand various access mechanisms for medium sharing.
5. Be able to understand and utilize various diversity techniques in wireless communication systems

Contents

Large scale path loss, free space propagation model, propagation effects such as reflection, diffraction, scattering etc. Outdoor and indoor propagation models, ray tracing and coverage prediction. Small scale fading effects: time-variant impulse response model, channel correlation functions and spectral densities, coherence time, coherence bandwidth,

Main Characteristics of Fading Channels, Envelope and Phase Fluctuations, Slow and Fast Fading, Frequency-Flat and Frequency-Selective Fading, Modeling of Flat-Fading Channels, Multipath Fading, Rayleigh, Nakagami-m. Modeling of Frequency-Selective Fading Channels

Review of radio propagation and cellular engineering concepts: frequency reuse, frequency management and channel assignment, handoff and handoff strategies, trunking theory, Interference measurement and reduction, co-channel and other interference, coverage and capacity improvements, medium access techniques, FDMA, TDMA, CDMA, SDMA.

Diversity, types of diversity: time diversity, space diversity, transmit and receive diversity, cooperative diversity, combining techniques for diversity reception: selection combining, maximal ratio combining, equal gain combining and their SNR analysis.

Introduction to optical wireless communication: concept of atmospheric turbulence, scintillation index, channel models, misalignment errors and their modelling, introduction to millimetre wave communication.

Text Books

1. Theodore S Rappaport: "Wireless Communications, Principles and Practice", Pearson Education Asia
2. Simon, Alouni, "Digital Communication over Fading Channels" John Wiley & Sons, 2005.
3. Andreas F. Molisch, "Wireless Communication", Wiley Publishers. 2005.

Reference Books

1. William C Y Lee. "Mobile Communications Engineering Theory and Applications", Second Edition, McGraw Hill Telecommunication.
2. William Stallings. "Wireless Communications and Networks, Pearson Education Asia.
3. 3G Mobile Networks by Sumit Kasera McGraw Hills publication. 2007.
4. Simon Haykin and Michael Moher, " Modern Wireless Communications", Person Education.

ECL524 Statistical Signal Analysis [(3-0-0); Credit: 3] **Back**

Course Outcomes

Students will

1. understand the significance and importance of Probability and Statistics in Real life, Engineering and Industrial applications.
2. consolidate the theoretical foundations of Probability and Statistics theory.
3. use theory for probability estimation, decision making and statistical inference.
4. apply the theory to real life, engineering and industrial problems.
5. formulate Probabilistic and Statistical models of real life/ engineering problems and use them.

Contents

Review of probability theory, Bayes theorem, total probability theoem,.
Random variables, PDF, CDF, moments, standard random variables, moment generating function, characteristic function, joint distributions, function of one random variable, function of two random variables, correlation of random variables, Complex random variables.
laws of large numbers, central limit theorem, convergence of sequence of random variables. Introduction to random processes, specification of random processes, Stationary and ergodic processes, nth order joint PDFs, independent increments, stationary increments, Markov property, Markov process and martingales, Gaussian process, Poisson process and Brownian motion.
Response of Processes to LTI Systems Mean and correlation of random processes, stationary, wide sense stationary and ergodic processes. Random processes as inputs to linear time invariant systems: power spectral density, Gaussian processes as inputs to LTI systems, white Gaussian noise. In-Phase and quadrature representation of random processes.
Discrete-time Markov chains: state and n-step transition probabilities, Chapman-Kolmogorov equations, first passage probabilities, classification of states, limiting state probabilities Series representation of random process: Fourier series, Karhunen-Loeve expansion, Mercer's theorem, sampled band-limited processes, filtering using series representation

Text Books

1. A. Papoulis and S. U. Pillai, "Probability, Random Variables and Stochastic Processes", 4th Edition, McGraw Hill 2002
2. Henry Stark and John W. Woods, "Probability and Random Processes with Applications to Signal Processing", Prentice Hall, 3 rd Edition 2001

Reference Books

1. Geoffrey Grimmett, "Probability and Random Processes", 3rd edition, Oxford University Press 2001
2. Yannis Viniotis, "Probability and Random Processes for Electrical Engineers" McGraw-Hill College,1998
3. Albert Leon Garcia: "Probability and Random Processes for Electrical Engineering", Prentice Hall 1993 .
4. V. Krishnan: "Probability and Random Processes", John Wiley & Sons 2006

ECL525 Signal Processing for Communication Systems [(3-0-0); Credit: 3] **Back**

Course outcomes

Students will

1. review basics of digital signal processing and to study the advances in digital signal processing mechanism.
2. study different transform techniques like STFT, DCT, DWT.
3. study application of different transform techniques
4. study various methods and algorithms for adaptive signal processing.
5. study the role of adaptive signal processing in the field of communication engineerin

Contents

Short Term Fourier Transform (STFT) and Cepstrum analysis for speech processing, Discrete Cosine Transform (DCT) and its application to image compression. Discrete Wavelet Transform (DWT), Applications of DWT.
Application of STFT for Speech processing. Application of DCT in Image compression. Applications of DWT.

Spectral factorization theorem and innovation processes, autoregressive moving average processes; Linear minimum mean-square error (LMMSE) estimation: minimum mean-square error(MMSE) estimation of jointly Gaussian random variable.

FIR Wiener filters, linear prediction-forward and backward predictions, IIR Wiener filters; Kalman filters, Adaptive filters, steepest descent solution of FIR Wiener filter, LMS algorithm- convergence, steady-state behaviour and practical considerations, RLS algorithm- method of least-squares, recursive solution and square-root algorithms, application of adaptive filters-equalization and noise cancellation.

Computational characteristics of DSP algorithms and applications; Techniques for enhancing computational throughput: Harvard architecture, parallelism, pipelining, dedicated multiplier, split ALU and barrel shifter

Text Books

1. S. Haykin Adaptive Filter Theory4th edition Prentice Hall
2. Khalid Sayood Introduction to Data Compression 2nd editionMorgan Kaufmann Publishers
3. R. M. Rao and A. S. Bopardikar Wavelet Transforms: Introduction to theory and Application 4th edition Pearson Edition

Reference Books

1. S. K. Mitra *Digital Signal Processing: A Computer Based Approach* 4th EDITION TMH

ECP525 Signal Processing for Communication Systems Lab. [(0-0-2); Credit: 1] **Back**

Course Outcomes

Students will

1. implement basic digital signal processing techniques for different applications related to communication
2. study different systems related to advanced digital signal processing
3. implement different transform algorithms like STFT, DWT for different applications
4. implement adaptive signal processing for different applications
5. implement basic digital processing algorithms in dedicated DSP platforms

Contents

Speech Synthesis and reconstruction using LPC model
Study of interpolation and Decimation
Study of Sigma Delta ADC
Synthesis & Analysis of signal using STFT
Synthesis & Analysis of signal using DWT.
Design and implementation of Wiener filter for different applications

Implementation of Speech signal analysis and synthesis using TMS DSP kit

Implementation of Matched filtering Algorithm using TMS DSP kit

Text Books

1. S. Haykin Adaptive Filter Theory 4th edition Prentice Hall
2. Khalid Sayood Introduction to Data Compression 2nd edition Morgan Kaufmann Publishers
3. R. M. Rao and A. S. Bopardikar Wavelet Transforms: Introduction to theory and Application 4th edition Pearson Edition

Reference Books

1. S. K. Mitra *Digital Signal Processing: A Computer Based Approach* 4th edition TMH
2. www. ti.com

ECL409 Radio Frequency Circuit Design [(3-0-0); Credit: 3] Back

Course Outcomes

Students will

1. be able to design passive matching networks.
2. be familiar with RF amplifiers in general
3. be able to design LNA, PA for a specified application.
4. design other circuits such as mixer, oscillator and phase locked loops
5. be familiar with A/D and D/A converters for RF applications

Contents

Characteristics of passive components for RF circuits. Passive RLC networks. Transmission lines. Two-port network modeling. S-parameter model. The Smith Chart and its applications.
Active devices for RF circuits: SiGe MOSFET, GaAs pHEMT, HBT and MESFET. PIN diode. Device parameters and their impact on circuit performance.
RF Amplifier design: single and multi-stage amplifiers. Review of analog filter design. Low-pass, high-pass, band-pass and band-reject filters. Bandwidth estimation methods. Voltage references and biasing.
Low Noise Amplifier design: noise types and their characterization, LNA topologies, power match vs noise match. Linearity and large-signal performance.
RF Power amplifiers: General properties. Class A, AB and C PAs. Class D, E and F amplifiers. Modulation of power amplifiers.
Analog communication circuits: Mixers, phase-locked loops, oscillators and synthesizers.
Design and performance characterization. Transceiver design.

Text Books

1. The Design of CMOS Radio Frequency Integrated Circuits, Lee Thomas H , Cambridge University Press.
2. Design of Analog CMOS integrated circuits, Razavi Behzad, McGraw Hill
3. VLSI for wireless communication Bosco Leung, Pearson Education

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ECL516 Converged Communication Networks [(3-0-0); Credit: 3] Back

Course Outcomes

Students will

1. be familiar with transfer of information (Data, Voice etc.) over Internet protocol.
2. Understand the principle of protocol architectures like SIP, H.323, MEGACO in IP based communications.
3. Understand and explain special media transport protocols in IP based communications.
4. be familiar with coding techniques of data in IP based communications.
5. be familiar with securities issues related with data transmission over IP.

Contents

Review of circuit switched digital telephony, signaling and transmission, ISDN, SS7. Evolution of packet switched networks, Internet and LANs. The TCP/IP protocol stack.

Introduction to XoIP, network convergence, Needs of individual users, enterprises and network operators. How XoIP is expected to meet all these concerns.

Source coding (speech, audio and video coding) PCM, ADPCM, LP coding, CELP, RPE-LTP, adaptive sub-band coding, MPEG standards for audio and video coding.

Signaling protocols Review of H.323, MEGACO protocols, Session Initiation Protocol (SIP), detailed study of SIP.

Media Transport Need of special media transport protocols, RTP, RTCP, RTSP, QoS issues, routing, security etc.

Books

1. IP Telephony- O. Hersent, D. Gurle and JP Petit- Pearson Education Asia
2. Multimedia Communications – J. D. Gibson (Editor) – Harcourt India
3. IP Telephony – Bill Douskalis – Prentice Hall

4. Multicast Communication- R. Wittman, M.Zitterbart-Morgan Kaufman

ECP519 Communication System Lab II [(0-0-2); Credit: 1] **Back**

Course Outcomes

Students will

1. Understand the significance of parameter estimation and detection in communication engineering.
2. Understand the concept of various detection criteria such as Bayes' Criterion, Minimax Criterion, Neyman-Pearson Criterion etc, and their applications to communication engineering and signal processing.
3. Understand the criteria for good estimators, maximum likelihood estimation, generalized likelihood ratio test, Bayes' estimation and their applications to communication engineering and signal processing.
4. Understand the fundamental working and related protocols for video and voice over IP (VoIP) systems.
5. Develop their interest in research related to communication and networking systems.

Contents

Statistical Decision Theory

Introduction, Bayes' Criterion-Binary Hypothesis Testing, M-ary Hypothesis Testing, Minimax Criterion, Neyman-Pearson Criterion, Composite Hypothesis Testing, Sequential Detection. Parameter Estimation, Some Criteria for Good Estimators, Maximum Likelihood Estimation, Generalized Likelihood Ratio Test, Bayes' Estimation

Understanding of XoIP (anything over IP) systems and protocols such as RTP, MEGACO etc.

ECL528 Detection and Estimation in Wireless Systems [(3-0-0); Credit: 3] **Back**

Course outcomes

Students will

1. decompose a signal in terms of its basis functions.
2. to evaluate the error performance of the various modulation techniques.
3. state maximum likelihood, maximum a posteriori probability, and least-squares estimation problems;
4. find the maximum likelihood, maximum a posteriori probability and least-squares estimates of a parameter;
5. evaluate performance of decision making and estimation systems;

Contents

Representation of bandpass signals and system, signal space representation, representation of digitally modulated signals.

Memoryless modulations, linear and non-linear modulations with memory, spectral characteristics of digitally modulated signals: linear and non-linear modulations. Adaptive receivers and channel equalization: MMSE, ZFE, FSE; Carrier and clock synchronization; Effects of phase and timing jitter;

Introduction, binary hypothesis test: decision criterion, performance, receiver operating characteristics. M-Hypotheses.

Estimation theory: random parameters, Baye's estimation, likelihood ratio test, real parameter estimation, multiple parameter estimation. Detection and estimation in white Gaussian noise, detection of signals in additive white Gaussian noise, linear estimation, nonlinear estimation, known signals in white Gaussian noise, detection and Estimation in Non-white Gaussian Noise, whitening approach.

Text Books

1. H. L. Van Trees, K. L. Bell , Z. Tian, "Detection Estimation and Modulation Theory (I)" 2E, Wiley.
2. U. Madhow, "Fundamentals of Digital Communication", Cambridge University Press, 2008.
3. J. G. Proakis, "Digital Communications", 4E, McGraw Hill, 2000.

Reference Books

1. S. Benedetto and E. Biglieri, "Principles of Digital Transmission with Wireless Applications", Kluwer Academic, 1999.
2. R. G. Gallager, "Principles of Digital Communication", Cambridge University Press, 2008.

ECD501 Project Phase I [(0-0-0); Credit: 3] Back

Course outcomes

Students will

1. get an opportunity to apply knowledge of several courses in developing a new algorithm or circuit or a larger system.
2. implement innovative ideas and publish them as a research paper or file a patent.
3. learn working as a team.
4. acquire additional skills otherwise not covered in the curriculum
5. gain practical knowledge about the topic including social, commercial, manufacturing, testing, measurements, simulation, marketing and legal issues (as applicable).

ECD502 Project Phase II [(0-0-0); Credit: 9] Back

Course outcomes

Students will

1. get an opportunity to apply knowledge of several courses in developing a new algorithm or circuit or a larger system.
2. implement innovative ideas and publish them as a research paper or file a patent.
3. learn working as a team.
4 acquire additional skills otherwise not covered in the curriculum
5. gain practical knowledge about the topic including social, commercial, manufacturing, testing, measurements, simulation, marketing and legal issues (as applicable).

ELECTIVE COURSES

ECL402 Comm. Net. & Network Applications [(3-0-0); Credit: 3] **Back**

Course Outcomes

Students will

1. Be able to distinguish between various network topologies and types of switching
2. Be knowing various medium access protocols and network hardware components
3. Be knowing details of network layer protocols IPv4 and IPv6
4. Be familiar with various protocols used for network control, management and testing.
5. Be conversant with application layer of internet (web technology)

Contents

Networks and services; network topologies; switching methods; network evolution; concept of layered architecture; the OSI model; the TCP/IP model; standardization and standards organizations. Study of telephone network; PCM-TDM based IDN; circuit switching; space and time division switching; signaling methods; store-and-forward switching. ISDN fundamentals; SS#7; Frame relay and ATM networks; SONET and SDH;

LANs and MAC protocols; ALOHA, slotted ALOHA, CSMA and CSMA-CD protocols; IEEE 802.3 protocol and MAC frame format. Details of 802.3 hardware options; 100 Mbps and 1000 Mbps Ethernet LANs, switches, bridges and VPN; Wireless LANs; LAN applications; client-server architecture;

Network Layer: services offered to the transport layer, internal organization as datagram or virtual circuit subnets; routing algorithms; congestion control; internetworking; Study of IPv4 and IP v6, DNS and Internet routing protocols.

Transport Layer: Design issues; study of TCP; connection setup and removal; flow control; reliable and efficient delivery, timer management. The TCP/IP protocol stack: ICMP, IGMP, UDP, BOOTP, DHCP etc.

Network applications: World Wide Web and HTTP; Web servers and browsers, Content Engines; FTP and TFTP; SMTP and MIME; DNS; multimedia networking; streaming stored audio and video; Internet audio and video communications.

Books

1. Communication Networks ; Leon-Garcia and Widjaja TMH 3e
2. Computer Networks, a systems approach Peterson and Davie- Morgan Kauffman, Harcourt India 3e ,
3. Computer Networks , Tanenbaum A. S.; PHI, 4e,
4. Data Comuncation and Networking , B. Forouzan, TMH ,4e
5. Data and Computer Communication, Stallings William, PHI, 6e
6. Computer Networking, a top-down approach featuring the Internet; Kurose and Ross ; Addison Wesley, (Low Price Edition)
7. Communications and Networking Technologies- Gallo and Hancock ;Thomson Learning 2e
8. Behrouz A. Forouzan, Cryptography and Network Security, McGraw Hill

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ECP402 Comm. Net. & Network Applications Lab [(0-0-2); Credit: 1] **Back**

Students will

1. Be able to configure user machines, switches and routers
2. Perform network functioning analysis tools using packet sniffer tools such as WireShark.
3. Be able to gather information on status, configuration and settings of various equipment on the network.
4. Be able to use the network for file sharing, printer sharing etc.
5. Be able to understand working of higher layer protocols.

Contents

1. Using utilities such as ‘net help’, ‘netstart’, ‘netview’ etc.
2. Study of networking devices, topologies and IEEE 802 series standards
3. Gathering information about NIC of a PC.
4. TCP/IP diagnostics and configuration using ‘ping’, ‘ipconfig’ etc.
5. Files sharing in LANs
6. User login and security settings
7. WireShark or similar open source packet sniffers and their use
8. Network protocol analyzer equipment.

ECL416 Fuzzy Logic and Neural Networks [(3-0-0); Credit: 3] Back

Course outcomes

Students will

1. Understand the concept of fuzziness involved in various systems.
   Compare biological and Artificial Neural networks.
2. Be provided adequate knowledge about fuzzy set theory and mathematical derivations.
3. Comprehend the fuzzy logic control to design the fuzzy controllers using MATLAB and SIMULINK.
4. Study different configurations of Neural networks..
5. Design Neural Networks for applications in pattern recognition problems and curve fitting algorithms.

Contents

Crisp sets & Fuzzy Sets : Introduction, Concepts, Fuzzy operations, General Aggregation of operation, Fuzzy relations, Binary relations, Equivalence & similarity relations, Fuzzy relation equation. Applications : Natural, Engineering, Management & Decision making & Computer science.
Supervised and Unsupervised Learning, Multilayer feed forward networks, back propogation algorithm. RBF networks, RLS algorithm, Single layer feedback networks, Hopfield networks, Applications of ANN. SOM,

Books

1. Fuzzy Sets Uncertainty & Information; George Klir, Prentice Hall, 2e.
2. Introduction to Artificial Neural Systems, Zurada J. M, West Publishing Co, 2e.
3. Communication Electronics- Principle and Applications, Frenzel, Publisher TMH 3e.
4. Neural Networks and Fuzzy Systems; B.Kosko; Publisher Prentice Hall, 3e.
5. Elements of Neural Networks; Mehrotra K., Mohan C.K., Ranka S.; Publisher

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ECL418 Network Planning and Management [(3-0-0); Credit: 3] **Back**

Course Outcomes

Students will

1. Understand applications of traffic analysis to network planning
2. Understand various procurement and installation procedures.
3. Understand operation and maintenance systems for telecom networks
4. Design an enterprise network based on the requirements of an organisation.
5. Understand protocols and applications for enterprise network management and diagnosis

Contents

Network traffic data analysis and forecasting, resource planning, procurement and installation
Telecom network operation and maintenance system. Case studies of ISDN, ATM, GSM, CDMA networks.
Enterprise need analysis and LAN design, component selection, procurement and installation.
Network management issues such as configuration management, fault and maintenance management, security and access management.
Management protocols such as SNMP, web based management tools such as Netconf, management protocol issues such as scalability, efficiency, effectiveness etc.

Text/References

1. Subramanian ; Network Management ; Addison Wesley (Low Price Edition)
2. McCabe J.D., Network analysis, architecture and design, Elsevier
3. FitzGerald J., Dennis A., Business Data Communications and networking,

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ECL424 Optical Communication [(3-0-0); Credit: 3] **Back**

Course Outcomes

1. Familiarity with basic concepts and theory of Optical Communication.
2. Ability to demonstrate OPCOMM components, assemble them and solve problems on Optical Communication system.
3. Ability to design, implements, analyzes and maintains optical communication system
4. Knowledge of different source of light as well as receiver nd their comparative study
5. To get idea about power budget and ultimately be an engineer with adequate knowledge in optical domain

Contents

Optical Fiber: Basic concepts of optical communication. The nature of light. Light as an Electromagnetic Wave, Polarisation, Interference. Transmitting light on a Fibre Refractive index, Fibre refractive index profiles, Modes of propagation. Light Propagation in Multimode Fibre, Snell's Law Critical Angle, Numerical aperture.
Optical Sources: Light Emitting Diodes (LEDS), The Semiconductor Junction Diode, Construction and Operation of LED's , Heterojunctions (Practical LED's) , Characteristics of LED'S, Lasers, Principle of the LASER, Semiconductor Laser Diodes.
Optical Detectors: Photoconductors, Photodiodes, P-N Diodes, P-I-N Diodes, Schottky-Barrier Photodiodes, Avalanche Photodiodes (APDS), Hetero-interface Photodetectors, Travelling Wave photo detectors, Phototransistors.
Optical Communication Systems: Point-to-point Transmission Systems, Modulation techniques, On-off key, Multi state coding, Forward Error correction, Receiving the signal, Timing recovery, Bandwidth Occupancy.

References

1. "Optical Fibre Communication Practice and Principles", Senior
2. "Fibre Optic Communication", D. C. Agrawal
3. "Optical Communication", Keiser

Text Books

1. Optical Fibre Communication Practice and Principles, J. Senior
2. Fibre Optic Communication , D. C. Agrawal
3. Optical Communication , Keiser

ECP424 Optical Communication Lab. [(0-0-2); Credit: 1] **Back**

Course Outcomes

1. Familiarity with basic concepts and theory of Optical Communication.
2. Ability to measure different optical fiber parameter.
3. Ability to measure and understand different characteristics of source and receiver
4. Visualise different scheme of communication in optical medium.
5. ability to design a optical communication link

Course Contents

1. Measurement of propagation losses in an Optical Fiber
2. Measurement of Numerical Aperture of an Optical Fiber using 660 nm LED
2) Study of V-I , I-P characteristics of laser and V-I characteristics of 660 nm LED
   (a). Study of Fiber optic transmission sensor
   (b). Study of Fiber optic reflection sensor
   (c). Transmission of light through fiber with gaps
3) Setting up of Fiber optic digital link
4) Setting up of Fiber optic analog link
5) Study and measurement of Bit Error Rate (BER)
6) Study of Pulse width modulation and demodulation
7) Study of Pulse amplitude modulation and demodulation
8) Study of Pulse position modulation and demodulation

ECL428 Industrial Communication Systems [(3-0-0); Credit: 3] **Back**

Course Outcomes

1. Familiarity with basic concepts of various interfaces.
2. Ability to design different systems for interfacing.
3. Ability to measure and understand different characteristics of source and receiver
4. Visualise different scheme of communication in industrial environment.
5. ability to design a practical communication link

Interface: Introduction, principles of interface, serial interface and its standards.
Parallel interfaces and buses. Fieldbus: Use of field buses in industrial plants, functions, international standards, performance, use of Ethernet networks, fieldbus advantages and disadvantages. Fieldbus design, installation, economics and documentation.
Instrumentation network design and upgrade: Instrumentation design goals, cost optimal and accurate sensor networks. Global system architectures,advantages and limitations of open networks, HART network and foundation fieldbus network.
PROFIBUS-PA: Basic, architecture, model, network design and system configuration. Designing PROFIBUS-PA and foundation. Fieldbus segments: general considerations, network design.

Text Books

1. Noltingk B.E. “Instrumentation Reference Book” . 2nd E dition. Butterwort Heinenmann. 1995.
2. B.G. Liptak. Process software and digital networks, 3rd Edition. CRC press, Florida.

Reference Books

1. John Park ,Steve Mackay “Practical Data acquisition for Instrumentation and control systems” Elsevier ,2003
2. Creed Huddleston “Intelligent sensor Design Using the Microchip dsPIC” Elsevier ,2007

ECP440 Cyber Laws and Telecom Regulation Workshop [(0-0-2); Credit: 1] **Back**

Course Outcomes

1. Familiarity with basic concepts of telecom regulation.
2. Appreciation of functioning of various regulatory authorities.
3. Understanding of issues related to tariff plans.
4. Ability of Analysis of case studies.
5. An overview of cyber laws

Contents

Telecom regulatory authorities, objectives, functioning. Mobile phone tariff plans, spectrum regulation, privacy and consumer protection.
Laws related with financial crimes through electronic network, prevention of abuse, harassment etc.
[Students are expected to take up various case studies and make presentations.]

References

1. www.trai.gov.in/

ECP441 Network Standards Workshop [(0-0-2); Credit: 1] **Back**

Course Outcomes

1. Familiarity with basic concepts of standardization.
2. Appreciation of functioning of various standard development organizations.
3. Understanding of issues related to standardization of cabling .
4. Ability of Analysis of case studies.
5. An overview of technologies influencing future standards

Contents

Need of standardization in communication technology, social, economical, commercial and managerial issues. Standardization in ETSI and ITU, 3GPP and 3GPP2, IETF, IEEE
Structured cabling and best practices in cabling installation. Installation of LAN wiring, optical fiber cables, installation standards for telecom cabling.

References

1. www.ieee.org
2. www.ietf.org
3. www.etsi.org
4. www.3gpp.org
5. www.itu.org
6. www.3gpp2.org
7. www.iso.org
8. www.tiaonline.org

ECP442 Software Engineering Workshop [(0-0-2); Credit: 1] Back

Course Outcomes

1. Familiarity with basic concepts of software engineering.
2. Appreciation of need of software engineering.
3. Understanding of issues related to tools for software engineering.
4. Ability of Analysis of case studies.
5. An overview of technologies influencing future practices and standards

Contents

Software requirements analysis, design documentation and business rules. Software development, testing, maintenance, configuration management. Software engineering tools and methods, Computer Aided Software Engineering and Software development methodology, Software quality. Software project management. Software engineering concepts as applied to communication related software development
[Students are expected to take up various case studies and make presentations.]

References

1. Pressman, Roger S (2005). Software Engineering: A Practitioner's Approach (6th ed.). Boston, Mass: McGraw-Hill. ISBN 0072853182.
2. Sommerville, Ian (2007) [1982]. Software Engineering (8th ed.). Harlow, England: Pearson Education. ISBN 0-321-31379-8.
3. Jalote, Pankaj (2005) [1991]. An Integrated Approach to Software Engineering (3rd ed.). Springer. ISBN 0-387-20881-X.
4. Ghezzi, Carlo; Mehdi Jazayeri, Dino Mandrioli (2003) [1991]. Fundamentals of Software Engineering (2nd (International) ed.). Pearson Education @ Prentice-Hall.
5. IEEE Computer Society, Guide to the Software Engineering Body of Knowledge (SWEBOK) http://www.computer.org/portal/web/swebok

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ECL513 Synchronization and Tracking [(3-0-0); Credit: 3] Back

Course Outcomes

1. Familiarity with basic concepts of standardization.
2. Appreciation of functioning of various standard development organizations.
3. Understanding of issues related to standardization of cabling .
4. Ability of Analysis of case studies.
5. An overview of technologies influencing future standards

Contents

Network synchronization for TDM networks, timing references and their distribution, hierarchical systems, mutual synchronization.
PLL: Design and analysis of PLL, Loop modeling; linear and non-linear, acquisition and tracking range. Static and dynamic performance. Phase noise and jitter.
Carrier Synchronization methods: Costas Mth power loop, phase ambiguity issues, advances in carrier synchronization
Symbol timing recovery: Early-late gate method, steady state and transient response, modeling and simulation.
Code acquisition and tracking techniques for spread spectrum methods
Carrier synchronization issues in OFDM. Performance degradation due to frequency offset error.
Chaotic synchronization

Text / References

1. Proakis John; Digital communication(Third Edition); Tata- McGraw-Hill.
2. Haykin Simon; Communication systems (Fourth Edition); Wiley.
3. Korsch H.J., Jodl H.J., Chaos, Springer-Verlag

ECL526 Computer Vision [(3-0-0); Credit: 3] **Back**

Course outcomes
Students will

1. Be knowing computer vision fundamentals (image formation and image processing).
2. Be familiar with different feature extraction techniques and their applications.
3. Be conversant with basics of image segmentation and different image segmentation algorithms.
4. Be familiar with basic pattern recognition methods.
5. Be conversant with basics of multi view imaging and depth estimation.

Contents
Introduction about computer vision: What is computer vision, advantages and disadvantages of computer vision, general applications of computer vision.
Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.
Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.
Pattern Analysis: Clustering: K-Means, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.
Computational imaging: Image sensor, noise, HDR, super resolution, blur removal, compressive sensing, Depth estimation and Multi-camera views: projective geometry, binocular stereo, stereo matching, Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration.
Case studies of computer vision projects such as medical image analysis, 3D modeling from LiDar point clouds etc.

Text Books
1 Shapiro and Stockman Computer Vision Illustrated edition Prentice Hall
2. Rafael C. Gonzalez and Richard E. Woods Digital image processing 3rd edition Pearson Education
3. Christopher Bishop Pattern Recognition and Machine learning Illustrated edition Springer
4 Richard Hartley and Andrew Zisserman Multiple View Geometry in Computer Vision 2nd edition Cambridge University Press

Reference Books
1. Richard Szeliski Computer Vision: Algorithms and Applications Springer

ECP526 Computer Vision Lab [(0-0-2); Credit: 1] **Back**

Course Outcomes

Students will

1. Be able to implement basic image evaluation methods
2. Be able to implement different feature detector algorithms for images
3. Implement basic segmentation algorithms on grayscale images
4. Implement basic clustering & dimensionality reduction techniques
5. Implement 3D reconstruction using 2D images

Contents

Histogram plotting of an Image. Implementation of Histogram equalization
Design and implementation of simple filters like averaging, sharpening & edge detector filters
Design and implementation of Harris corner detector
Design and implementation of SIFT algorithm for image matching
Implementation of simple segmentation algorithms
Implementation of PCA for dimensionality reduction
Implementation of simple clustering algorithms
Implementation of 3D reconstruction algorithms using stereo images

Text Books

1 Shapiro and Stockman Computer Vision Illustrated edition Prentice Hall
2. Rafael C. Gonzalez and Richard E. Woods Digital image processing 3rd edition Pearson Education
3. Christopher Bishop Pattern Recognition and Machine learning Illustrated edition Springer

4 Richard Hartley and Andrew Zisserman Multiple View Geometry in Computer Vision 2nd edition Cambridge University Press

Reference Books

1. Richard Szeliski Computer Vision: Algorithms and Applications Springer

ECL406 Mobile Communication Systems [(3-0-0); Credit: 3] Back

Course Outcomes

Students will

1. Be aware of generations of wireless mobile communication technologies
2. Be conversant with how various decisions were made while evolving the mobile communication system standards.
3. Be aware of functioning of mobile communication network
4. Be familiar with features of wireless LAN technologies
5. Be familiar with Bluetooth communication technology

Contents

The second generation (2G) systems
GSM: services, features, architecture, radio link, channel types, frames, call handling
CDMA IS95: forward and reverse channels, system architecture, call handling.
2.5G systems
GPRS: data rates, basic services, system architecture, protocols, coding schemes, mobility management, hardware and software components
EDGE: evolution, advanced modulation methods, radio transmission and data rates, services and protocols.
The 3G systems: Introduction, evolution of 3G networks, ITU IMT 2000,
CDMA 2000: bandwidth, chip rate, channels, spreading and modulation, power control, soft handoff, EV-DO, EV-DV
UMTS: radio access network, spreading and modulation, channels, core network.
Wireless LANs
IEEE 802.11 system and protocol architecture, physical layer and MAC, options like 802.11b, a g etc. and their purpose.
Bluetooth: User scenarios, layered architecture, link management, L2CAP, SDP, IEEE 802.15Mobile Communication

Books

1. Jochen Schiller Addison Wesley 2nd Edition
2. Wireless Communication: Principles and Practices
3. Theodre S. Rappaport, Pearson Education
4. Wireless and Mobile Network Architecture Yi-Bing Lin and Imrich Chlamtac Wiley Publication.
5. Principles of Mobile Communication Gordon L., Stuber Kluwer Academic Publishers, Norwell, Ma, USA 1st Edition
6. 3G Mobile Network: Architecture, Protocol and Procedures Kasera Sumit, Narang Nishit Tata McGraw Hill.

ECP409 Radio Frequency Circuit Design Lab.[(0-0-2); Credit: 1] Back

Course Outcomes

Students will

1. be able to analyze an impedance transformation network using a software tool and use the circuit in their design.
2. be able to design physical lay-out of a passive component and evaluate its performance with software tools such as ADS or Microwave Office.
3. will be able to characterize an RF component or circuit using S-parameter matrix
4. be able to design RF amplifier and related circuits and evaluate the performance using software tools.
5. Be able to design mixers and oscillators and evaluate performance using software tools

Contents

Phase-I: Simulation of impedance transformation passive networks

1. L- section upward transformation
2. L-section, downward transformation
3. π- circuit
4. T-circuit
5. Tapped capacitor resonator
6. Tapped inductor resonator
7. Double tapped resonator

For every network, plot the Zin as function of frequency and load resistance Rs.

Phase-II: Simulation of passive RF components.
(Layout design and simulation, circuit models and parameter extraction, circuit simulation)

1. Design of resistor using poly-silicon over field oxide.
2. Parallel plate capacitor using poly-insulator-poly and metal-insulator-metal layers.
3. Lateral flux capacitors (inter-digitated, simple fractal)
4. Spiral inductor and transformer. (Use of Razavi's formula and Lee's formula)
5. Active resistor and MOS capacitor using MOSFETs

Phase-III: S parameter characterization of passive and active components
Using the advanced micro-strip trainer, find the S-parameters of the following components

1. Patch antenna (transformer feed and inset feed)
2. Low-pass filter
3. Band-pass filter
4. Band-reject filter
5. Ring resonator
6. Power divider (with and without isolation resistor)
7. Rat race hybrid ring coupler
8. Parallel line coupler
9. Branched line coupler
10. Amplifier

Phase-IV Design and simulation of active circuits

1. Common Source and Common Gate CMOS amplifier
2. Differential amplifier
3. Single ended LNA
4. Double ended LNA
5. Power amplifiers class A, B, C
6. Power amplifiers class D, E and F
7. Gilbert mixer
8. Colpitt and Hartley oscillators
9. Negative frequency oscillators

ECL410 Satellite Communication [(3-0-0); Credit: 3] **Back**

Course Outcomes

Students will

1. Be conversant with orbital aspects of satellite communication
2. Be able to design satellite link
3. Be knowing about digital satellite links
4. Be familiar with multi-access schemes
5. Be familiar with earth station technology

Contents

Orbital aspects of satellite communication, Orbit mechanisms, Equation of orbit, Locating satellite in orbit, Orbital elements, Orbital area coverage, Look angles, Slant range,
Space craft subsystems, Attitude and orbit control system, Telemetry tracking and command system (TTC), Power subsystems, Antennas, Reliability
Satellite link design, System noise temperature, G/T ratio, Down link design, Uplink design, Link for specified (C/N) base-band noise signal.
Digital Satellite Links, Frequencies and channel allocations, Modulation techniques, QPSK, QAM, BER analysis, medium access methods for satellite communication.
Earth station technology, Earth station design for low system noise temperature. Equipment for earth stations, LNA and HPA.
VSAT systems- overview of VSAT systems, Access control protocols, multiple access selection, modulation, coding and interference issues .

Books

1. Satellite communication , Timothy Pratt, Charles Bostian, Jeremy Allnut, John Willey and Sons Inc. Second edition
2. Satellite Communication Systems Engineering, W. L. Pritchard, H.G. Suyderhoud, R.A. Nelson, Pearson Education Second edition
3. Advanced Electronic communications, Wayne Tomasi, Prentice Hall of India Pvt. Ltd Fifth edition
4. Electronic Communication Systems Frank.R. Dungan, International Thomson Publishing Company Third edition.
5. Satellite Communication, Roddy Second edition .
6. Satellite Communication Technology , Dr. K. Miya, Second edition

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ECL411 Digital Image Processing [(3-0-0); Credit: 3] **Back**

Course Outcomes

Students will

1. understand and explore importance of Digital Image Processing.
2. be able to extend the theory concepts of Digital Signal Processing further to Digital Image Processing.
3. physically understand concepts of digital image enhancement and filtering in spatial domain.
4. implement frequency domain filters for image processing applications.
5. visualize basic computer vision algorithms using the learned Image Processing concepts.

Contents

Elements of visual perception, Digital Image fundamentals, Basic image processing steps, Image Transforms, Image enhancement in spatial and frequeny domain, linear gray level transformations, Histogram equalization and specification ,smoothing & sharpening spatial filters, Image degradation models ,image restoration, inverse filtering, Wiener filtering. Image reconstructions from projections, radon transform, projection theorem of computerized tomography Morphological image processing ,dilation ,erosion, Basic morphological algorithms ,thinning algorithms

Edge detection ,Edge linking & Boundary Detection ,watershed segmentation algorithm , Introduction to object recognition., colour image processing ,RGB and HSI color models, Gray level to color transformations

Books

1. Digital Image Processing Gonzalez R.C. and Woods R.E., Pearson, Second
2. Digital Image Processing Pratt W.K., Wiley, Third
3. Fundamentals of Digital Image Processing, A.K.Jain, PHI

ECL413 Adaptive Signal Processing [(3-0-0); Credit: 3] Back

Course Outcomes

Students will

1. review the basic concepts related to vector space and Eigen analysis
2. review the basic concepts of stochastic signals and statistics of stationary signal
3. implement Wiener filter using different LMS algorithms
4. be familia with RLS algorithm
5. able to design adaptive filters for different applications

Contents

Vectors, Matrices and Eigen Analysis. Application to adaptive signal processing. Stochastic Processes, Ensemble average, mean, average power, auto and cross correlation functions, stationarity and white noise, Auto-regressive process. Least Squares and LMS algorithms, Normal equations, properties. Eigen System decomposition. Gradient search technique, convergence properties of LMS. Normalized LMS algorithm. Recursive solution techniques, RLS algorithm. Application to noise cancellation, modeling of physical processes, communications.

Text Books

1 S. Haykin Adaptive Filter Theory Fourth Edition Prentice Hall
2. B. Widrow and S. D. Sterns Adaptive Signal Processing Pearson Education

Reference Books

1. M. J. Larrimore, C. R. Johnson and J. R. Treichler Theory and Design of Adaptive Filters publisher

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ECL419 Wireless Sensor Networks [(3-0-0); Credit: 3] Back

Course outcomes

Students will

1. Be introduced to wireless sensors which have applications in many fields.
2. be able to design wireless sensor networks for an application after completion of the course.
3. Be aware of emerging research areas in the field of sensor networks after successful completion of this course.
4. Be familiar with various MAC protocols used for different communication standards used in WSN
5. Students can explore new protocols for WSN

Contents

Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Types of wireless sensor networks
Mobile Adhoc NETworks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks. Issues and challenges in wireless sensor networks
Routing protocols, MAC protocols: Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and ZigBee,
Dissemination protocol for large sensor network. Data dissemination, data gathering, and data fusion; Quality of a sensor network; Real-time traffic support and security protocols.
Design Principles for WSNs ,Gateway Concepts Need for gateway ,WSN to Internet Communication, Internet to WSN Communication.
Single-node architecture, Hardware components & design constraints,
Operating systems and execution environments, introduction to TinyOS and nesC.

Text Books

1 Waltenegus Dargie , Christian Poellabauer, Fundamentals Of Wireless Sensor Networks Theory And Practice By John Wiley & Sons Publications

Reference Books

1. Sabrie Soloman, SENSORS HANDBOOK by Mc Graw Hill publication.
2. Feng Zhao, Leonidas Guibas, Wireless Sensor Networks, Elsevier Publications.
3. Kazem Sohrby, Daniel Minoli, Wireless Sensor Networks: Technology, Protocols and Applications, Wiley-Inderscience

4. Philip Levis, And David Gay Tinyos Programming by Cambridge University Press.

ECL420 Smart Antennas [(3-0-0); Credit: 3] **Back**

Course Outcomes

Students will

1. Be acquainted with fundamentals and terminology of antenna arrays.
2. Be familiar with working of smart arrays.
3. Be able to utilize various signal processing techniques for smart arrays.
4. Be conversant with smart array implementation for different communication technologies and standards.
5. Be able to assess impact of channel characteristics on antenna arrays.

Contents

Array Antenna Fundamentals: Linear Arrays , Array Weighting, Beamsteered Arrays , Circular Arrays ,Fixed Beam and Sectorized Arrays. Sidelobe Cancellors , Retrodirective Arrays.

Smart Antennas, Benefits of smart antennas, Adaptive Algorithm Basics , Gradient Based Methods, Howells Applebaum Processor , Adaptive Beamforming Elimination of the Effects of Mutual Coupling on Adaptive Antennas.

Adaptive Arrays for CDMA , Waveform Diversity Methods, MIMO Examples Angle-of-Arrival Estimation, Array Correlation Matrix ,Bartlett AOA Estimation method ,Capon AOA Estimation method , Spectral Estimation Methods

Channel Characterization ,Channel Impulse Response, Slow Fading; Fast Fading; Fast Fading Modeling ,Spreading , Channel Equalization. Methods for Optimizing the Location of Base Stations for Indoor Wireless Communication, Identification and Elimination of Multipath Effects, Signal Enhancement in Multiuser Communication.

Books

1. Smart Antennas for Wireless Communications By Frank Gross, McGraw hill
2. Smart Antennas, Tapan A. Sarkar ,M. C. Wicks, M. Salazar-Palma, R. J. Bonneau , Wiley
3. Introduction to Smart Antennas , Balanis, Constantine A. , Morgan & Claypool

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ECL427 Broadband Communication [(3-0-0); Credit: 3] **Back**

Course Outcomes

Students will

1. Be conversant with orbital aspects of satellite communication
2. Be able to design satellite link
3. Be knowing about digital satellite links
4. Be familiar with multi-access schemes
5. Be familiar with multi-carrier communication systems

Contents

Satellite Communication Systems
Orbital aspects of satellite communication, Attitude and orbit control system, Telemetry tracking and command system (TTC), Power subsystems, Antennas, Reliability
Satellite link design, System noise temperature, G/T ratio, Down link design, Uplink design, Link for specified (C/N) base-band noise signal.
Digital Satellite Links, Frequencies and channel allocations, Modulation techniques, QPSK, QAM, BER analysis, medium access methods for satellite communication.
Multicarrier communication systems:
DMT, OFDM, MIMO systems, space-time coding, WiFi, WiMax, UWB systems

Books

1. Timothy Pratt, Charles Bostian, Jeremy Allnut ,"Satellite communication" John Willey and Sons Inc. Second edition
2. W. L. Pritchard, H.G. Suyderhoud, R.A. Nelson, "Satellite Communication Systems Engineering" Pearson Education Second edition
3. Wayne Tomasi "Advanced Electronic communications" PHI Learning, Fifth edition
4. Frank.R. Dungan," Electronic Communication Systems" International Thomson Publishing Company Third edition
5. J. Proakis, "Digital Communication" 4e, TMH
6. Simon Haykin, "Communication Systems", 4e, John Wiley

ECL511 Non-linear System Modeling [(3-0-0); Credit: 3] Back

Course outcomes

Students will

1. Be familiar with non linear systems and methods of analysis of the non linear systems.
2. Be able to do stability analysis of non linear systems
3. Be aware of different nonlinear phenomena
4. Be familiar with chaos based communication
5. Be aware of chaos in different signal processing applications

Contents

Introduction to nonlinear systems, analysis by phase plane and describing function methods. Nonlinear circuits.
Lyapunov stability theory. The Lure problem: Popov's method, circle criterion. Hyperstability. Hamiltonian, Lagrangian and gradient systems
Introduction to dynamical systems, examples of discrete and continuous dynamical systems, Lorenz attractor, Logistic map, Bifurcation ,Chaos in dynamical system
Chaos based communication: chaotic modulation, chaotic multiplexing, chaotic masking. Chaotic oscillator, Chaotic synchronization methods.
Chaos and signal processing: chaos based noise modeling for adaptive filtering, invertible chaotic encryption ,chaos based jamming. Fractal basics, iterated function systems, fractal applications.

Text Books

1 Khalil, Hassan K. Nonlinear Systems 3rd Edition Prentice Hall
2. Steven H, Strogatz Nonlinear dynamics and chaos: with applications to physics, biology chemistry and engineering Addison Wesley
3 M. Vidyasagar Nonlinear Systems 2nd Edition Prentice Hall

Reference Books

1. Lawrence Perko Differential Equations and Dynamical Systems Second Edition Springer
2. V. M. Popov Hyperstability of control systems Springer Grundleheren series

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ECL515 Intelligent System Design [(3-0-0); Credit: 3] Back

Course Outcomes

Students will

1. Be well versed with concept of intelligent system design: features, standards etc.
2. Be familiar with and able to apply various approaches of modeling of intelligent systems.
3. Be able to perform error analysis in intelligent system design.
4. Be familiar with utilizing soft computing tools for intelligent system design.
5. Develop skill of implementing real time various hardware/software platforms based intelligent systems.

Contents

Concept of Intelligent systems, motivation and design features, Modeling of Intelligent Systems. Evolution in ISD Errors and types of errors for intelligent control, different methods of error estimation. Relevance of Artificial Intelligence in ISD. Relevance of soft computing tools in ISD: Fuzzy logic, Neural network, GA, Rough Sets, SWARM etc. Real Time ISD implementation, software and hardware tools and methodologies used. Case Studies and applications of ISD.

Books

1. Intelligent system Design and applications, Springer, Ajith Abraham, Katrin Franke, Mario Köppen
2. Soft computing and intelligent systems design: theory, tools, and applications, Fakhreddine O. Karray, Clarence W. De Silva, Pearson/Addison Wesley,
3. Intelligent systems design: integrating expert systems, hypermedia, and database technologies
4. Larry Bielawski, Robert Lewand Wiley,
5. Planning in Intelligent Systems: Aspects, Motivations, and Methods, Wout van Wezel (Editor), R. J. Jorna (Editor), Alexander M. Meystel (Editor) , Wiley
6. Intelligent Systems: Architecture, Design, and Control, Alexander M. Meystel, James S. Albus Wiley

ECL527 Spectrum Management [(3-0-0); Credit: 3] Back

Course Outcomes

Students will

1. Be familiar with fundamental issues in spectrum management
2. Be conversant with issues in EMC
3. Be aware of functioning of organizations like ITU
4. Be knowing fundamentals of spectrum planning.
5. Be aware of spectrum monitoring techniques and their role in spectrum management.

Fundamentals of Spectrum Management, Management of RF Spectrum and satellite Orbit, Services Fixed, mobile and Satellite, Radio determination and Radiolocation, Broadcasting etc

Electromagnetic Compatibility (EMC) Studies for providing interference free environment/protection of various services Coordination efforts to ensure co-existence of various types of radiocommunication services.

Major National Spectrum Management Directives/Laws, Organizational Structure and Processes of ITU-Radiocommunication Sector (ITU-R) Spectrum Management Planning, Regulation and Policy Making, Development of a National Frequency Allocation Plan,Frequency Assignment and Licensing, Relevance of Spectrum usage charge with the Spectrum Management, Monitoring and Spectrum Enforcement, Types of Spectrum Monitoring Stations International and National Cooperationand coordination

Spectrum Planning

Significance of Planning, Costs and Benefits, Concept of Harmonization

Planning Processes, Establishing Spectrum Planning Objectives, Spectrum Availability and Usage Trends, Future Spectrum/Service Requirements Rights of spectrum usage, exclusive or market driven or collective, Planning Implementation, Short Term, Long Term, Strategic Planning Improving the Spectrum Management Planning System Frequency Assignment and Licensing

Assigning Frequencies to Radio Stations, Regulatory and Technical Aspects of the Frequency Assignment Process, Frequency Plans, Process Automation

Requirements of Licensing , Licensing Radio Stations, Deregulation of Licensing, Licensing Practices, On-Line Licensing and Security Issues

Spectrum Monitoring and Inspection

Spectrum Monitoring as an Element of the Spectrum Management Process, Monitoring to Assist Frequency Assignment, to Assess Spectrum Occupancy and for Compliance with National Rules and Regulations.

Monitoring Facilities Depending on a Frequency Band and Purpose, Automation of Monitoring, Integration of Monitoring Sub-System with Automated Spectrum Management System, Spectrum Inspection and Investigation as Elements of the Spectrum Management Process, Inspections and Investigations for Compliance with National Rules and Regulations, Verification of Technical and Operational Parameters, Detection and Identification of Unauthorized Transmissions, Inspections and Investigations to Identify the Source of, and to Resolve, Interference, Equipment for Inspections and Investigations Measures of Spectrum Utilization and Utilization Efficiency

Different Methods for Calculating optimal Spectrum Utilization, Measure of Spectrum Utilization Efficiency, Ratio of Spectrum Utilization Efficiencies/Relative Spectrum Efficiency

Whitespace and Beyond-Towards a common framework for spectrum sharing

White space overview and applications, Regulatory rules, Opportunities for the use of Space

Books

1. Radio Spectrum Conservation: Radio Engineering Fundamentals- by William Gosling.
2. Cognitive Radio Policy and Regulation. Editors: Medeisis, Arturas, Holland, Oliver.
3. Radio Spectrum Management: Management of the Spectrum and Regulation by David J. Withers.
4. The Radio Spectrum- by Jean- Marc Chaudc, Gerard Pogorel.
5. Essentials of Modern Spectrum Management-by Martin Cave etal.
6. Wireless Spectrum Management: Policies, Practices, and Conditioning Factors- by Amit. K. Mitra.
7. Globalization of Mobile and Wireless Communications: Today and in 2020- by Ramjee Prasad

Reference

1. ITU- Handbook on Spectrum Monitoring.
2. ITU Survey on Spectrum Management.
3. ITU Radio Spectrum Management Hand book.
4. Economic Aspects of Spectrum Management- Report ITU-R 2012-3.
5. ITU- Radio Regulations Articles, Edition of 2012.
6. ITU-R, “Computer-aided Techniques for Spectrum Management (CAT)”.
7. ITU-R, “Radio wave propagation information for designing terrestrial point-to-point links”.
8. ITU-R, “Digital Radio-Relay Systems”.
9. ITU-R, “Handbook on Global Trends in International Mobile Telecommunications

ECL529 Advanced Computer Architecture [(3-0-0); Credit: 3] Back

Course Outcomes

Students will

1. Understand high performance computing, RISC philosophy and overview of pipelined architecture.
2. Check Performance evaluation and limitations of pipelined architecture .Instruction level parallelism, superscalar architecture, dynamic pipelines, superscalar techniques,
3. Verify performance evaluation of superscalar architectures, VLIW architecture, data-level parallelism, thread-level parallelism,
4. Principles of simultaneous multi-threaded architectures, instruction fetch policies in multi-threaded architectures, multi-core architectures.
5. Design Memory and storage system.

Contents

Course Introduction, Introduction to Computer Architecture, Instruction set architecture, Evolution of architectures, RISC architecture (Single cycle, multi-cycle, and pipelined architectures) , Pipeline hazards, Memory system, Cache architecture, Beyond Pipeline, Superscalar architecture, Superscalar architecture: An overview, Instruction flow optimization: Handling branches, Branch predictors – 1, Branch predictors – 2, Advanced optimization in instruction flow, register flow techniques: Register renaming and out of order execution, Out of order execution, Advanced data flow techniques: Instruction reuse and value prediction, Memory data flow, Advanced memory data flow architectures, Limits of superscalar architectures, Beyond ILP, Multi-threading, Simultaneous multithreaded (SMT) architectures, SMT architecture: Choices, SMT performance on various designs, SMT architecture: OS impact and adaptive architectures, VLIW architectures, Multiscalar architecture, Multi-core Architectures, Multicore Interconnect – NOC, Network-on-Chip, Cache Coherence, Cache Consistency model, Dynamic Core architectures, GP-GPU Architecture ,CPU-GPU Integration

Reference Book

1. J.L. Hennessy, and D.A. Patterson, *Computer Architecture: A quantitative approach*, Fifth Edition, Morgan Kaufman Publication, 2012
2. J.P. Shen and M.H. Lipasti, *Modern Processor Design*, MC Graw Hill, Crowfordsville, 2005
3. Current Literature (Papers from ISCA, Micro, HPCA, ICCD, and IEEE Trans. on Computers, IEEE Architecture Letters)

CSL528 Cryptography and Information Security [(3-0-0); Credit: 3] Back

Course Outcomes

Students will be

1. Familiar with basic concepts and theory of cryptography.
2. Familiar with encryption and decryption algorithms used in mobile communication systems.
3. Be conversant with issues and solutions for authentication.
4. Be able to design a security system.
5. Have an idea about different security threats and counter measures.

Contents

Introduction and Classical Ciphers, Block Ciphers and DES, Algebraic Structures: Groups, Rings, Finite and Galois Fields, AES, 2DES and 3DES, Block Modes of Operation: ECB, CBC, Basic Number Theory: Primes, Congruences, CRT, Modular Exponentiation , Asymmetric Key Cryptosystems: RSA, Elgamal, Hash and MAC: SHA-512 , Digital Signatures: RSA, Elgamal. Schnorr, DSS , Key Management: Kerberos, Diffie-Hellman, Digital Certificates, Email Security: PGP, Viruses, Worms, and other Malware , Firewalls ,

Text books

1. William Stallings, Cryptography and Network Security, PHI
2. Behrouz A. Forouzan, Cryptography and Network Security, McGraw Hill

ECL425 High Power RF Devices and Systems [(3-0-0); Credit: 3] Back

Course Outcomes

Students will be

1. Familiar with basic concepts and theory of RF & Microwave Engineering.
6. Be able to demonstrate working of high frequency source.
7. Be able to solve problems on microwave communication system.
8. Be able to design, implement, analyse and maintain a high frequency communication system
9. Have an idea about different microwave network circuits.

Contents

Review of RF & Microwave spectrum, introduction to applications of high power RF & Microwaves Microwave Tubes: Two cavity and multi-cavity Klystron, Reflex Klystron- relation between repeller voltage and accelerating voltage, relation between repeller voltage and frequency of operation, Transit time and mode number, power frequency characteristics tuning, application.
Traveling wave tube: Study of slow wave structure, M & O type TWT, Expression for optimum value D.C biasing voltage to build up amplification in TWT, application. Magnetron: Operation of magnetron oscillator, mode jumping in magnetron, Rikie diagram and graphical representation of performance characteristics of magnetron, application. Backward wave oscillator: working principles, characteristics. Study of O type BWO. Microwave Passive components for high power systems: Directional coupler – Bathe hole coupler, double hole coupler, Moreno crossed guide coupler, multi hole coupler, Faraday rotation: Circulator, Isolator, Gyrator
Microwave hybrid circuits – Magic Tee, Rat race, Branch line coupler Waveguide Irises
Cavity Resonators – Rectangular cavity resonator, Q of a rectangular cavity resonator
Microwave Measurement: Measurement of VSWR-Low, Medium and High, Measurement of power, Bolometer, Frequency measurement, Impedance measurement, attenuation measurement Cavity Q measurement.
High power RF system: Case studies, Radar, TV transmission, Satellite Communication Systems.

Text Books

1. S.Y.Liao; Microwave Devices & Circuits; Pearson Education/PHI
2. Microwave Engineering 3rd Edition, David M Pozar, John Wiley and Sons, 2005

Reference Books

3. Foundation of Microwave Engineering, R E Collin, McGraw Hill International;
4. Microwave Devices & Circuit Design, Ganesh Prasad Srivastava & Vijay Laxmi Gupta, PHI, 2006
5. K.C.Gupta; Microwaves; New Age Publishers

ECL512 Topics in Communication Systems [(3-0-0); Credit: 3] Back

Course Outcomes

After completing this course the student will demonstrate the knowledge and ability to:

1. Apply the fundamentals of communication engineering to understand the advanced topics.
2. Understand the need and evolution of advanced communication systems.
3. Learn various tools required for the analysis and design of the upcoming communication systems.
4. Evaluate the performance of contemporary communication systems and relate it to the quality of service.
5. Utilize their basic knowledge for optimizing the cross-layer parameters to design an end-to-end system.

Contents

The course will contain the advance topics related to (but not limited to) one or more than one areas of communication engineering

- Communication Engineering
- Wireless Communication
- Satellite Communication
- Optical Communication
- Signal processing for communication
- RF circuits design
- Computer Communication
- Information Theory
- Multimedia Communication

Text Books

1. Theodore S Rappaport: “Wireless Communications, Principles and Practice”, Second Edition Pearson Education Asia.

2. K J Ray Liu et al, Cooperative Communication
3. Simon, Alouni, "Digital Communication over Fading Channels" John Wiley & Sons, 2005.
3. Andrea Goldsmith, "Wireless Communication", Wiley Publishers. 2005.

Reference Books

1. William Stallings. "Wireless Communications and Networks, Pearson Education Asia.
2. 3G Mobile Networks by Sumit Kasera McGraw Hills publication. 2007.
3. Simon Haykin and Michael Moher, " Modern Wireless Communications", Person Education.

ECL514 Electromagnetic Interference and Compatibility [(3-0-0); Credit: 3] **Back**

Course Outcomes

Students will

1. Be familiar with basic concepts of EMI &EMC
2. Be able to understand different types of EMI &EMC.
3. Be able to solve problems on EMI & EMC.
4. Be able to test any electronic circuit for EMI
5. Will have idea about minimization of EMI and ensuring EMC.

Contents

Aspects of EMC with examples , Common EMC units, EMC requirements for electronic systems , Radiated emissions, Conducted emissions, ESD.
Application of EMC design , Wires, PCB lands, Component leads, resistors, capacitors, inductors, ferrites. Electromechanical devices ,Digital circuit devices . Mechanical switches (as suppression) , Noise pick-up modes and reduction techniques for analog circuits.
Use of co-axial cables and shielding of signal lines.
Simple emission models for wires and PCB lands, Line impedance stabilisation network (LISN), Power supply filters. Power supplies including SMPS. EMI induced failure mechanisms for power electronic equipment.
Three conductor lines and crosstalk, Shielded wires , Twisted wires, Multiconductor lines and effects of incident fields, Shielding, Origin effects , prevention of ESD event, its harware and immunity. System design for EMC, Grounding, System configuration, PCB design. EMC in the design of digital circuits. ESD and switching interference reduction.
Susceptibility aspects of power electronic and digital equipment.
Shielding of electronic equipment.
EMC standards and test equipment.

Reference Books

1. Noise Reduction Techniques in Electronic Systems, 2nd Edition - Ott HW
2. Electrostatic Damage in Electronics : Devices and Systems - Willium B Greason, Johan Wiley and Son'.
3. Digital Bus Hand Book - Joseph Di Giacomo, McGraw-Hill Publishing Company. 11

ECL530 Contemporary Embedded Systems [(3-0-0); Credit: 3] **Back**

Reading Switches Introduction, Basic techniques for reading from port pins, Example: Reading and writing bytes, Example: Reading and writing bits (simple version), Example: Reading and writing bits (generic version), The need for pull-up resistors, Dealing with switch bounce, Example: Reading switch inputs (basic code), Example: Counting goats, Conclusions
Adding Structure to the Code Introduction, Object-oriented programming with C, The Project Header (MAIN.H), The Port Header (PORT.H), Example: Restructuring the 'Hello Embedded World' example, Example: Restructuring the goat-counting example, Further examples, Conclusions
Meeting Real-Time Constraints Introduction, Creating 'hardware delays' using Timer 0 and Timer 1, Example: Generating a precise 50 ms delay, Example: Creating a portable hardware delay, Why not use Timer 2?, The need for 'timeout' mechanisms, Creating loop timeouts, Example: Testing loop timeouts, Example: A more reliable switch interface, Creating hardware timeouts, Example: Testing a hardware timeout, Conclusions

Text Books

1. Embedded C - Michael J. Pont, 2nd Ed., Pearson Education, 2008

Reference Books

1. PICmicro MCU C-An introduction to programming, The Microchip PIC in CCS C - Nigel Gardner

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ECL531 Machine Learning and Learning Machines [(3-0-0); Credit: 3] Back

Course Outcomes

Students will

1. Have learnt the foundations and concepts of probability and statistics required for machine learning and learning machines.
2. Be familiar with the theory of machine learning
3. Be able to apply the concepts and theory of machine learning to solve problems
4. Be able to transform the concepts and theory of machine learning into design of learning machines and their architectures.
5. Be able to use simple learning machines for solving real life problems.

Introduction Basic concepts Supervised learning. Supervised learning setup. LMS. Logistic regression. Perceptron. Exponential family. Generative learning algorithms. Gaussian discriminant analysis. Naive Bayes. Support vector machines. Model selection and feature selection. Ensemble methods: Bagging, boosting. Evaluating and debugging learning algorithms.
Learning theory Bias/variance tradeoff. Union and Chernoff/Hoeffding bounds. VC dimension. Worst case (online) learning. Practical advice on how to use learning algorithms. Unsupervised learning. Clustering. K-means. EM. Mixture of Gaussians. Factor analysis. PCA (Principal components analysis). ICA (Independent components analysis). Reinforcement learning and control.MDPs. Bellman equations, Value iteration and policy iteration. Linear quadratic regulation (LQR). LQG,Q-learning. Value function approximation. Policy search. Reinforce. POMDPs.

Books

1. Richard Duda, Peter Hart and David Stork, Pattern Classification, 2nd ed. John Wiley & Sons, 2001.
2. Tom Mitchell, Machine Learning. McGraw-Hill, 1997.
3. Richard Sutton and Andrew Barto, Reinforcement Learning: An introduction. MIT Press, 1998
4. Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning. Springer, 2009

ECL532 Wavelets and Multi-media Applications [(3-0-0); Credit: 3] Back

Course Outcomes

Students will

1. Have learnt, understood and consolidated theory of multi-resolution analysis and filter banks.
2. Have visualized mathematical concepts of Wavelets based analysis.
3. Be able to solve simple and real life analysis problems using computer programs of wavelets.
4. Have learnt concepts of wavelet filter synthesis for specific applications.
5. Be able to design wavelet filters for real life applications

Contents

Signal Representation: Fourier, Cosine, Sine, Hartley, Haar, Slant, Walsh and Short-time orthogonal transforms
Image and video international compression standards: JPEG, H.261 , Subband decompositions 1-D and 2-D Wavelets: construction, properties, decomposition, and reconstruction, multiresolution and analysis, Wavelet Packets
Multimedia Signal Processing (multimedia signal enhancement, de-noising, compression), Multimedia Security (Watermarking and Steganography)

Books

1. Chun-Shien Lu, Multimedia Security: Steganography and Digital Watermarking Techniques for Protection of Intellectual Property, Idea Group Publishing, ISBN: 1591401925
2. Metin Akay, Time Frequency and Wavelets in Biomedical Signal Processing, Wiley-IEEE Press, ISBN: 0780311477

CSL517 : Pattern Recognition [(3-0-0); Credit: 3] Back

Course Outcomes

Students will

1. Be familiar with applications of pattern recognition
2. Be conversant with parameter estimation approaches
3. Be able to distinguish between various types of classifiers
4. Be able to apply concepts of artificial neural networks to classification problem
5. Be able to apply various pattern recognition methods to image processing

Contents

Applications of pattern recognition, statistical decision theory, probability of events, Random variables, Estimation of parameters, Minimum Risk Estimators, Baye's Theorem, conditionally independent features. Decision boundries, Estimation of error rates, characteristics curves, Histograms, Kernel and window parameters, Nearest Neighbour classification techniques, Adaptive Decision boundries, clustering, Artificial Neural Networks, Nets without hidden layers and with hidden layers. The back propagation Algorithm, Hopfield Nets, Gray level scaling transformations, Equalization smoothing transformations. Edge detection Logarithmic Gray scale level scaling. Scene segmentation and labelling , counting objects, Hough Transforms, Eigenvector line fitting , Fourier transforms.

Text / References

1. Pattern Classification : Richard O.Duda, Peter E.Hart, David G.Shork, John Wiley & Sons 200, 2nd Edittion
2. Pattern Recognition and Image Analysis , Earl Gose, Richard Johnsonbough , Steve Jost . Prentice Hall of India
3. Pattern Recognition and Image Processing : Sing Tze bow; Marcel Dekker

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MAL503 Optimization Techniques [(3-0-0); Credit: 3] **Back**

Course Outcomes

Students will

1. Be able to apply linear programming and simplex methods to engineering problems
2. Be conversant with various searching algorithms
3. Be applying concepts of constrained optimization
4. Be conversant with successive linear programming
5. Be conversant with successive quadratic programming.

Contents

Motivation. mathematical review , matrix factorizations, sets and sequences, convex sets and functions, linear programming and simplex method, Weierstrass' theorem, Karush Kuhn Tucker optimality conditions, algorithms, convergence, unconstrained optimization, Line search methods, method of multidimensional search, steepest descent methods, Newton's method, modifications to Newton's method , trust region methods, conjugate gradient methods, quasi-Newton's methods. constrained optimization, penalty and barrier function methods, augmented Lagrangian methods, polynomial time algorithm for linear programming, successive linear programming, successive quadratic programming.

Text Books

1. J.C. Pant : Introduction to Optimisation: Operations Research, Jain Brothers, New Delhi, 2004.
2. S.S. Rao: Engineering Optimization : Theory & Practice, New Age International (p) Limited, 1998.

Reference Books

1. H.M.Wagner : Principles of Operations Research, Prentice Hall of India, New Delhi, 1982.
2. David Luenberger and Yinyu Ye, Linear and Nonlinear Programming, 3rd Edition,Springer, 2008.
3. Fletcher R., Practical Methods of Optimization, John Wiley, 2000.
4. Venkataraman P., Applied Optimization with MATLAB Programming, Wiley, 2001

MAL504 Linear Algebra and Applications [(3-0-0); Credit: 3] Back

Course Outcomes

Students will

1. Be able to apply matrix algebra for finding solutions to equations
2. Be able to find inverse of non-singular matrix
3. Be applying concepts of linear operators.
4. Be able to apply concepts of orthonormal sets to vector spaces
5. Be able to apply various optimization techniques to engineering problems

Contents

Matrices: Review of Matrix Algebra; Rank of matrix; Row reduced Echelon form, Determinants and their properties, Solution of the matrix Equation Ax = b, Gauss elimination method; Vector Space, Subspaces, Linear Dependence/Independence, Basis, Dimension, Linear transformation, Range Space and Rank, Null Space and Nullity, Rank nullity theorem, Matrix Representation of a linear transformation, Linear Operators on Rn and their representation as square matrices, Invertible linear operators, Inverse of a non-singular matrix.

Eigen values and eigenvectors of a linear operator, properties of eigenvalues and eigenvectors of Hermitian, skew-Hermitian, Unitary, and Normal matrices (including symmetric, skew-symmetric, and orthogonal matrices), Characteristic Equation, Bounds on eigenvalues, Cayley Hamilton theorem, Diagonalizability of a linear operator.
Inner Product Spaces, Norm, Orthonormal Sets, Gram Schmidt orthogonalisation process, projections and least squares approximation.
Optimization: Modeling and formulation of optimization problems, Least cost and Convex domain, Linear programming and Simplex Algorithm (Big M and Two Phase Method), Duality and the primal dual method.

Text Books

1. Hoffman and Kunze : Linear Algebra, Prentice Hall of India, New Delhi
2. Gilbert Strang : Linear Algebra And Its Applications (Paperback) , Nelson Engineering (2007)

Reference Books

1. V. Krishnamoorthy et al : An introduction to linear algebra , Affiliated East West Press, New Delhi
2. P.G. Bhattacharya, S.K. Jain and S.R. Nagpaul : First course in Linear Algebra, Wiley Eastern Ltd., New Delhi
3. K.B.Datta : Matrix and Linear Algebra, Prentice Hall of India, New Delhi