M.E. COMMUNICATION SYSTEMS

SEMESTER I										
Sl. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**CA**	**FE**	**Total**
1	PICM004	Advanced Applied Mathematics for Communication Engineers	ICC	3	1	0	4	40	60	100
2	PCOC001	Advanced Radiation Systems	PCC	3	0	0	3	40	60	100
3	PCOC002	Statistical Digital Signal Processing	PCC	3	1	0	4	40	60	100
4	PCOC003	Advanced Digital Communication	PCC	3	0	0	3	40	60	100
5	PCOC004	Wireless Communication Engineering	PCC	3	0	0	3	40	60	100
6	PCOC005	Communication Systems Laboratory	PCC	0	0	2	2	60	40	100
7	xxxxxxx	Professional Elective I	PE	3	0	0	3	40	60	100
			Total	**18**	**2**	**2**	**22**			

SEMESTER II										
Sl. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**CA**	**FE**	**Total**
1	PCOC006	Advanced Fiber Optic Technologies	PCC	3	0	0	3	40	60	100
2	PCOC007	Multimedia Compression Techniques	PCC	3	0	0	3	40	60	100
3	PCOC008	Microwave Integrated Circuits	PCC	3	0	0	3	40	60	100
4	xxxxxxx	Professional Elective II	PE	3	0	0	3	40	60	100
5	xxxxxxx	Professional Elective III	PE	3	0	0	3	40	60	100
6	xxxxxxx	Professional Elective IV	PE	3	0	0	3	40	60	100
7	PCOO001	Technical Seminar	EEC	0	0	2	1	60	40	100
8	PCOO002	Industrial Internship Training	EEC	0	0	2	1	60	40	100
			Total	**18**	**0**	**4**	**20**			

SEMESTER III										
Sl.No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**CA**	**FE**	**Total**
1	PCOC009	Cognitive Radio Technologies	PCC	3	0	0	3	40	60	100
2	xxxxxxx	Professional Elective V	PE	3	0	0	3	40	60	100
3	xxxxxxx	Generic Elective	GE	3	0	0	3	40	60	100
4	PCOO003	Project Phase – I	EEC	0	0	6	6	60	40	100
			Total	**9**	**0**	**6**	**15**			

SEMESTER IV										
Sl.No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**CA**	**FE**	**Total**
1	PCOO004	Project Phase - II	EEC	0	0	12	12	60	40	100
			Total	**0**	**0**	**12**	**12**			

PROFESSIONAL ELECTIVES

Sl.No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**CA**	**FE**	**Total**
1	PCOE001	Micro Electro Mechanical Systems	PE	3	0	0	3	40	60	100
2	PCOE002	Research Methodology	PE	3	0	0	3	40	60	100
3	PCOE003	Image and Video Processing	PE	3	0	0	3	40	60	100
4	PCOE004	Telecommunication Switching Systems and Networks	PE	3	0	0	3	40	60	100
5	PCOE005	Wireless Sensor Networks	PE	3	0	0	3	40	60	100
6	PCOE006	Global Satellite Communication Systems	PE	3	0	0	3	40	60	100
7	PCOE007	Network Security	PE	3	0	0	3	40	60	100
8	PCOE008	Multirate Signal Processing	PE	3	0	0	3	40	60	100
9	PCOE009	Smart Antennas	PE	3	0	0	3	40	60	100
10	PCOE010	Communication Network Design	PE	3	0	0	3	40	60	100
11	PCOE011	Global Positioning System	PE	3	0	0	3	40	60	100

12	PCOE012	Detection & Estimation Theory	PE	3	0	0	3	40	60	100
13	PCOE013	Space Time Wireless Communications	PE	3	0	0	3	40	60	100
14	PCOE014	Electromagnetic Interference and Compatibility	PE	3	0	0	3	40	60	100
15	PCOE015	RF Microelectronics	PE	3	0	0	3	40	60	100
16	PCOE016	Satellite Communication	PE	3	0	0	3	40	60	100
17	PCOE017	Network Routing Algorithms	PE	3	0	0	3	40	60	100
18	PCOE018	Advanced Satellite Based Systems	PE	3	0	0	3	40	60	100
19	PCOE019	Internetworking Technologies	PE	3	0	0	3	40	60	100
20	PCOE020	High Speed Switching Architectures	PE	3	0	0	3	40	60	100
21	PCOE021	Advanced Microwave Communication Techniques	PE	3	0	0	3	40	60	100
22	PCOE022	Advanced Wireless Communication Techniques	PE	3	0	0	3	40	60	100
23	PCOE023	Advanced Electromagnetic Engineering	PE	3	0	0	3	40	60	100
24	PCOE024	Cloud Computing	PE	3	0	0	3	40	60	100
25	PCOE025	Adhoc Wireless Networks	PE	3	0	0	3	40	60	100
26	PCOE026	Radar Engineering	PE	3	0	0	3	40	60	100
27	PCOE027	High Performance Networks	PE	3	0	0	3	40	60	100
28	PCOE028	Advanced Wireless Networks	PE	3	0	0	3	40	60	100
29	PCOE029	Optical Switching and Networking	PE	3	0	0	3	40	60	100

GENERIC ELECTIVES

Sl.No	Course Code	Course Title	Category	L	T	P	C	CA	FE	Total
1	PCOG001	Network Management	GE	3	0	0	3	40	60	100
2	PCOG002	Soft Computing Techniques	GE	3	0	0	3	40	60	100
3	PMGG003	Intellectual Property Rights	GE	3	0	0	3	40	60	100

SEMESTER I

PICM004	ADVANCED APPLIED MATHEMATICS FOR COMMUNICATION ENGINEERS	L	T	P	C
		3	1	0	4

Course Objectives

- To evaluate the correlation properties of signals applied in communication systems and to formulate Stochastic Process Models in the time domain.
- To formulate the LPP and analyse the solution for optimization.
- To perceive the concept of Queuing Models and apply appropriate Queuing Model in Communication systems.

Course Content

Two Dimensional Random Variables

Joint distributions – Marginal and Conditional distributions – Functions of two dimensional random variables.

Stochastic Process

Introduction – Classification of Stochastic process – Characterizing a Random Process – Stationary Process (SSS and WSS) – Correlation Functions –Ergodic Random Process.

Application of Stochastic Process

Narrowband Process – Shot Noise Process – Representation of Band limited Processes.

Queueing Models

Steady State Analysis of M/M/1, M/M/1/k, M/M/c, M/M/c/k and M/M/∞ Models – Little's formula – Machine Interference Model.

Linear Programming

Formulation – Graphical solution – Simplex method – Two phase method - Transportation and Assignment Models

References

1. Peyton Z. Peebles, "Probability, Random Variables and Random Signal Principles", Tata McGraw-Hill Edition, 4th Edition, Reprint 2011.
2. Oliver C. Ibe, "Fundamentals of Applied Probability and Random Processes", New Age International Publishers, Academic Press, Elsevier Inc., Reprint 2013.
3. Scott L. Miller, Donald G. Childers, "Probability and Random Processes with Applications to Signal Processing and Communications", Academic Press, Elsevier Inc., Reprint 2011.
4. Donald Gross, John F. Shortle and James M. Thompson, Carl M. Harris, "Fundamentals of Queueing Theory", John Wiley and Sons, New York, 4th Edition, Reprint 2013.
5. Taha H.A. "Operations Research: An Introduction", Pearson Education, Asia, New Delhi, 9th Edition, 2012.

PCOC001	ADVANCED RADIATION SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the concepts of different antennas and antenna array.
- To study the constraints in miniaturization, efficiency, bandwidth and polarization of the antenna.
- To educate knowledge in design issues and selection of antenna and antenna array.

Course Content

Concepts of Radiation

Physical Concept of Radiation: Radiation from surface and line current distributions – radiation integrals and auxiliary potential functions – radiation pattern – near and far field regions – dipoles and monopole antennas –reciprocity – directivity and gain – effective aperture – polarization –input impedance – efficiency – Friss transmission equation.

Aperture and Reflector Antennas

Huygens's principle – radiation from rectangular and circular apertures – design considerations –radiation from sectoral, pyramidal, conical and corrugated horns antennas-Babinet principle – slot antenna – design concepts of parabolic reflectors and cassegrain antennas.

Antenna Arrays

N element linear arrays – uniform amplitude and spacing. Phased arrays. Directivity of Broadside and End fire arrays. Binomial arrays and Dolph-Tchebycheff arrays. Circular array. Antenna Synthesis – Line source and discretization of continuous sources. Schelkunoff polynomial method– Fourier transforms method.

Broadband Antennas

Principles - design and properties of frequency independent antennas: log periodic antenna, spiral antenna, biconical antenna – Yagi-Uda - loop antenna – helical antennas - broadcast antenna.

Microstrip Antennas

Radiation mechanism of Microstrip antenna – parameters and applications – feeding methods –design of rectangular and circular patch antenna – impedance matching of microstrip antennas.

References

1. Balanis C.A, "Antenna Theory", John Wiley and Sons, 4th Edition, 2016.
2. J.D. Krauss, "Antennas and Wave Propagation", John Wiley and Sons, 2010.
3. Robert S Elliot, "Antenna Theory and Design", John Wiley and Sons, 2015.
4. Jordan E.C, "Electromagnetic Waves and Radiating Systems", Prentice Hall of India, 2nd Edition, 2012.
5. Zhijun Zhang, "Antenna Design for Mobile Devices", John Wiley & Sons, 2nd Edition, 2017.

PCOC002	STATISTICAL DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	1	0	4

Course Objectives

- To understand random signal processing ,Signal Modeling and Model based Approach.
- To introduce phenomenon of power spectrum estimation, Predictors and Adaptive filters.
- To educate on multi-rate digital signal processing ,poly phase realization and Wavelets.

Course Content

Random Signal Processing and Signal Modeling

Weiner Khitchine theorem – Power spectral density – filtering of various types of random process, solving problems in Random Process, Spectral Factorization Theorem, special types of random process – Signal modeling- Least Squares method, Pade approximation, Prony's method.

Spectrum Estimators and Model based approach

Non-Parametric methods – Correlation method – Co-variance estimator – Performance analysis of estimators – Unbiased consistent estimators – Design of Periodogram estimator – Barlett spectrum estimation – Welch estimation – Model based approach - AR, MA, ARMA Signal modeling - Parameter estimation using Yule Walker method.

Estimation and Prediction

Efficiency of estimator –Wiener filter – Discrete Wiener Hoff equations – Recursive estimators – Kalman filter – Linear prediction, Prediction error –Whitening filter, Inverse filter –Design solutions for problem –Levinson recursion, Lattice realization, Levinson recursion algorithm for solving Toeplitz system of equations.

Filters based on Adaptive theory

Identify Problems – FIR Adaptive filters – Newton's steepest descent method – Adaptive filters based on steepest descent method – Widrow Hoff LMS Adaptive algorithm – Adaptive channel equalization - Adaptive echo canceller – Adaptive noise cancellation – RLS Adaptive filters – Exponentially weighted RLS –Sliding window RLS – Simplified IIR LMS Adaptive filter, Graph Signal Denoising via Trilateral Filter on Graph Spectral Domain.

Multirate Digital Signal Processing, Polyphase Realisation and Wavelet Transform

Change of sampling rate and its Mathematical description – Interpolation and Decimation – Decimation & Interpolation by an integer factor –Single and multistage realization – Poly phase realization – Subband Coding and Applications to sub band coding –Wavelet transform and filter bank implementation of wavelet expansion of signals

References

1. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons Inc., New York, 2008.

2. John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing”, Prentice Hall of India, New Delhi, 2006.
3. Simon Haykin, “Adaptive Filter Theory”, Prentice Hall, Englehood Cliffs, 2013.
4. P. P. Vaidyanathan, “Multirate Systems and Filter Banks”, Prentice Hall, 1993.
5. Mitra S.K. “Digital Signal Processing - A Computer based approach”, Tata McGraw Hill, 4th Edition ,2013.

PCOC003	ADVANCED DIGITAL COMMUNICATION	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the concept of analog and digital communication techniques.
- To know the concept of Equalizers and Block code digital communication.
- To understand the principles of Orthogonal Frequency Division Multiplexing.

Course Content

Coherent and Non-Coherent Communication

Coherent receivers – Optimum receivers in WGN – IQ modulation & demodulation – Non - coherent receivers in random phase channels, MFSK receivers – Rayleigh and Rician channels – Partially coherent receivers – DPSK, M-PSK, M-DPSK – BER Performance Analysis, Carrier Synchronization – Bit synchronization.

Equalization Techniques

Band Limited Channels – ISI – Nyquist Criterion – Controlled ISI – Partial Response signals – Equalization algorithms – Viterbi Algorithm – Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms.

Block Coded Digital Communication

Architecture and performance – Binary block codes, Orthogonal, Biorthogonal, Transorthogonal – Shannon's channel coding theorem, Channel capacity, Matched filter, Model of Spread Spectrum Digital Communication System, Direct Sequence Spread Spectrum Signals, Frequency-Hopped Spread Spectrum Signals – Coded BPSK and DPSK demodulators – Linear block codes, Hamming, Golay, Cyclic, BCH, Reed – Solomon codes – Space time block codes.

Convolutional Coded Digital Communication

Representation of codes using Polynomial, State diagram, Tree diagram and Trellis diagram – Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding.

Multicarrier Systems

OFDM- Generation of sub-carriers using the IFFT; Guard Time and Cyclic Extension; Windowing; Peak to Average Power reduction schemes; Multicarrier CDMA- System design, Performance parameters.

References

1. M. K. Simon, S. M. Hinedi and W. C. Lindsey, "Digital communication techniques; Signaling and detection", Prentice Hall India, New Delhi, 1995.
2. Bernard Sklar, "Digital Communication Fundamentals and Applications", 2nd Edition, Pearson Education, 2011.

3. John G. Proakis and Masoud Salehi, “Digital Communication”, McGraw- Hill, International Edition 2008.
4. Stephen G. Wilson “Digital Modulation and Coding”, 1st Indian Reprint, Pearson Education, 2003.
5. Richard Van Nee & Ramjee Prasad, “OFDM for Multimedia Communications”, Artech House Publication, 2001.

PCOC004	WIRELESS COMMUNICATION ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives

- To learn the concepts of wireless communication.
- To understand the various propagation methods, Channel models and capacity calculations.
- To analyze various multiple antennas and multiple user techniques used in the mobile communication.

Course Content

Wireless Channel Propagation and Model

Propagation of EM signals in wireless channel – Reflection, diffraction and Scattering-free space, two ray. Small scale fading- channel classification- channel models – COST -231 Hata model, Longley-Rice Model, NLOS Multipath Fading Models: Rayleigh, Rician, Nakagami, Composite Fading –shadowing Distributions, Link power budget Analysis.

Capacity of Wireless Channels

Capacity in AWGN, capacity of flat fading channel, capacity of frequency selective fading channels.

Diversity

Realization of independent fading paths, Receiver Diversity: selection combining, Threshold Combining, Maximum-ratio Combining, Equal gain Combining. Transmitter Diversity: Channel known at transmitter, channel unknown at the transmitter.

MIMO Communications

Narrowband MIMO model, Parallel decomposition of the MIMO channel, MIMO channel capacity, MIMO Diversity Gain: Beam forming, Diversity-Multiplexing trade-offs, Space time Modulation and coding : STBC,STTC, Spatial Multiplexing and BLAST Architectures.

Multi User Systems

Review of Multiple Access Techniques, Scheduling, power control, Uplink and Downlink channel capacity, multiuser diversity, MIMO-MU systems.

References

1. Andrea Goldsmith, “Wireless Communications”, Cambridge University Press, 2007.
2. Harry R. Anderson, “Fixed Broadband Wireless System Design”, John Wiley, India, 2003.
3. Andreas. F. Molisch, “Wireless Communications”, John Wiley – India, 2006.
4. Rappaport. T.S., “Wireless communications”, Pearson Education, 2003.
5. Upena Dalal, “Wireless Communication”, Oxford Higher Education 2009.

PCOC005	COMMUNICATION SYSTEMS LABORATORY	L	T	P	C
		0	0	2	2

Course Objectives

- To understand the basic principles of operation of optical and microwave system components and analyze the methods to evaluate the performance characteristics of various components.
- To learn the different high frequency system and communication network design tools.
- To design and conduct experiments, as well as to analyze and interpret data to produce meaningful conclusions and match with theoretical concepts.
- To know the performance parameters for the components and the overall system.

Course Content

Hardware Experiments:

1. Antenna Radiation Pattern measurement
2. Microwave measurements
3. Measurement of transmission line parameters using Network Analyzer.
4. S-parameter estimation of Microwave devices using Network Analyzer.
5. Design and testing of a Microstrip coupler using Network Analyzer.
6. Study of Characteristics of GPS.

Software Experiments:

1. Channel equalizer design (LMS, RLS) using appropriate simulation tools.
2. Performance Evaluation of digital modulation schemes using appropriate simulation tools.
3. OFDM transceiver design using appropriate simulation tools.
4. Simulation of Microstrip Antennas using appropriate simulation tools.
5. Performance evaluation of simulated CDMA System using appropriate simulation tools.

SEMESTER II

PCOC006	ADVANCED FIBER OPTIC TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the basic principles of operation of optical system components.
- To know the architecture of optical networks and issues associated with network design.
- To understand the concepts in design of optical TDM and CDM systems.

Course Content

Optical System Components and Network Design

Optical system components – MZIM – multiplexers – filters – switches – wavelength converters – optical amplifiers – EDFA – Raman amplifiers – transmission system engineering – system model – aimer penalty – transmitter – receiver – cross talk – dispersion compensation – wavelength stabilization – FWM.

Coherent Systems

Basic principles of coherent detections – practical constraints – injection laser line width – state of polarization – local oscillator power – fiber limitations – modulation formats – ASK – FSK – PSK – DPSK – Polarization Shift Keying (POL SK) – demodulation schemes – homodyne – heterodyne – synchronous and non-synchronous detection, comparison – carrier recovery in coherent detection.

Optical Network Architectures

Introduction – first generation optical networks – SONET / SDH network – second generation (WDM) optical networks – broad cast and select networks – wavelength routing architectures – media access control protocols.

Optical TDM and Soliton

Optical time division multiplexing – interleaving – packet interleaving – multiplexer and demultiplexers – AND Gates – non-linear optical loop mirror – soliton – soliton trapping AND Gate - synchronization.

Optical CDMA

Prime codes and its properties – generalized and extended prime codes – experimental demonstration of optical CDMA – synchronization of optical CDMA Networks – multiwavelength optical CDMA Networks – enhancing optical CDMA confidentiality with multicode-keying encryption.

References

1. Max Ming-Kang Liu, “Principles and Applications of Optical Communication”, Tata McGraw Hill Education Pvt., Ltd., New Delhi, 2010.
2. Le Nguyen Binh, “Digital Optical Communications”, CRC Press – Taylor and Francis Group, Indian Reprint 2012.

3. Rajiv Ramaswami and Kumar N. Sivarajan, “Optical Networks: A Practical Perspective”, Morgan Kaufmann, 3rd Edition, 2010.
4. Wing C. Kwong and Guu-Chang Yang, “Optical Coding Theory with Prime”, CRC Press, May 2, 2013.
5. G.Keiser, “Optical fiber communication”, Fifth Edition, McGraw-Hill, New York, 2013.

PCOC007	MULTIMEDIA COMPRESSION TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives

- To analyze the key aspects of data compression and VoIP networks.
- To study the features of Text, Audio, Image and Video compression standards and use these standards in various applications.
- To impart the knowledge on Architecture and Protocols of VoIP Technology.

Course Content

Introduction and Text Compression

Special features of Multimedia – Graphics and Image Data Representations - Fundamental Concepts in Video and Digital Audio – Storage requirements for multimedia applications – Need for Compression -Taxonomy of compression techniques - Static Huffman coding – Dynamic Huffman coding - Lempel-Ziv coding - Lempel-Ziv Welsh coding.

Audio Compression

Audio compression techniques – Frequency domain and filtering – Basic sub band coding – Application to speech coding – G.722 - Application of audio coding: MPEG audio – Speech compression techniques – Linear predictive coder.

Image Compression

Approaches to image compression – Graphics interchange format, Tagged image file format, Digitized documents - Digitized pictures – JPEG – Wavelet methods – Filter banks – EZW coding – SPIHT coding – JPEG 2000 standards – Lossy predictive image compression

Video Compression

Video signal representation – Video compression techniques – MPEG 1, 2, 4 – Motion estimation – H.261, H.263 – Overview of wavelet based compression – PLV performance Real time compression.

VOIP Technology

Basics of IP transport, VoIP challenges, H.323/ SIP Network Architecture, Protocols, Call establishment and release, VoIP and SS7, Quality of Service – CODEC Methods- VOIP applicability.

References

1. Fred Halsall, James F. Kurose, “Multimedia communication-Applications, Networks, Protocols and standards”, Pearson Education Limited, 2011.
2. Sayood Khaleed, “Introduction to Data Compression”, Morgan Kauffman, 4th Edition, 2012.
3. Tay Vaughan, “Multimedia: making it work”, 9th Edition, TMH 2014.
4. Marcus Goncalves, “Voice over IP Networks”, Mc Graw Hill, 2011.
5. David Solomon, “Data Compression the complete reference”, Springer, 4th Edition, 2011.

PCOC008	MICROWAVE INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3

Course Objectives

- To study the different technologies of microwave integrated circuits and analyze the micro strip line.
- To design and analyze the non-reciprocal components, active devices, High Power and Low Power Circuits.
- To design microwave amplifiers and oscillator for wireless system.
- To impart practical knowledge by conducting experiments incorporating the concepts learnt.

Course Content

Technology of Hybrid MICs & Monolithic MICs

Hybrid MICs: Dielectric substrates – thick film technology and materials – thin film technology and materials – methods of testing – encapsulation of devices for MICs – mounting of active devices. MMICs: Processes involved in fabrication – epitaxial growth of semiconductor layer – growth of dielectric layer – diffusion-ion implantation – electron beam technology.

Microstrip Transmission Lines

Strip lines- formulas for propagation constant, characteristic impedance and attenuation, an approximate electrostatic solution, Slot Lines, and Coplanar waveguides – Static TEM parameters and design of microstrips – High frequency dispersion effects in microstrips.

Lumped Elements and Non-Reciprocal Components

Design and fabrication using microstrips – flat resistors – flat inductors – interdigital capacitors – sandwich capacitors – ferromagnetic substrates for non-reciprocal devices – microstrip circulators –latching circulators – isolators – phase shifters.

Coplanar MICs

Coplanar waveguides- transmission properties, discontinuities - Introduction to Coplanar MICs, Coplanar transistors and coplanar switches-coplanar microwave active filters - coplanar microwave active amplifiers - Coplanar Electronic circulators and coplanar frequency doublers.

Microwave Circuit Design

Microwave amplifier Design – Two port power gain, stability single stage transistor amplifier design, low noise amplifier design. Microwave Oscillator Design - negative resistance oscillator, transistor oscillators design, dielectric resonator oscillator design, oscillator phase noise, microwave mixer - single ended diode mixer, FET mixer, balanced mixer, image reject mixer, double balanced mixer.

References

1. David. M. Pozar, “Microwave Engineering”, Fourth Edition, John Wiley and Sons, 2013.
2. Reinmut K. Hoffmann, “Handbook of Microwave Integrated Circuits”, Artech House, 1987.
3. Ingo Wolff, “Coplanar Microwave Integrated Circuits”, John Wiley and Sons, 2006.
4. K. C. Gupta and Amarjit Singh, “Microwave Integrated Circuits”, John Wiley and Sons – Wiley Eastern Reprint, 2004.
5. Reinhold Ludwig and Gene Bogdanov, “RF Circuit Design: Theory and Applications”, Pearson Education Inc., 2011.

PCOC009	COGNITIVE RADIO TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives

- To acquire knowledge on Software defined radio, Cognitive radio technology, Cognitive radio technical challenges and Spectrum sensing.
- To learn the performance of cognitive radio systems.
- To impart the knowledge of the evolved solutions in wireless network design.

Course Content

Software Defined Radio

Basic SDR – Software and Hardware Architecture of an SDR – Spectrum Management – Managing unlicensed spectrum – Noise Aggregation.

SDR as Platform for Cognitive Radio

Introduction – Hardware and Software architecture – SDR development process and Design – Application software – Component development – Waveform development – cognitive waveform development.

Cognitive Radio Technology

Introduction – Radio flexibility and capability – Aware Radios – Adaptive Radios – Cognitive Radios – Comparison of Radio capabilities and Properties – Available Technologies for CR: Geolocation, Spectrum Awareness / Frequency Occupancy, Creating Spectrum Awareness, Spatial Awareness and Situational Awareness, Software Technology.

CR– Technical Challenges

Design Challenges associated with CR – Hardware requirements – Hidden primary user problem – detecting spread spectrum primary users – sensing duration and frequency – security.

Spectrum sensing and identification

Introduction – Primary Signal Detection – Energy detector, Cyclo stationary Feature detector, Matched filter, Cooperative sensing and other sensing methods – From detecting primary signals to detecting Spectrum opportunities: Definition and implications of spectrum opportunity, Spectrum opportunity detection – fundamental Trade-offs: Sensing Accuracy versus Sensing Overhead.

References

1. Bruce A Fette, “Cognitive Radio Technology”, Academic Press, 2009.
2. Alexander M Wyglinski, Maziar Nekovee, Thomas Hou, “Cognitive Radio Communication and Networks Principles and Practice”, Academic Press Publications, Elsiever, USA, 2010.
3. Huseyin Arslan, “Cognitive Radio, Software Defined Radio and Adaptive wireless system, Springer, 1st Edition , 2011.
4. Mitola, J. and J. Maguire, G. Q., “Cognitive radio: Making Software Radios More Personal,” IEEE Personal Communication Magazine, vol. 6, no. 4, pp. 13–18, Aug. 2010.

5. Tevfik Y¨ucek and H¨useyin Arslan, “A Survey of Spectrum Sensing Algorithms for Cognitive Radio Applications” , IEEE Communications Surveys & Tutorials, Vol. 11, No.1, First Quarter 2009, pp. no.: 116–130.

PROFESSIONAL ELECTIVES

PCOE001	MICRO ELECTRO MECHANICAL SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives

- To familiarize with the basic principles of sensors and actuators, materials and fabrication aspects of MEMS and Microsystems.
- To acquaint with the mechanical and the electrostatic design and the associated system issues.
- To introduce the concepts of different MEMS applications, the design basics, the design tools and the performance issues.

Course Content

Introduction to MEMS

MEMS and Microsystems, Miniaturization, Typical products, Micro sensors, Micro actuation, MEMS with micro actuators, Microaccelorometers and Micro fluidics, MEMS materials

Mechanics for MEMS Design

Elasticity, Stress, strain and material properties, Bending of thin plates, Spring configurations, torsional deflection, Mechanical vibration, Resonance, Thermo mechanics – actuators, force and response time, Fracture and thin film mechanics.

Electro Static Design and System Issues

Electrostatics: basic theory, electrostatic instability. Surface tension, gap and finger pull up, Electro static actuators, Comb generators, gap closers, rotary motors, inch worms, Electromagnetic actuators. bistable actuators. Electronic Interfaces, Feedback systems, Noise , Circuit and system issues.

MEMS Fabrication Technologies

Microsystem fabrication processes: Photolithography, Ion Implantation, Diffusion, and Oxidation. Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching, electrochemical etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect-Ratio (LIGA and LIGA-like) Technology; Packaging: Microsystems packaging, Essential packaging technologies, Selection of packaging materials.

MEMS Application

Case studies – Capacitive accelerometer, Piezo electric pressure sensor, Microfluidics application, Modeling of MEMS systems, CAD for MEMS.

References

1. Stephen Santeria, “Microsystems Design”, Kluwer publishers, 2000.
2. N.P.Mahalik, “MEMS”, Tata McGraw hill, 2007.
3. Nadim Maluf, “An introduction to Micro Electro Mechanical System Design, Artech House, 2000.
4. Mohamed Gad-el-Hak, editor, “The MEMS Handbook”, CRC Press Baco Raton, 2000.
5. Tai Ran Hsu, “MEMS & Micro systems Design and Manufacture”, Tata McGraw Hill, New Delhi, 2002. Liu, MEMS, Pearson education, 2007.

PCOE002	RESEARCH METHODOLOGY	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the basic framework of research process.
- To identify the sources of information for literature review and data collection.
- To understand the ethical dimensions of conducting applied research and the value of components of scholarly writing and evaluate its quality.

Course Content

Introduction to Research

The hallmarks of scientific research – Building blocks of science in research- Concept of Applied and Basic research – Quantitative and Qualitative Research Techniques –Need for theoretical frame work – Hypothesis development – Hypothesis testing with quantitative data. Research design – Purpose of the study: Exploratory, Descriptive, Hypothesis Testing.

Experimental Design

Laboratory and the Field Experiment – Ethics - Internal and External Validity – Factors affecting Internal validity. Measurement of variables – Scales and measurements of variables. Developing scales – Rating scale and attitudinal scales – Validity testing of scales –Reliability concept in scales being developed –Stability Measures.

Data Collection Methods

Interviewing, Questionnaires, etc., Secondary sources of data collection. Guidelines for Questionnaire Design –Electronic Questionnaire Design and Surveys. Special Data Sources: Focus Groups, Static and Dynamic panels. Review of Advantages and Disadvantages of various Data-Collection Methods and their utility. Sampling Techniques –Probabilistic and non- probabilistic samples. Issues of Precision and Confidence in determining Sample Size. Hypothesis testing, Determination of Optimal sample size.

Multivariate Statistical Techniques

Data Analysis–Factor Analysis – Cluster Analysis – Discriminant Analysis – Multiple Regression and Correlation – Canonical Correlation – Application of Statistical (SPSS) Software Package in Research.

Research Report

Purpose of the written report – Ethics - Concept of audience – Basics of written reports. Integral parts of a report – Title of a report, Table of contents, Abstract, Synopsis, Introduction, Body of a report – Experimental, Results and Discussion – Recommendations and Implementation section – Conclusions and Scope for future work.

References

1. Donald R. Cooper and Ramela S. Schindler, “Business Research Methods”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2000.
2. Uma Sekaran, “Research Methods for Business”, John Wiley and Sons Inc., New York, 2000.
3. C.R.Kothari, “Research Methodology”, Wishva Prakashan, New Delhi, 2001.
4. Donald H.McBurney, “Research Methods”, Thomson Asia Pvt. Ltd. Singapore, 2002.
5. G.W.Ticehurst and A.J.Veal, Business Research Methods, Longman, 1999.

PCOE003	IMAGE AND VIDEO PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the fundamentals of image and video techniques
- To be familiar with different techniques in imaging
- To educate the concepts of video processing and coding techniques.

Course Content

Fundamentals of Image and Video

Light and Spectra, Human Vision, Image Formation, Camera Systems, Block diagram of Digital Image Processing, Image Data Types and Image Formats, Chromaticity Diagram, Color Models in Images, Color Models in Video, Types of Video Signals, Video Standards, Analysis of Coding Techniques for Images and Videos, Huffman Coding, Arithmetic Coding and Dictionary Techniques.

Image Analysis and Computer Vision

Image analysis techniques for complex images, Spatial feature extraction, Amplitude and Histogram features, Transform features, Edge detection, Gradient operators, Boundary extraction, Edge linking, Boundary representation, Boundary matching, Shape representation, Typical computer vision system.

Video Processing

Fundamental Concepts in Video, Types of video signals, Analog video, Digital video, Color models in video, Video Compression Techniques, Motion compensation, Fast Motion Estimation for MPEG -4, Analysis of PSNR/bit rate and Complexity Search for motion vectors, H.261, H.263, MPEG I, MPEG 2, MPEG 4, MPEG 7 and beyond, Content based video indexing.

Spatio- Temporal Video Sampling and Two-dimensional Motion Estimation

Digital Video Concepts, Sampling Structures for Digital Video, Two- Dimensional Rectangular Sampling, Two- Dimensional Periodic Sampling, Sampling on 3-D Structures, Reconstruction from Samples, Sampling Structure Conversion, Two-dimensional Motion Estimation, Interframe filtering, Optical Flow Methods, Block-based Methods, Pixel-based Methods, Analysis of Bayesian and Mesh Based Methods.

Video coding techniques

Temporal redundancy, Spatial redundancy, Block-based motion estimation and compensation, Analysis of Coding techniques, Model-based coding, Motion-compensated waveform coding, Codec examples, Case study of 3 D imaging.

References

1. Wang Y, Ostermann J and Zhang Y.Q, “Digital video processing and communications”, Prentice-Hall, 2015.

2. Richardson I.E.G, “H.264 and MPEG-4 video compression”, Hoboken, NJ: Wiley, 2010.
3. Khalid Sayood, “Introduction to Data Compression”, Morgan Kaufmann Publishers, 3rd Edition, Reprint 2015.
4. Tinku Acharya, Ping-Sing Tsai, “JPEG 2000 Standard for Image Compression: Concepts, Algorithms and VLSI Architectures, John Wiley Publishers, 2011.
5. A.Murat Tekalp, “Digital Video Processing”, Pearson Education, Noida, 2015.

PCOE004	TELECOMMUNICATION SWITCHING SYSTEMS AND NETWORKS	L	T	P	C
		3	0	0	3

Course Objectives

- To introduce the concepts of multiplexing and SONET.
- To understand the concepts of space switching, time switching and combination switching.
- To review statistical modeling of telephone traffic and blocking system characteristics.

Course Content

Multiplexing

Transmission Systems, FDM Multiplexing and modulation, 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-Switched Ring, Bidirectional Line-Switched Ring.

Digital Switching

Electronic Space Division Switching: Stored Program Control (SPC), Centralised SPC, Distributed SPC, Enhanced Services, Two-Stage Networks, Three-Stage Networks

Time Division Switching: Principle of Time Division Space Switching, Time Multiplexed Space Switching, Time Multiplexed Time Switching, Introduction to Combination Switching.

Traffic Engineering

Network Traffic Load and Parameters, Grade of Service and Blocking Probability, Modelling Switching systems, incoming traffic and service characterization, blocking models and loss estimates, delay systems-Erlang B formula, Delay Systems.

Integrated Services Digital Networks

ISDN and its Motivation, New Services, Network and Protocol Architecture, Transmission Channels, Internetworking, BISDN- Telephone Networks: Network Subscriber Loop Systems, Switching Hierarchy & Routing, Transmission Plan, Numbering Plan, National and International numbering schemes.

Network Management

Introduction to network management, SNMPv1, SNMPv2, SNMPv3 Network monitoring tools and systems, Network monitoring applications- Remote Monitoring (RMON), ATM network management, web-based management.

References

1. Viswanathan.T. “Telecommunication Switching System and Networks”, Prentice Hall of India Ltd., 2015.
2. Flood J.E., “Telecommunications switching traffic and networks”, Pearson education Ltd, 2011.
3. William Stallings “Data & Computer Communications by”, 10th Edition 2014, PHI.
4. John.C. Bellamy, ‘Digital Telephony’, John Wiley & Sons, 3rd Edition, 2009.
5. Theodore S Rappaport, “Wireless Communication Principles and Practice”, Second Edition, Pearson Education, 2010.

PCOE005	WIRELESS SENSOR NETWORKS	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the fundamentals of wireless sensor networks and its application to critical real time scenarios.
- To study the various protocols at various layers and its differences with traditional protocols.
- To understand the issues pertaining to sensor networks and the challenges involved in managing a sensor network.

Course Content

Architecture of Wireless Sensor Network

Challenges for Wireless Sensor Networks, Characteristics requirements, Taxonomy of WSN- Difference between Mobile Adhoc and Sensor Networks, Applications of sensor networks- Sensor Node Architecture, Hardware Components, Energy Consumption of Sensor Nodes, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts, Physical Layer and Transceiver Design Considerations.

Infrastructure Establishment

Topology Control, Clustering- types, high-level overview, clustering in WSNs, Time Synchronization, Sensor Tasking and Control.(Stanford University)(University of Rochester) Maryland Baltimore.

WSN Routing, Localization & QoS

Issues in WSN routing, OLSR- Localization, Indoor and Sensor Network Localization-absolute and relative localization, triangulation, Localization and Positioning, QoS in WSN-Energy Efficient Design-Synchronization, Transport Layer issues.

Network Protocols

Issues in Designing MAC Protocol for WSNs, Classification of MAC Protocols, S-MAC Protocol, B-MAC Protocol, IEEE 802.15.4 Standard and Zig Bee, Dissemination Protocol for Large Sensor Network.

Sensor Network Platforms and Tools

Operating Systems for Wireless Sensor Networks, Sensor Node Hardware –Berkeley Motes, Programming Challenges, Node-level software platforms, Node level Simulators, State-centric programming. Intrusion Detection in Wireless Sensor Networks.

References

1. Ian F. Akyildiz, Mehmet Can Vuran, " Wireless Sensor Networks" John Wiley, 2010.
2. Fei Hu and Xiaojun Cao, "Wireless Sensor Networks Principles and Practice", CRC Press, 2010.
3. Kazem, Sohraby, Daniel Minoli, TaiebZanti, "Wireless Sensor Network: Technology, Protocols and Application", John Wiley and Sons, 2010.
4. Bhaskar Krishnamachari, "Networking Wireless Sensors", Cambridge Press, 2010.
5. Dr. Harsh K. Verma, "Wireless Sensor Networks", S.K. Kataria & Sons, 2014.

PCOE006	GLOBAL SATELLITE COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the basics of satellite orbits and subsystems.
- To analyze the various methods of satellite access ,modulation and multiplexing.
- To be familiar with the error control techniques and know the applications of satellite communication.

Course Content

Satellite Orbits

Introduction: Overview of Satellite Communications, GEO, MEO and LEO satellite systems, frequency bands Orbital Mechanics: Orbit Equations, Locating the satellite, Orbital elements, Look Angles, Orbital perturbation, Effects of earth's oblate ness ,moon and sun, Satellite eclipse, sun transit outage, Coverage angle, slant range, satellite launching Keller's Laws, Newton's law, orbital parameters, orbital perturbations, station keeping, geo stationary and non-Geo– stationary orbits.

Satellite Subsystems

Attitude and Orbit Control System(AOCS), Telemetry, Tracking and Command System(TT&C), Power System, Satellite antennas, Communications subsystem, transponders Satellite Link Design: Basic transmission theory , System noise temperature and G/T ratio, CNR, CIR, ACI, IMI, Down link design, Up link design, System design examples.

Modulation and Multiplexing

FM with multiplexed telephone signals, Analog FM SCPC, PSK, QPSK, Multiple Access Schemes: FDM/FM/FDMA, TDMA, Frame structure, frame acquisition, synchronization, TDMA in VSAT network, On-board processing, CDMA, Spread spectrum transmission and reception, DS-SS CDMA capacity.

Error Control for Digital Satellite Links

Error control coding, Block codes, Convolution codes– Implementation of error detection on satellite links VSAT Systems: Overview of VSAT systems, Network architectures, Access control, Multiple access selection LEO Satellite systems: Orbits, Coverage and frequency bands, off axis scanning, delay and throughput, NGSO constellation design.

Satellite Applications

INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, INMARSAT, LEO, MEO, Satellite Navigational System – Direct Broadcast satellites (DBS) – Direct to home Broadcast (DTH) – Digital audio broadcast (DAB) – World space services, Business TV(BTV), GRAMSAT, Specialized services – E–mail, Video conferencing, Internet –An adaptive Gaussian model for satellite image deblurring .

References

1. Timothy Pratt, Charles Bostian Jermey Allnutt, “Satellite Communications”, John Wiley, 2nd Edition, reprint 2013.
2. M. Richharaia, “Satellite Communication Systems”, BS Publishers, 2nd Edition, 2010.
3. Dennis Roddy, “Satellite Communication”, McGraw Hill International, 4th Edition, 2012.
4. Tri.T. Ha, “Digital Satellite Communications”, McGraw-Hill, 2nd Edition, 2010.
5. Wilbur L.Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, “Satellite Communication Systems Engineering”, Prentice Hall, 2011.

PCOE007	NETWORK SECURITY	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the importance and goals of communication network and network security and introduce different types of attacks.
- To understand the concepts of conventional encryption, public key encryption and number theory.
- To know the practical aspects of security features design and their implementation in wireless internetworking domain.

Course Content

Introduction on Security

Security Goals – Types of attacks: Passive attack, Active attack, Attacks on confidentiality, Attacks on integrity and availability – Security services and mechanisms – Cryptography – Steganography – Revision on mathematics for cryptography.

Symmetric & Asymmetric Key Algorithms

Substitution ciphers – Transposition ciphers – Stream and block ciphers – Data Encryption Standards (DES) – Advanced Encryption Standard (AES) – RC4 – Principle of asymmetric key algorithms – RSA cryptosystem.

Public Key Encryption, Hashing and Key Management

Principles of public key cryptosystems – Diffie-Hellman Key Exchange – Elliptic curve cryptology – Message and Entity authentication – Hash functions – Hash and Mac algorithms – Key management techniques –Digital signatures.

Network Security, Firewalls and IP Security

Introduction on firewalls – Types of firewalls – Firewall configuration and limitation of firewall – IP security overview – IP security architecture – Authentication header – Security payload – Security associations.

Web Security

Web security requirement – Secure sockets layer – Transport layer security – Secure electronic transaction – Dual signature – Security attack issues specific to wireless systems – Worm hole – Tunneling – DoS – WEP for Wi-Fi network – Security for 4G networks – Secure ad hoc Network – Secure sensor network.

References

1. W. Stallings, “Cryptography and Network Security: Principles and Practice”, 5th Edition, Prentice Hall, 2013.
2. William Stallings, “Network Security Essentials: Applications and Standards”, Pearson Education, 4th Edition 2010.
3. Behrouz A. Forouzan and Debdeep Mukhopadhyay, “Cryptography and Network Security”, 2nd Edition, Tata McGraw - Hill, 2011.
4. AtulKahate, “Cryptography and Network security”, 3rd Edition, Tata McGraw- Hill, 2013.
5. Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, “Computer Networks: An Open Source Approach”, McGraw Hill Publisher, 2011.

PCOE008	MULTIRATE SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives

- To provide rigorous foundations in multirate signal processing and filters.
- To introduce the concepts of fundamentals of multirate theory and various filter banks.
- To understand the concept of Filter in signal processing.

Course Content

Fundamentals of Multirate Theory

The Sampling theorem–Sampling at Sub-Nyquist rate – Basic Formulations and schemes – Basic Multirate operations–Decimation and Interpolation.

Maximally Decimated Filter Banks

Digital Filter Banks- DFT Filter Bank- Identities–Polyphase representation-Maximally decimated filter banks–Polyphase representation – Errors in the Quadrature Mirror Filter bank–Perfect reconstruction (PR) –QMF Bank – Design of an alias frees QMF Bank.

M-Channel Perfect Reconstruction Filter Banks

Uniform band and non-uniform filter bank – tree structured filter bank- Errors created by filter bank system–Polyphase representation–perfect reconstruction systems.

Perfect Reconstruction Filter Banks

Paraunitary PR Filter Banks–Filter Bank Properties induced by paraunitarity–Two channel FIR paraunitary QMF Bank–Linear phase PR Filter banks- Necessary conditions for Linear phase property–Quantization Effects–Types of quantization effects in filter banks–Coefficient sensitivity effects–dynamic range and scaling.

Cosine Modulated filter banks

Cosine Modulated pseudo QMF Bank–Alas cancellation–phase –Phase distortion–Closed form expression-Polyphase structure–PR Systems.

References

1. P.P. Vaidyanathan. “Multirate systems and filter banks”, Prentice Hall. PTR. Reprint, 2011.
2. Sanjit K. Mitra, “Digital Signal Processing: A computer based approach”, McGraw Hill, 4th Edition, 2011.
3. R. E. Crochiere. L. R, “Multirate Digital Signal Processing”, Prentice Hall. Inc. Reprint, 2011.
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5. N.J. Fliege, “Multirate digital signal processing”, John Wiley, Reprint, 2011.

PCOE009	SMART ANTENNAS	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the concept of smart antenna systems for different environment.
- To impart knowledge in beam forming technology and signal processing algorithms for smart antenna systems.
- To analyze signal processing algorithms for different smart antenna systems.

Course Content

Introduction to Smart Antennas

Need for Smart Antennas – printed antenna, multiband and UWB antennas, smart Antenna Configurations – beam steering, degree of freedom – optimal antenna – switched-beam antennas, adaptive Antenna Approach – SDMA – Architecture of a Smart Antenna System.

Beamforming Fundamentals

Classical beamformer and statistically optimum beamforming weight vectors – maximum SNR beamformer – multiple sidelobe canceller – SINR Beamformer – MMSE – DMI – Linearly Constrained Minimum Variance, – adaptive algorithms for beamforming, Least Mean-Square algorithm, Recursive Least-Squares Algorithm.

Space Time Processing

Discrete space time Channel and signal models – ISI Suppression, CCI Suppression, joint ISI and CCI Suppression – space time processing for DS-CDMA – capacity and data rates in MIMO systems – single user data rate limits – multiple-users data rate limits.

DOA Estimation Fundamentals

Array response vector – subspace-Based Data Model – signal autocovariance matrices – conventional DOA estimation methods – conventional beamforming method – Capon's minimum variance method, subspace approach to DOA estimation – ESPRIT Algorithm – Uniqueness of DOA Estimates.

Mobile Stations Smart Antennas

Multiple antenna, combining techniques, diversity – maximal ratio combining – Adaptive beamforming or Optimum Combining – RAKE receiver size – mutual coupling effects – dual antenna performance improvements – downlink capacity gains.

References

1. Constantine A. Balanis, Panayiotis I. Ioannides, "Introduction to Smart Antennas" Morgan & Claypool Publishers, 2007.
2. Ahmed El Zooghby, "Smart Antenna Engineering", Artech House, 2005.
3. R.Janaswamy, "Radio Wave Propagation and Smart Antennas for Wireless Communication", Kluwer, 2014.
4. Lal Chand Godara, "Smart Antennas", CRC Press. London, 2016.
5. T.S.Rappaport & J.C.Liberti, "Smart Antennas for Wireless Communication", Prentice Hall. (PTR), 1999.

PCOE010	COMMUNICATION NETWORK DESIGN	L	T	P	C
		3	0	0	3

Course Objectives

- To expose the functional elements and evolution of networking, the multiplexing, switching and routing related issues and some case studies of wired and wireless network design process.
- To analyze the various aspects of a protocol and implement it using a network simulation tool.
- To solve communication network design problem for a specific application.

Course Content

Introduction

Importance of Quantitative Modeling in Engineering of Telecommunication Networks, The Functional Elements of Networking, Evolution of Networking in the Wired and Wireless Domain.

Multiplexing

Performance Measures and Engineering Issues Network performance and source characterization, Circuit multiplexed Networks, packet Multiplexing over wireless networks, Events and processes in packet multiplexer models, Deterministic traffic Models and network calculus, stochastic traffic models, LRD traffic, Link Scheduling and network capacity in wireless networks.

Switching

Performance Measures of packet switches and circuit switches, queuing in packet switches, delay analysis in Output Queued Switch, Input Queued Switch and CIOQ Switch with Parallelism, Blocking in Switching Networks, Closed Networks.

Routing

Algorithms for Shortest Path Routing - Dijkstra‘s Algorithm, Bellman Ford Algorithm, Generalized Dijkstra‘s Algorithm, Optimal Routing, Routing Protocols-Distance Vector, Link State and Exterior gateway protocols, Formulations of the Routing Problem-minimum interference Routing, MPLS, QoS Routing, Non-additive and Additive metrics.

Case Studies

Design of a wireless network and a wired network, prototype implementation to be simulated in a network simulator.

References:

1. Anurag Kumar, D. Manjunath and Joy, “Communication Networking”, Morgan Kaufan Publishers, 2005.
2. A.Lean Garica and Indra Widjaja, “Communications Networks”, Tata Mc Graw Hill, 2004.
3. Thomas G. Robertazzi, “Computer Networks and Systems”, 3rd Edition, Springer, 2006.
4. Keshav.S, “An Engineering Approach to Computer Networking”, Addison – Wesley, 1999.
5. Mischa Schwartz, “Computer-Communication Network Design and Analysis”, Prentice Hall of India, 2007.

PCOE011	GLOBAL POSITIONING SYSTEM	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the basic principles of GPS, co-ordinate system and satellite motion.
- To analyze GPS technologies and concepts to real world spatial questions.
- To understand the technical issues of GPS & Geographic Information Systems (GIS).

Course Content

GPS Fundamentals

History of GPS – BC -4 System –HIRAN –NNSS –NAVSTAR GLONASS and GNSS Systems –GPS Constellation –Space Segment –Control Segment –User Segment –Single and Dual Frequency –Point –Relative – Differential GPS –Static and Kinematic Positioning –2D and 3D –reporting Anti Spoofing (AS); Selective Availability (SA) –DOP Factors.

Co-Ordinate System and Satellite Motion

Coordinate Systems –Geo Centric Coordinate System –Conventional Terrestrial Reference System –Orbit Description –Keplerian Orbit – Kepler Elements –Satellite Visibility – Topocentric Motion –Disturbed Satellite Motion – Perturbed Motion – Disturbing Accelerations - Perturbed Orbit –Time Systems –Astronomical Time System – Atomic Time –GPS Time –Need for Coordination –Link to Earth Rotation – Time and Earth Motion Services.

Tracking Techniques

C/A code; P-code; Y- code; L1, L2 Carrier frequencies – Code Pseudo Ranges – Carrier Phases – Pseudo Ranges –Satellite Signal Signature – Navigation Messages and Formats – Undifferenced and Differenced Range Models – Delta Ranges –Signal Processing and Processing Techniques – Tracking Networks – Ephemerides – Data Combination: Narrow Lane; Wide Lane – OTF Ambiguity.

Atmospheric Effects

Propagation Media –Multipath –Antenna Phase Centre –Atmosphere in brief –Elements of Wave Propagation – Ionospheric Effects on GPS Observations –Code Delay –Phase Advances –Integer Bias –Clock Error – Cycle Slip –Noise-Bias –Blunders –Tropospheric Effects on GPS Oberservables –Multipath Effect –Antenna Phase Centre Problems and Correction.

Applications

Inter Disciplinary Applications –Crystal Dynamics – Gravity Field Mapping – Atmospheric Occulation –Surveying –Geophysics –Air borne GPS Ground Transportation – Space borne GPS – Metrological and Climate Research using GPS – Vehicle Tracking Enhancement.

References

1. B.Hoffman -Wellenhof, H.Lichtenegger and J.Collins, "GPS: Theory and Practice", 4th Revised Edition, Springer, Wein, New york, 1997.

2. A.Leick, "GPS Satellites Surveying", 2nd edition, John Wiley & Sons, NewYork, 1995.
3. B.Parkinson, J.Spilker, Jr.(Eds), "GPS: Theory and Applications", Vol.I&Vol.II, AIAA, 370 L'Enfant Promenade SW, Washington, DC 20024, 1996.
4. A.Kleusberg and P.Teunisen (Eds), “GPS for Geodesy”, Springer- Verlag, Berlin, 1996.
5. L.Adams, "The GPS -A Shared National Asset”, Chair, National Academy Press, Washington, DC, 1995.

PCOE012	DETECTION & ESTIMATION THEORY	L	T	P	C
		3	0	0	3

Course Objectives

- To acquire the fundamental concepts of signal ddetection and estimation.
- To familiarize with different Hypotheses in detection and estimation problems.
- To understand the time varying waveform detection and its estimation.

Course Content

Statistical Decision Theory

Bayesian – Minimax and Neyman – Pearson decision rules – likelihood ratio – receiver operating characteristics – composite hypothesis testing – locally optimum tests – detector comparison techniques – asymptotic relative efficiency.

Signal Detection Applications

Detection of deterministic signals – Matched filter and its performance – Detection of random signals – Energy detector and its performance – Detection of signals with unknown parameters and Sinusoid detection example – Chernoff and related performance bounds.

Random Parameter Estimation

Bayesian formulation – Minimum mean squared error and MAP estimation – Linear MMSE estimation – Orthogonality principle – Applications to channel estimation problems.

Minimum Variance Unbiased Estimation

MVUE criterion – finding MVUE – sufficient statistics – Neyman-fisher factorization – Rao-Blackwell theorem – Cramer-Rao lower bound – Fisher information matrix.

Non-Random Parameter Estimation

Least squares estimation – Best linear unbiased estimation – Geometric interpretations – Maximum likelihood Estimation – Efficiency and consistency of estimators and asymptotic properties.

References

1. H. L. Van Trees, "Detection, Estimation, and Modulation Theory, Part I," Wiley, 2nd Edition 2013.
2. H. V. Poor, "An Introduction to Signal Detection and Estimation," Springer, 2nd Edition, Reprint 2011.
3. S. M. Kay, "Fundamentals of Statistical Signal Processing: Detection Theory," Prentice Hall, 3rd Edition, 2013.
4. Thomas Schonhoff and Arthur A Giordano, “Detection and Estimation Theory", Prentice Hall, 2nd Edition 2010.
5. Nicholas T. Longford “Statistical Decision Theory”, (Springer Briefs in Statistics), Springer Ebook, 2013.

PCOE013	SPACE TIME WIRELESS COMMUNICATIONS	L	T	P	C
		3	0	0	3

Course Objectives

- To understand multipath fading channel models, channel capacity and bit error rate.
- To understand and analyze different spatial diversity techniques and channel estimation.
- To gain knowledge on OFDM and spread spectrum modulation.

Course Content

Sampled Signal and Multipath Fading Channel Models

Physical scattering models – Extended channel models – Signal model for SISO – SIMO – MISO and MIMO – ITU Channel Models – 3GPP Channel Models – Extended ITU Models – Spatial Channel Model SCM Extension Channel Model – WINNER Channel Model.

Capacity Analysis and Bit Error Rate Analysis

Capacity in Frequency Flat Fading channel – Capacity in Frequency Selective Fading Channel – BER Analysis for Space Time Coding –Transmit Beam forming – Receiver Selection Combining – Receiver Equal Combining – Receiver Maximal Ratio Combining.

Spatial Diversity at Transmitter and Receiver

Diversity gain – Transmit and receive Antenna diversity – Diversity order and performance – Combined space and path diversity – Indirect transmit diversity – space time coding for frequency flat channels – frequency selective channels – Receivers – frequency flat and selective channels in SISO, SIMO and MIMO.

Channel Estimation, Timing & Frequency Synchronization

LS Estimation – MMSE Estimation – Robust MMSE Estimation – Coarse Time Synchronization – Fine Time Synchronization – Coarse Frequency Synchronization – Fine Frequency Synchronization.

OFDM and Spread Spectrum Modulation

SISO-OFDM – MIMO OFDM – SISO SS modulation – MISO SS modulation – Model – capacity and receiver gain of MIMO MAC – MIMO BC – MIMO MU.

References

1. Paulraj A, R. Nabar and D Gore, “Introduction to Space-Time Wireless Communications”, Cambridge University Press, 2003.
2. E. Biglieri, R. Calderbank, A. Constantinides, A. Goldsmith, A. Paulraj, “MIMO Wireless Communications”, Cambridge University press, 2007
3. Erik. G. Larsson, “Space Time Block Coding for Wireless Communications”, Cambridge University Press, 2003.
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5. L. Hanzo, Y.A. Li Wang, M. Jiang “MIMO-OFDM for LTE, Wi-Fi and WiMAX”, John Wiley & Sons Ltd, 2011.

PCOE014	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	L	T	P	C
		3	0	0	3

Course Objectives

- To understand EMI/EMC concepts.
- To understand the different measurement techniques of EMI.
- To study different compatibility techniques (EMC) to reduce/suppress EMI.

Course Content

EMI Environment

EMI/ EMC concepts and definitions, Sources of EMI, conducted and radiated EMI, Transient EMI, Time domain Vs Frequency domain EMI, Units of measurement parameters, Frequency Spectrum Allocation.

EMI coupling principles and standards

Conducted, Radiated and Transient Coupling, Common Impedance Ground Coupling, Radiated Common Mode and Ground Loop Coupling, Radiated Differential Mode Coupling, Near Field Cable to Cable Coupling, Power Mains and Power Supply coupling. Units of specifications, Standards.

EMI Measurements

EMI Test Instruments/ Systems, EMI Shielded Chamber, Open Area Test Site, TEM Cell, Sensors/ Injectors/ Couplers, Test beds for ESD and EFT.

EMI Control techniques

Shielding, Filtering, Grounding, Bonding, Isolation Transformer, Transient Suppressors, Cable Routing, Signal Control, Component Selection and Mounting.

EMC design of PCBs

PCB Traces Cross Talk, Impedance Control, Power Distribution Decoupling, Zoning, Board Layout, Multilayer boards, Motherboard Designs and Propagation Delay Performance Models.

References

1. V Prasad Kodali, “Engineering Electromagnetic Compatibility”, IEEE Press, New York, 2001.
2. Clayton R. Paul, “Introduction to Electromagnetic compatibility”, John Wiley & Sons, 2nd Edition, 2012 Reprint.
3. Henry W. Ott, “Engineering Electromagnetic Compatibility”, John Wiley and Sons, New York, 2009 Reprint.
4. Dr.Kenneth L Kaiser, “The Electromagnetic Compatibility Handbook”, CRC Press 2005.
5. W Scott Bennett, “Control and Measurement of Unintentional Electromagnetic Radiation”, John Wiley & Sons Inc., (Wiley Interscience Series) 1997.

PCOE015	RF MICROELECTRONICS	L	T	P	C
		3	0	0	3

Course Objectives

- To impart knowledge on basics of IC design and wireless technology at RF frequencies.
- To provide basic skills to analyze and design of RF integrated circuits.
- To understand the architecture and circuit level issues with respect to monolithic implementation in VLSI technologies.

Introduction

Course Content

Introduction to RF and Wireless Technology: Complexity, design and applications - Choice of Technology. Basic concepts in RF Design: Nonlinearly and Time Variance - inter symbol interference - random processes and Noise - Sensitivity and dynamic range, conversion of gain and distortion.

RF Modulation

Analog and digital modulation of RF circuits - Comparison of various techniques for power efficiency - Coherent and non-coherent detection - Mobile RF communication and basics of Multiple Access techniques. Receiver and Transmitter architectures: Direct conversion and two-step transmitters.

BJT and MOSFET behavior at RF frequencies

Overview of RF Filter design and design issues in integrated RF filters - Active RF components & modeling - Matching and Biasing Networks - Basic blocks in RF systems and their VLSI implementation - Design of Mixers at GHz frequency range - various mixers- working and implementation.

RF circuits design

Noise-Power trade-off - Resonator less VCO design - Quadrature and single sideband generators - Radio Frequency Synthesizes: PLL - Various RF synthesizer architectures and frequency dividers - Linearization techniques - Design issues in integrated RF filters - CAD tools for RF
VLSI designs.

RF Testing and Measurements

Time Domain / Combining Sine Waves Measurement Setups - Power Gain / Gain Measurements - Amplifier Compression / P1dB Measurement - Common Types of Noise / Noise Figures Phase Noise - Signal Matching Distortion and Mixer Measurements- Intermodulation Distortion - Third Order Intercept Converters and Tuners Down-converting Mixer Measurements - Adjacent Channel Power Ratio (ACPR) Measuring ACPR.

References

1. B.Razavi, “RF Microelectronics”, Prentice-Hall PTR, 2011.
2. T.H.Lee, “The Design of CMOS Radio Frequency Integrated Circuits”, Cambridge University Press, 2nd Edition 2015.
3. R.Jacob Baker,H.W.Li and D.E.Boyce, “CMOS Circuit Design, Layout and Simulation”, Wiley, 3rd Edition,2010.
4. Y.P.Tsividis, “Mixed Analog and Digital VLSI Devices and Technology”, 2002 McGraw Hill.
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PCOE016	SATELLITE COMMUNICATION	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the necessity for satellite based communication system.
- To impart knowledge on different interferences and attenuation mechanisms in satellite link design.
- To know the advances in satellite based navigation, GPS and the different application scenarios.

Elements of Satellite Communication

Satellite Systems, Orbital description and Orbital mechanics of LEO, MEO and GSO, Placement of a Satellite in a GSO, Antennas and earth coverage, Altitude and eclipses, Satellite drift and station keeping, Satellite – description of different Communication subsystems, Bandwidth allocation.

Satellite Space Segment and Access

Introduction; attitude and orbit control system; telemetry, tracking and command; power systems, communication subsystems, antenna subsystem, equipment reliability and space qualification, Multiple Access: Demand assigned FDMA - spade system - TDMA - satellite switched TDMA – CDMA.

Satellite Link Design

Basic link analysis, Interference analysis, Rain induced attenuation and interference, Ionospheric characteristics, Link Design: System noise temperature and G/T ratio, Downlink and uplink design, C/N, Link Design with and without frequency reuse, Error control for digital satellite link.

Satellite Navigation and Global Positioning System

Radio and Satellite Navigation, GPS Position Location Principles of GPS Receivers and Codes, Satellite Signal Acquisition, GPS Receiver Operation and Differential GPS.

Applications

Satellite Packet Communications , Intelsat series, INSAT series, VSAT Systems: Network architectures , access control protocols, earth station engineering, antennas , link margins, system design procedure , mobile satellite services, Satellite Phones, INMARSAT, Remote Sensing, Satellite and Cable Television, DBS (DTH).

References

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2. Timothy Pratt and Charles W.Bostain, Satellite Communications, John Wiley and Sons, 2nd Edition, 2012.
3. D. Roddy, Satellite Communication, 4th Edition (Reprint), McGraw Hill, 2009.
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PCOE017	NETWORK ROUTING ALGORITHMS	L	T	P	C
		3	0	0	3

Course Objectives:

- To expose to the layered architecture for communication networks and the specific functionality of the network layer.
- To understand the basic principles of routing and the manner this is implemented in conventional networks and the evolving routing algorithms based on Internetworking requirements, optical backbone and the wireless access part of the network.
- To understand the different routing algorithms existing and their performance characteristics.

Introduction

ISO OSI Layer Architecture, TCP/IP Layer Architecture, Functions of Network layer, General Classification of routing, Routing in telephone networks, Dynamic Non - hierarchical Routing (DNHR), Trunk status map routing (TSMR), real-time network routing (RTNR), Distance vector routing, Link state routing, Hierarchical routing.

Internet Routing

Interior protocol : Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Bellman Ford Distance Vector Routing. Exterior Routing Protocols: Exterior Gateway Protocol (EGP) and Border Gateway Protocol (BGP). Multicast Routing: Pros and cons of Multicast and Multiple Unicast Routing, Distance Vector Multicast Routing Protocol (DVMRP), Multicast Open Shortest Path First (MOSPF), MBONE, Core Based Tree Routing.

Routing in Optical WDM Networks

Classification of RWA algorithms, RWA algorithms, Fairness and Admission Control, Distributed Control Protocols, Permanent Routing and Wavelength Requirements, Wavelength Rerouting- Benefits and Issues, Lightpath Migration, Rerouting Schemes, Algorithms- AG, MWPG.

Mobile - IP Networks

Macro-mobility Protocols, Micro-mobility protocol: Tunnel based : Hierarchical Mobile IP, Intra domain Mobility Management, Routing based: Cellular IP, Handoff Wireless Access Internet Infrastructure (HAWAII).

Mobile Adhoc Networks

Internet-based mobile ad-hoc networking communication strategies, Routing algorithms – Proactive routing: destination sequenced Distance Vector Routing (DSDV), Reactive routing: Dynamic Source Routing (DSR), Ad hoc On-Demand Distance Vector Routing (AODV), Hybrid Routing: Zone Based Routing (ZRP).

References

1. William Stallings, “High speed networks and Internets Performance and Quality of Service”, 2nd Edition, Pearson Education Asia. Reprint India 2002.
2. M. Steen Strub, “Routing in Communication Network”, Prentice–Hall International, Newyork,1995.

3. S. Keshav, “An engineering approach to computer networking” Addison Wesley, 1999.
4. William Stallings, “High speed Networks TCP/IP and ATM Design Principles”, Prentice-Hall, New York, 1995.
5. C. Siva Rama Murthy and Mohan Gurusamy, “WDM Optical Networks – Concepts, Design and Algorithms”, Prentice Hall of India Pvt. Ltd, New Delhi –2002.

PCOE018	ADVANCED SATELLITE BASED SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives

- To gain knowledge on satellite concepts and different navigation systems.
- To apply various remote sensing concepts for safety of life services.
- To uunderstand the usage of lasers in satellites and satellite service applications.

Course Content

Introduction to Satellite and GPS

Origin of satellite communication, Development, Space segment, Ground segment, Types of orbit, Evolution of satellite communications, Development of service Global Navigation Satellite Systems – Basic concepts of GPS and its segments, GPS constellation, GPS measurement characteristics, selective availability (AS), Anti spoofing (AS).

Inertial Navigation and Differential GPS Systems

Introduction to Inertial Navigation- Inertial Sensors - Navigation Coordinates-System Implementations- System-Level Error Models- Introduction to Differential GPS-LADGPSWADGPS-WAAS - GEO Uplink Subsystem (GUS) - GEO Uplink Subsystem (GUS) Clock Steering Algorithms - GEO Orbit Determination – Problems.

Remote Sensing Systems and Techniques

Introduction - Commercial Imaging - Digital Globe – GeoEye - Meteorology – Meteosat – Land Observation – Landsat- Remote Sensing Data- Sensors- Overview - Optical Sensors: Cameras- Non-Optical Sensors- Image Processing - Image Interpretation- System Characteristics.

Broadcast Systems

Introduction - Satellite Radio Systems - XM Satellite Radio Inc. - Sirius Satellite Radio - world space- Direct Multimedia Broadcast- MBCO and TU Multimedia - European Initiatives - Direct-to-Home Television - Implementation Issues - DTH Services-Representative DTH Systems – Military Multimedia Broadcasts - US Global Broadcast Service (GBS)- Business TV(BTV), GRAMSAT, Specialized services – E –mail, Video conferencing, Internet.

Services and Applications

Applications of Satellite and GPS for 3D position, Velocity, determination as function of time, Interdisciplinary applications. Regional navigation systems – distress and safety – Cospas-Sarsat – Inmarsat Distress System – Location-Based service. Mixed and mobile services – Multimedia satellite services – Advanced applications based on satellite platforms

References

1. Dennis Roddy, “Satellite Communication”, 4th Edition, McGraw Hill International, 2006.
2. Timothy Pratt, Charles Bostian Jermey Allnutt, “Satellite Communications”, John Wiley, Singapore, 2nd Edition, Reprint 2013.
3. Madhavendra Richharia, “Satellite Systems for Personal Applications”, A John Wiley and Sons, Ltd., Publication, 2010.

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PCOE019	INTERNETWORKING TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the fundamental concepts of internetworking.
- To solve complex problems in networking.
- To configure and verify the functions of socket in client-server application framework

Course Content

Application Development

Introduction to Socket Programming – Overview of TCP/IP Protocols –Introduction to Sockets – Iterative TCP programming – Iterative UDP programming – Concurrent programming – fork and exec - I/O multiplexing – I/O Models – select function – shutdown function – TCP echo Server (with multiplexing) – poll function – TCP echo Client (with Multiplexing) Multiplexing TCP and UDP sockets- Threaded servers – thread creation and termination – TCP echo server using threads – Mutexes – condition variables.

Elementary SCTP Sockets and Socket Options

Introduction to SCTP- Interface Modules – SCTP functions- sctp_bindx, sctp_connectx, sctp_getpaddrs, sctp_free paddrs, sctp getladdrs, sctp_freeladdrs, sctp_sendmsg, sctp_recvmsg, sctp_opt_info, sctp_peeloff, shutdown – Notifications - Socket options – getsockopt and setsockopt functions- Socket states – generic socket options – IP socket options – ICMP socket options – TCP socket options -.SCTP socket options – fcntl functions.

Raw Sockets and DNS

Ipv4 and Ipv6 interoperability - raw sockets – raw socket creation – raw socket output – raw socket input – ping program – trace route program - Domain name system – gethostbyname function – Ipv6 support in DNS – gethostbyadr function – getservbyname and getservbyport functions – Data link Access – BPF, DLPI, libpcap, libnet.

Advanced Sockets-I

Dynamically maintaining SA's – Broadcasting – Broadcast addresses – Unicast versus Broadcast – (Client) Application development for broadcasting – Race conditions – Multicasting – Multicast addresses- Multicasting versus Broadcasting on a LAN – Multicasting on a WAN – Source specific Multicast – Multicast socket options – mcast_join, (Client) Application development for multicasting .

Advanced Sockets-II

Advanced UDP sockets – Receiving flags, Destination IP address and Interface index – Datagram truncation – Using UDP instead of TCP – Adding reliability to UDP – Binding interface addresses – Concurrent UDP servers – Advanced SCTP sockets – Partial delivery - Notifications – Unordered data – Binding a subset of addresses – Determining peer and local address information.

References

1. W. Richard Stevens, “Unix Network Programming Vol-I”, 2nd Edition, Pearson Education, 1998.
2. D.E. Comer, “Internetworking with TCP/IP Vol- III”, (BSD Sockets Version), 2nd Edition, Pearson Education, 2003.
3. Michael Donahoo, Kenneth Calvert, “TCP/IP Sockets in C, A practical guide for Programmers”, 2nd Edition, Elsevier, 2009.
4. Forouzan, “ TCP/IP Protocol Suite”, 2nd Edition, Tata Mc Graw Hill, 2003.
5. Fred Halsall, Lingana Gouda Kulkarni, “Computer Networking and the Internet”, 5th Edition Pearson Education, 2006.

PCOE020	HIGH SPEED SWITCHING ARCHITECTURES	L	T	P	C
		3	0	0	3

Course Objectives:

- To understand the basics of switching technologies and their implementation in LANs, ATM networks and IP networks.
- To understand the different switching architectures and queuing strategies and their impact on the blocking performances.
- To expose to the advances in packet switching architectures, IP addressing and switching solutions and methods to exploit and integrate the best features of different architectures for high speed switching.

Course Content

LAN Switching Technology

Switching Concepts, LAN Switching, switch forwarding techniques - cut through and store and forward, Layer 3 switching, Loop Resolution, Switch Flow control, virtual LANs.

ATM Switching Architectures

Blocking networks - basic - and- enhanced banyan networks, sorting networks - merge sorting, re-arrangable networks - full-and- partial connection networks, non-blocking networks - Recursive network construction, comparison of non-blocking network, Switching with deflection routing - shuffle switch, tandem banyan switch.

Queues in ATM Switches

Internal Queueing -Input, output and shared queueing, multiple queueing networks – combined Input, output and shared queueing - performance analysis of Queued switches.

Packet Switching Architectures

Architectures of Internet Switches and Routers- Bufferless and buffered Crossbar switches, Multi-stage switching, Optical Packet switching; Switching fabric on a chip; Internally buffered Crossbars.

IP Switching

Addressing model, IP Switching types - flow driven and topology driven solutions, IP Over ATM address and next hop resolution, multicasting, Ipv6 over ATM.

References

1. Achille Pattavina, “Switching Theory: Architectures and performance in Broadband ATM networks”, John Wiley & Sons Ltd, New York. 1998
2. Rich Siefert, Jim Edwards, “The All New Switch Book – The Complete Guide to LAN Switching Technology”, Wiley Publishing, Inc., 2nd Edition, 2008.
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PCOE021	ADVANCED MICROWAVE COMMUNICATION TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the basic principles of microwave amplifiers and oscillators.
- To impart the knowledge on passive component characteristics, resonators and filters.
- To demonstrate the principles of antennas and microwave radio link characterization.

Course Content

Microwave Amplifiers and Oscillators

Klystron Amplifier – Reflex Klystron Amplifier –Travelling wave tube Amplifier – Magnetron Oscillator and Modulator – Varactor diode – Solid State Broad band Amplifiers – diode detector and mixer – YIG tuned Oscillators – Comb generators. GUNN, Tunnel IMPATT diode oscillators.

Microwave Passive Components

Scattering parameters-S-Matrix – Attenuator –Phase shifters – T Junctions – Hybrid T Junctions – Directional couplers – Isolator, Properties of ferrite devices – YIG devices – Step recovery Diodes – Gyrator – Circulator – Scattering parameter measurement.

Microwave Resonators and Filters

Review of resonant circuits – principle of Microwave resonators – field analysis of cavity resonators – Characteristics of filters –YIG tuned filters – Filter and resonant applications – SRD Frequency multipliers and frequency Discriminators.

Microwave Antennas

Characteristics of Microwave Antennas – Half Wave Dipole –Array – Horn –Paraboloidal Reflector – feeds – Lens and slot Antennas – Leaky and surface wave Antennas – Broad band Antennas – Micro strip Antennas – Antenna measurements.

Microwave Radio System

Types of propagation – Line of sight transmission – Radio horizon – Broadband Microwave Surveillance Receivers—ELINT and Electronic support measures--Microwave links-Repeaters – Diversity – frequency and space diversity systems – Fading – System gain and path losses - Noise and Absorption in Microwave links.

References

1. Roddy. D. , “Microwave Technology”, Reston Publications,1986.
2. Chatterjee R. “Microwave Engineering” East West Press. 1988.
3. Rizzi. P. “Microwave Engineering Passive circuits”. Prentice Hall, 1987.
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5. Combes, Graffewil and Sauterean, “Microwave Components, Devices and Active Circuits”, John Wiley, 1987.

PCOE022	ADVANCED WIRELESS COMMUNICATION TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the evolving paradigm of cooperative and green wireless communication concepts and the challenges and trade-offs involved in such networks.
- To understand the different power saving strategies and energy efficient signal, system and network design.
- To expose to the energy saving techniques adopted in existing wireless components, protocols and networks and the evolution of green future wireless communication technologies.

Course Content

Cooperative Communications And Green Concepts

Network architectures and research issues in cooperative cellular wireless networks; Cooperative communications in OFDM and MIMO cellular relay networks: issues and approaches; Fundamental trade-offs on the design of green radio networks, Green modulation and coding schemes.

Cooperative Techniques

Cooperative techniques for energy efficiency, Cooperative base station techniques for cellular wireless networks; Turbo base stations ; Antenna architectures for cooperation; Cooperative communications in 3GPP LTE-Advanced, Partial information relaying and Coordinated multi-point transmission in LTE-Advanced.

Relay-Based Cooperative Cellular Networks

Distributed space-time block codes ; Collaborative relaying in downlink cellular systems ; Radio resource optimization; Adaptive resource allocation ; Cross-layer scheduling design for cooperative wireless two-way relay networks ; Network coding in relay-based networks.

Green Radio Networks

Base Station Power-Management Techniques- Opportunistic spectrum and load management, Energy-saving techniques in cellular wireless base stations , Power-management for base stations in smart grid environment , Cooperative multicell processing techniques for energy-efficient cellular wireless communications.

Access Techniques for Green Radio Networks

Cross-layer design of adaptive packet scheduling for green radio networks; Energy-efficient relaying for cooperative cellular wireless networks ; Energy performance in TDD-CDMA multihop cellular networks ; Resource allocation for green communication in relay-based cellular networks ; Green Radio Test-Beds and Standardization Activities.

References

1. Ekram Hossain, Dong In Kim, Vijay K. Bhargava , “Cooperative Cellular Wireless Networks”, Cambridge University Press, 2011.
2. Ekram Hossain, Vijay K. Bhargava(Editor), Gerhard P. Fettweis (Editor), “Green Radio Communication Networks”, Cambridge University Press, 2012.

3. F.Richard Yu, Yu, Zhang and Victor C. M. Leung, “Green Communications and Networking”, CRC press, 2012.
4. Mazin Al Noor, “Green Radio Communication Networks Applying Radio-Over-Fibre Technology for Wireless Access”, GRIN Verlag, 2012.
5. Mohammad S. Obaidat, Alagan Anpalagan and Isaac Woungang, “Handbook of Green Information and Communication Systems”, Academic Press, 2012.

PCOE023	ADVANCED ELECTROMAGNETIC ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the theoretical knowledge of electromagnetic wave propagation and wave radiation.
- To get exposed with quantitative values and theoretical descriptions for wave propagation.
- To understand the concepts of electromagnetic radiation on different regions.

Course Content

Wave Propagation and Polarization

Uniform plane waves in an Unbounded Lossy medium - Plane wave in arbitrary direction, Dielectric Interface - Wave polarization at media Interface - Lossy media Interface - Wave propagation through the Ionosphere - Reflection and refraction of waves at Dielectric Interface - polarization: Linear Polarization - circular Polarization – Elliptical Polarization - Magnetic Polarization

Interaction of Fields and Matter

Charged particle equation of motion - Force and Energy - Circular motion in Magnetic Field - Crossed-field motion of a charged particle - Plasma oscillation: Wave propagation in plasma - Frequency Response of Dielectric Material.

Electromagnetic Radiation

Hertzian Dipole - Electric Dipole Radiation - Thompson scattering and Rayleigh Scattering -Dispersion Relation of a collisional plasma - Potential functions and the Electromagnetic field - Potential functions for sinusoidal oscillations - Alternating current element and power radiated - Radiation Losses - Angular Distribution of Radiation - synchrotron Radiation.

Relativity and Electromagnetism

Relativity Principle - Lorentz Transformation - Transformation of velocities - Tensor and Pseudo Tensors - Electromagnetic Field Tensor - Dual Electromagnetic Field Tensor - Gauge Invariance - Retarded Potentials - Transformation of Fields-Potential and field due to moving charge - Relativistic Particle Dynamics - Larmor Formula.

Scattering and Diffraction

Infinite Line source cylindrical wave radiation - Plane wave scattering by Planar Surface - Cylindrical wave transformation and theorems - Scattering by circular cylinder - Scattering by conducting wedge - conducting sphere - Edge Diffraction: straight Edge Diffraction - Curved Edge Diffraction.

References

1. Constantine A. Balanis, “Advanced Engineering Electromagnetics”, Wiley India Pvt. Ltd, 2012.
2. Edward C. Jordan “Electromagnetic Waves and Radiating system”, Second Edition, Prentice-Hall of India Pvt. Limited, 2013.

3. Ernesto Mazzucato, “Electromagnetic Waves for Thermonuclear Fusion Research”, World Scientific Publishing Company Pvt. Limited, 2014.
4. David. K. Cheng, “Fields and wave Electromagnetics”, 2nd Edition, Pearson Education, 2014.
5. Richard Fitzpatrick “Maxwell’s Equations and the Principle of Electromagnetism”, Infinity Science Press, 2010.

PCOE024	CLOUD COMPUTING	L	T	P	C
		3	0	0	3

Course Objectives

- To introduce the basics of cloud computing, the architectural and storage needs and the challenges.
- To understand the different aspects of developing cloud services, communication infrastructure requirements and deployment tools.
- To be aware of the need for energy efficiency and the methods to achieve the same, the applications and the security requirements.

Course Content

Introduction to Cloud Computing

Cloud Computing – History of Cloud Computing – Cloud Architecture – Cloud Storage – Why Cloud Computing Matters – Disadvantages of Cloud Computing – Microsoft Azure and Elastic Computing – Cloud Services .

Developing Cloud Services

Web-Based Application – Pros and Cons of Cloud Service Development – Types of Cloud Service Development – Software as a Service – Platform as a Service – Web Services – On-Demand Computing – Discovering Cloud Services Development Services and Tools – Amazon Ec2 – Google App Engine – IBM Clouds .

Cloud Computing Infrastructures

Cloud-Aware Core Networks, Location and Provisioning Problems, Virtualization Approach to Resource Allocation, Optical Cloud Networks, Communication Infrastructures in Access Networks, Cloud Radio Access Networks, Survey on Mobile-Cloud Computing.

Energy-Efficiency in Cloud Communication

Energy-Efficient Optical Interconnects, Energy-Efficiency in Cloud Data Centers, Carrier-Grade Distributed Cloud Computing, Energy-Efficiency in a Cloud Computing Backbone, Energy Efficiency for Cloud Computing Services , Energy Efficient Content Distribution.

Cloud Applications and Security

Cloud Data Centers with Batch Task Arrivals, Virtual Machine Migration in Cloud Computing Environments, Resource Management in Hybrid Clouds, Scalability and Performance Management of Internet Applications in the Cloud, Security and Interoperability Issues, Cloud deploying tools.

References

1. Gautam Shroff, “Enterprise Cloud Computing”, Cambridge University Press, 2010.
2. Hussein T. Mouftah and Burak Kantarci, “Communication Infrastructures for Cloud Computing”, IGI Global, ISBN: 9781466645226, 2014.
3. Ronald Krutz and Russell Dean Vines, “Cloud Security”, Wiley-India.
4. Michael Miller, “Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online”, Que Publishing, August 2008.
5. Haley Beard, “Cloud Computing Best Practices for Managing and Measuring Processes for On-demand Computing, Applications and Data Centers in the Cloud with SLAs”, Emereo Pvt. Limited, July 2008.

PCOE025	ADHOC WIRELESS NETWORKS	L	T	P	C
		3	0	0	3

Course Objectives

- To introduce the characteristic features of Adhoc wireless networks and their applications to the students.
- To understand the functioning of different access and routing protocols that can be used for adhoc networks.
- To know the need for security and the challenges and also the role of cross layer design in enhancing the network performance.

Course Content

Introduction

Introduction to Adhoc networks – definition, characteristics features, applications. Characteristics of Wireless channel, Adhoc Mobility Models: - entity and group models.

Medium Access Protocols

MAC Protocols: design issues, goals and classification. Contention based protocols, reservation based protocols, scheduling algorithms, protocols using directional antennas. IEEE standards: 802.11a, 802.11b, 802.11g, 802.15. HIPERLAN.

Network Protocols

Addressing issues in Adhoc network, Routing Protocols: Design issues, goals and classification. Proactive Vs reactive routing, Unicast routing algorithms, Multicast routing algorithms, hybrid routing algorithm, Power/ Energy aware routing algorithm, Hierarchical Routing, QoS aware routing.

End -To - End Delivery and Security

Transport layer: Issues in designing- Transport layer classification, adhoc transport protocols. Security issues in adhoc networks: issues and challenges, network security attacks, secure routing protocols.

Cross Layer Design and Integration

Cross Layer Design: Need for cross layer design, cross layer optimization, parameter optimization techniques, Cross layer cautionary perspective, Co-operative networks:- Architecture, methods of co-operation, co-operative antennas, Integration of ad hoc network with other wired and wireless networks.

References

1. C.Siva Ram Murthy and B.S.Manoj, “Ad hoc Wireless Networks Architectures and protocols”, 2nd Edition, Pearson Education. 2007
2. Charles E. Perkins, “Ad hoc Networking”, Addison – Wesley, 2000
3. Stefano Basagni, Marco Conti, Silvia Giordano and Ivan Stojmenovic, “Mobile Adhoc Networking”, Wiley-IEEE Press, 2004.
4. Mohammad Ilyas, “The handbook of adhoc wireless networks”, CRC press, 2002.
5. Erdal Cayirci and Chunming Rong C, “Security in Wireless Ad Hoc and Sensor Networks”, 2009, John Wiley & Sons, Ltd. ISBN: 978-0-470-02748-6.

PCOE026	RADAR ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the operation of different types of RADAR and its performance.
- To analyze the working principles of radars and its navigational aids.
- To know the performance of radar receiver with appropriate criterion for detecting a target.

Course Content

Radar basics & radar equation

Radar Block Diagram & operation, Applications of Radar, derivation of radar equation, minimum detectable signal, probability of detection and false alarm, radar cross-section, system losses.

CW & Frequency modulated radar

Doppler Effect, CW Radar, applications, FM – CW radar, altimeter, Multiple Frequency Radar. Pulse Radar – MTI, Delay Line Canceller, Multiple Frequencies, Range-gated Doppler Filters, Non-coherent MTI, Pulse Doppler Radar.

Tracking Radar

Tracking with Radar, Sequential Lobbing, Conical Scan, Monopulse Tracking Radar, phase comparison monopulse, Tracking in range, acquisition, comparison of trackers.

Receivers, Displays & Duplexers

Radar Receivers, Noise Figure, Mixer, Low-noise Front ends, Displays, Duplexer, Receiver protectors, matched filter, detection criteria, detector characteristics.

Phased Arrays

Basic concepts, feeds, phase shifters, frequency scan arrays, multiple beams, applications, advantages and limitations. Navigational Aids: Direction Finder, VOR, ILS and Loran

References

1. Merrill I. Skolnik ,"Introduction to Radar Systems", Tata McGraw-Hill (3rd Edition)2003
2. F.E. Terman, "Radio Engineering", McGraw Hill Book Co., 4th Edition, 1955.
3. Simon Kingsley and Shaun Quegan, "Understanding RADAR Systems", McGraw Hill Book Co., 1993.
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5. P.Z.Peebles, "Radar Principles", Wiley, 1998.

PCOE027	HIGH PERFORMANCE NETWORKS	L	T	P	C
		3	0	0	3

Course Objectives

- To study the concept of Layered Architectures of high performance networks.
- To understand the principles of ATM, Broadband, IP and Mobile Ad-hoc Networks.
- To acquire knowledge in High Performance networks based WiMax and UWB.

Course Content

Introduction

Networking principles – Digitalization Service and layered architecture – traffic characterization and QoS – network services – Network elements – Network Monitoring – Network Control – network mechanisms – Network Element Management.

Broadband Networks

Introduction – Multihop Wireless Broadband Networks – Mesh Networks – Importance of Routing Protocols – Routing Metrics – Packet Scheduling – Admission Control – Classification of Routing Protocols – MANET Routing Protocols.

IP Networks

Technology Trends in IP Networks – internet protocol – IP Packet Communications in Mobile Communication Networks – TCP and UDP – Performance of TCP/IP networks – Circuits Switched Networks – SONET – DWDM – Fiber to home – DSL – Intelligent Network (IN) Scheme – CATV and layered network.

ATM Networks

ATM Reference Model – The ATM Layer – The ATM Adaptation Layer (AAL) – Traffic Classes –Traffic Management and Quality of Service – Traffic Descriptor – Traffic Shaping – ABR and Traffic Congestion – Network Management – Layer Management – ATM Signaling – ATM Addressing Format – Connection Establishment – IP/ATM Internetworking – IP Multicast over ATM.

High Performance Networking With WiMAX and Ultra Wideband (WPAN)

Introduction – WiMAX Overview – Competing Technologies – Overview of the Physical Layer – PMP Mode – Mesh Mode – Multihop Relay Mode–Time-Hopping Ultra-wideband – Direct Sequence Ultra-wideband – Multiband – Other Types of UWB – LTE.

References

1. Jean Warland and Pravin Varaiya, “High Performance Communication Networks”, Harcourt and Morgan Kanffman Publishers, London, 2nd Edition, 2011.
2. Leon Gracia and Widjaja, “Communication networks”, Tata McGraw Hill, 2nd Edition, 2014.
3. Lumit Kasera and Pankaj Sethi, “ATM Networks”, Tata McGraw Hill, 2010.
4. Keiji Tachikawa, “W-CDMA Mobile Communication System”, John Wiley & Sons, 2012.
5. David tung chong wong, Peng-yong kong, Ying-chang liang, Kee chaing chua and Jon W. Mark, “Wireless Broadband Networks”, John Wiley & Sons, 2009.

PCOE028	ADVANCED WIRELESS NETWORKS	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the basics of 4G networks and its features.
- To impart knowledge on internetworking between different wireless networks.
- To learn the concept of WLAN, WWAN, Wimax and LTE system.

Course Content

Wireless Local Area Networks

Introduction to wireless LANs - IEEE 802.11 WLANs - Physical Layer- MAC sublayer- MAC Management Sublayer- Wireless ATM - HIPERLAN- HIPERLAN-2

3G Overview and 2.5G Evolution

Migration path to UMTS, UMTS Basics, Air Interface, 3GPP Network Architecture, CDMA2000, overview- Radio and Network components, Network structure, Radio network, TD-CDMA, TDSCDMA.

Adhoc & Sensor Networks

Characteristics of MANETs, Table-driven and Source-initiated On Demand routing protocols, Hybrid protocols, Wireless Sensor networks- Classification, MAC and Routing protocols.

Internetworking between WLANS and 3G WWANS

Internetworking, objectives and requirements Schemes to connect WLANs and 3G Networks, Session Mobility, Internetworking Architectures for WLAN and GPRS, System Description, Local Multipoint Distribution Service, Multichannel Multipoint Distribution system.

4G & Beyond

4G features and challenges, Technology path, IMS Architecture, WiMAX, LTE, Convergent Devices, 4G technologies, Advanced Broadband Wireless Access and Services, Multimedia, MVNO.

References

1. Clint Smith. P.E., and Daniel Collins, “3G Wireless Networks”, 2nd Edition, Tata McGraw Hill, 2007.
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4. William Stallings, “Wireless Communications and Networks”, Pearson / Prentice Hall of India, 2nd Edition, 2007.
5. Andrew Richadrson, “WCDMA design Handbook”, Cambridge University Press, 2007.

PCOE029	OPTICAL SWITCHING AND NETWORKING	L	T	P	C
		3	0	0	3

Course Objectives

- To familiarize with the architectures and the protocols stack of optical networks.
- To understand the differences in the design of data plane and the control plane
- To learn routing, switching, resource allocation, network management and protection methods of optical networks.

Course Content

Optical Network Architectures

Introduction to optical networks – layered architecture – spectrum partitioning – network nodes – network access stations – overlay processor – logical network overlays.

Network Connections and the Control Plane

Connection management and control – static and wavelength routed networks – linear light wave networks – logically routed networks – traffic grooming – the optical control plane: architecture, interfaces, functions – generalized multiprotocol label switching: MPLS network and protocol stack, link management, routing and signaling in GMPLS.

Routing and Wavelength Assignment

Static multipoint network: shared media and multiple access, scheduling and optical, spectral efficiency, traffic constraints – passive optical networks – wavelength routed networks – static and dynamic routing and wavelength assignment – linear light wave networks – static and dynamic routing and wavelength assignment – the minimum cost design of transparent optical networks combining grooming, routing, and wavelength assignment.

Optical Packet Switched Networks and Access networks

Network architectures – unbuffered networks – buffering strategies – OPS enabling technologies – test beds – optical burst switching – switching protocols – contention resolution – optical label switching – OLS network test beds –access networks – network architecture overview – OTDM networks – optical access network architectures – future access networks.

Network Management and Survivability

Control and management – network management functions – configuration management – performance management – fault management – optical safety – service interface – network survivability – protection in SONET / SDH and IP Networks – optical layer protection – interworking between layers.

References

1. Xiaohua Jia, Xiao-Dong Hu, Ding-Zhu Du, “Multiwavelength Optical Networks -Network Theory and Applications”, Springer, 2010.
2. Rajiv Ramaswami and Kumar N. Sivarajan, “Optical Networks: A Practical Perspective”, Morgan Kaufmann, 3rd Edition, 2010.

3. C. Siva Ram Moorthy and Mohan Gurusamy, “WDM Optical Networks: Concept, Design and Algorithms”, Pearson Education; 1st Edition, 2015.
4. James F. Kurose, Keith W. Ross, “Computer Networking - A Top-Down Approach Featuring the Internet”, 5th Edition, Pearson Education, 2009.
5. Nader. F. Mir, “Computer and Communication Networks”, Pearson Prentice Hall Publishers, 2010.

GENERIC ELECTIVES

PCOG001	NETWORK MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the concepts and architecture behind standards based network management.
- To apply the knowledge in current trends in network management technologies.
- To familiarize the need for interoperable network management.

Course Content

Fundamentals of Computer Network Technology

Network Topology, LAN, Network node components- Hubs, Bridges, Routers, Gateways, Switches, WAN, ISDN Transmission Technology, Communications protocols and standards. Network Management: Goals, Organization, and Functions, Network and System Management, Network Management System Platform, Current Status and future of Network.

OSI Network Management

OSI Network management model - Organizational model-Information model, communication model. Abstract Syntax Notation - Encoding structure, Macros Functional model CMIP/CMIS

Internet Management (SNMP)

SNMP(V1 and V2)-Organizational model-System Overview, The information model, communication model-Functional model, SNMP proxy server, Management information, protocol remote monitoring- , RMON SMI and MIB, RMON1,RMON2 - A Case Study of Internet Traffic Using RMON.

Broadband Network Management

Broadband networks and services, ATM Technology-VP,VC, ATM Packet, Integrated service, ATMLAN emulation, Virtual Lan. ATM Network Management-ATM Network reference model, integrated local management Interface. ATM Management Information base, Role of SNMD and ILMI in ATM Management, M1, M2, M3, M4 Interface. ATM Digital Exchange Interface Management- , TMN conceptual Model- TMN Architecture, TMN Management Service Architecture.

Network Management Applications

Configuration management, Fault management, performance management, Event Correlation Techniques security Management, Accounting management, Report Management, Policy Based Management Service Level Management- Network Management Tools, Network Statistics Measurement Systems – Web Based Management, XML Based Network Management - : Future Directions.

References

1. Mani Subramanian, “Network Management Principles and practice”, Pearson Education, New Delhi, 2010.

2. Stallings, William, “SNMP, SNMPv2, SNMPv3, and RMON 1 and 2,” Pearson Education, 2012.
3. Salah Aiidarous, Thomas Plevayk, “Telecommunications Network Management Technologies and Implementations”, Eastern Economy Edition IEEE press, New Delhi, 1998.
4. Lakshmi G. Raman, “Fundamentals of Telecommunication Network Management”, Eastern Economy Edition IEEE Press, New Delhi, 1999.
5. J. Richard Burke, Network Management: Concepts and Practice A Hands-On Approach, Pearson Publications, 1st Edition, 2008.

PCOG002	SOFT COMPUTING TECHNIQUES	L	T	P	C
		3	0	0	3

Course Content

Course Objectives

- To familiarize in new computing paradigm for creating intelligent machines useful for solving complex real world problems.
- To create awareness in the application areas of soft computing techniques.
- To provide alternative solutions to the conventional problem solving techniques.

Introduction

Introduction of soft computing - soft computing vs. hard computing- various types of soft computing techniques- applications of soft computing-Neuron- Nerve structure and synapse Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- McCullochPitts neuron model- perceptron model- Adaline and Madaline- multilayer perception model- back propogation learning methods- effect of learning rule coefficient -back propagation algorithm- factors affecting back propagation training applications.

Artificial Neural Networks

Counter propagation network- architecture- functioning & characteristics of counter-Propagation network-Hopfield/ Recurrent network- configuration- stability constraints-associative memory and characteristics- limitations and applications- Hopfield v/s Boltzman machine- Adaptive Resonance Theory- Architecture- classifications-Implementation and training-Associative Memory.

Fuzzy Logic System

Introduction to crisp sets and fuzzy sets- basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control- Fuzzification- inferencing and defuzzification Fuzzy knowledge and rule bases-Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control- Fuzzy logic control for nonlinear time delay system.

Genetic Algorithm

Basic concept of Genetic algorithm and detail algorithmic steps-adjustment of free Parameters Solution of typical control problems using genetic algorithm- Concept on some other search techniques like tabu search and ant colony search techniques for solving optimization problems.

Hybrid Systems

Integration of Neural Networks, Fuzzy Logic and Genetic Algorithms, GA Based Back Propagation Networks, Fuzzy Back Propagation Networks, Fuzzy Associative Memories, Simplified Fuzzy ARTMAP. Soft computing based hybrid fuzzy controllers.

References

1. Timothy J. Ross, Fuzzy Logic with Engineering Applications, 3rd Edition, McGraw-Hill, 2011.
2. S.N. Sivanandam and S.N. Deepa, “Principles of Soft Computing”, Wiley India Pvt. Ltd., 2011.
3. J.M. Zurada, .Introduction to Artificial Neural Systems, Jaico Publishers, 1st Edition 1994.
4. H.J. Zimmermann, Fuzzy Set Theory and Its Applications, 4th Edition, Kluwer Academic Publishers, London, 2012.
5. Suran Goonatilake, Sukhdev Khebbal (Eds), Intelligent Hybrid Systems, John Wiley & Sons, New York, 1995.

PMGG003	INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
		3	0	0	3

Course Objectives

- To acquire knowledge of learn about the intellectual property rights.
- To learn the procedure for registering Patents, Copy Rights, Trademarks and Geographical Indication.
- To protect one's intellectual property rights.

Course Content

Introduction to IPR, International cooperation on IPR, Major Treaties, International convention relating to Intellectual Property – Establishment of WIPO – Mission and Activities – History – General Agreement on Trade and Tariff (GATT).

Nature & Importance of Patents, Copy Rights, Trade Marks, Geographical Indication. Procedure to file Application for grant of Patents, Copy rights, Trade Marks and Geographic Indication.

Emerging trends in IPR, IPR litigation, Case Studies on Patents, Copyright and related rights, Trade Marks, geographic indications

References

1. Bare Acts (Up-to-date)
2. Subbaram N. R., and Viswanathan S., "Handbook of Indian Patent Law and Practice", Printers and Publishers Pvt. Ltd., 2008.
3. Susan K. Sell, "Private Power, Public Law: The globalization of Intellectual Property Rights", Cambridge studies in International relations, Cambridge University Press, 2013.
4. Wadehra, B.L., "Law relating to Intellectual Property", University law publishing company Private Ltd, 4th Edition, 2010.
5. Bhandari, M.K., "Law Relating to Intellectual Property Rights", Central Law Publications, 4th Edition, 2015.