National Institute of Technology Hamirpur
Electronics and Communication Engineering
M.Tech. Communication Systems & Networks

Teaching Scheme (2011 onwards)

A. Distribution of Credits

Minimum Credits Through Course Work			Minimum Credits Through Research		Total Credits
Programme Core (PC)	Programme Electives (PE)	Open Electives (OE)	Dissertation-3rd Sem	Dissertation-4th Sem	
24	11	3	12	20	70

B. Semester-wise Distribution of Credits

(may vary as per the need of specific programme, but the requirement of minimum overall credits listed in **A** must be satisfied)

Sem-1	Sem-2	Sem-3	Sem-4	Total Credits
17	17	16	20	70

C. Grade of Dissertation (EC-801)

Semester	**Credits for Dissertation Work**	**Grade**	**Remarks**
Sem-3	12	AAA	$A \in S \mid X$ A is awarded for each set of 4 units, [S: Satisfactory, X: Unsatisfactory]
Sem-4	20	AAAAA	

D. Self Study Course

Self-study course will be related to the research/specialization area of a candidate. The concerned supervisor will act as course coordinator who will be responsible for proposing the course name and syllabus for approval of the DPGC. If the same course is offered to more than one student, there may only be one course coordinator. The candidate has to be continuously evaluated in same pattern as applicable to other courses (two mid-term exams, one semester exam, assignments, quizzes, etc.).

Department of Electronics & Communication Engineering
M.Tech. Communication Systems & Networks
Teaching Scheme (2011 onwards)

FIRST SEMESTER

S.No.	Course No.	Course Title	L	T	P	Hours/Week	C
1.	EC-611	Information Theory And Coding	3	0	0	3	3
2.	EC-612	Mobile Communication	3	0	0	3	3
3.	EC-613	Optical Networks	3	0	0	3	3
4.		Programme Elective-1	3	0	0	3	3
5.		Programme Elective-2	3	0	0	3	3
6.	EC-614	Optical Communication Lab	0	0	3	3	2
Total			**15**	**0**	**3**	**18**	**17**

SECOND SEMESTER

S.No.	Course No.	Course Title	L	T	P	Hours/Week	C
1.	EC-615	Digital Signal Processing	3	0	0	3	3
2.	EC-616	Modelling and Simulation of Communication System and Networks	3	0	0	3	3
3.	EC-617	CDMA Technology and Systems	3	0	0	3	3
4.		Programme Elective-3	3	0	0	3	3
5.		Open Elective-1 (from other Dept)	3	0	0	3	3
6.	EC-618	Communication System & Networks Simulation (Lab)	0	0	3	3	2
Total			**15**	**0**	**3**	**18**	**17**

THIRD SEMESTER

S.No.	Course No.	Course Title	L	T	P	Hours/Week	C
1.	EC–799	Self Study				3	2
2.	EC-800	Seminar	0	0	3	3	2
3.	EC-801	Dissertation (to be continued in IVth Sem)				24	12
Total						**30**	**16**

FOURTH SEMESTER

S.No.	Course No.	Course Title	L	T	P	Hours/Week	C

1.	EC-801	Dissertation (continued from IIIrd Sem)				40	20
Total							**20**

Programme Elective-1

EC-725 Advanced Digital Communication
EC-726 Soft Computing
EC-727 Computer Communication and Networks

Programme Elective-2

EC-733 Microwave Devices and Circuits
EC-734 Wi-Fi, Bluetooth and Zigbee Technology
EC-735 Advanced Antenna Design

Programme Elective-3

EC-741 Wireless Sensor Networks
EC-742 Wi-Fi Telephony and VoIP
EC-743 Digital Image Processing and Pattern Recognition

Open Electives

EC-750 Wi-Fi, Bluetooth and Zigbee Technology

EC-611 INFORMATION THEORY AND CODING

1. **Measures of information and Channel Capacity**

   Entropy, Relative Entropy And Mutual Information. Basic Inequalities :Jensen Inequality And Its Physical Application, Log-Sum Inequality And Its Physical Application, Fano Inequality And Its Physical Application, Data Processing Theorem And Its Physical Application, Consequences Of The Inequalities In The Field Of Information Theory.

2. **Entropy Rate And Channel Capacity**

   Stationary Markov Sources: Entropy Rate And Data Compression. Definition Of Capacity And Its Computation Of Discrete Memory Less Channels(BNC, BSC, BEC, Cascaded Channels, Noiseless Channels, Noisy Typewriter), The Channel Coding Theorem And The Physical Significance Of Capacity.

3. **Data Compression By Fixed-To-Variable-Length Codes**

   Unique Decodability And The Prefix Condition. Kraft Inequality, Relationship Of Average Codeword Length To Source Entropy. Examples Of Coding Techniques: Huffman, Shannon-Fano-Elias, Lempel-Ziv, Universal.

4. **Design Of Linear Block Codes**

   Introduction Of Linear Block Codes, Syndrome And Error Detection, Minimum Distance Of A Block Code, Error Detecting And Error Correcting Capability Of A Block Code, Design Of Encoder And Syndrome Decoder For Linear Block Codes.

5. **Design Of Cyclic Codes**

   Description Cyclic Codes, Generator And Parity Check Matrices Of Cyclic Codes, Encoding Of Cyclic Codes, Syndrome Computation And Error Detection, Decoding Of Cyclic Codes, Cyclic Hamming Codes.

6. **Convolutional Codes**

   Encoding Of Convolutional Codes, Structural Properties Of Convolutional Codes, Distance Properties Of Convolutional Codes, Design Of Encoder And Decoder For Convolutional Codes.

Textbooks/References

1. T.M. Cover and J.A. Thomas, *Elements of Information Theory*, John Wiley (1991).
2. Shu Lin, Daniel J. Costello, Jr., Error Control Coding(2005).
3. R.G. Gallager, *Information Theory and Reliable Communication*, Wiley (1968). for Discrete Memoryless Systems, Academic Press (1981).
4. R.J. McEliece, *The Theory of Information and Coding*, Addison-Wesley (1977).

EC-612 Mobile Communication

1. **Introduction to cellular mobile systems**

   Basic cellular systems, Performance criteria, Uniqueness of mobile radio environment, Operation of cellular systems, Concept of frequency reuse channels, Cochannel interference reduction factor, Desired C/I from a normal case in an omnidirectional antenna system, Handoff mechanism, Cell splitting.

2. **Cell coverage for signal and traffic**

   General introduction, Obtaining the mobile point-to-point model, Propagation over water or flat open area, Foliage loss, Propagation in near-in distance, Long-distance propagation, Obtain path loss from a point-to-point prediction model, Cell-site antenna heights and signal coverage cells.

3. **Cochannel and adjacent-channel interference in mobile communications**

   Cochannel interference, Design of an omnidirectional antenna system in the worst case, Design of a directional antenna system, Lowering the antenna height, Power control, Diversity receiver, Adjacent-channel interference, Near-end – far-end interference, Effect on near-end mobile units.

4. **Frequency management, channel assignment and handoffs:**

   Frequency management, Frequency-spectrum utilization, Set-up channels, Definition of channel assignment, Fixed channel assignment schemes, Nonfixed channel assignment schemes, Concept of handoff, Initiation of a hard handoff, Delaying a handoff, Forced handoffs, Queuing of handoffs, Power-difference handoffs, Mobile assisted handoff, Soft handoffs, Cell-site handoff only, Intersystem handoff.

5. **Multiple access techniques and digital cellular systems:**

   Multiple access techniques for mobile communications; Global system for mobile (GSM): GSM system architecture, GSM radio subsystem, GSM channel types, Frame structure for GSM, Signal processing in GSM; GPRS; EDGE; Overview of third generation (3G) wireless networks.

Textbooks/References

1. Mobile Cellular Telecommunications: Analog and Digital Systems by William C. Y. Lee; Tata McGraw Hill Publication
2. Wireless Communications: Principles and Practice by Theodore S. Rappaport; Pearson / PHI Publication
3. Wireless Communications and Networks: 3G and Beyond by Iti Saha Misra; Tata McGraw Hill Publication
4. Wireless and Digital Communications by Dr. Kamilo Feher; PHI Publication

EC- 613 OPTICAL NETWORKS

1. **Introduction to Optical Network**

Services, Circuit Switching, Packet Switching, Optical Networks, Optical Layer, Transparency and All Optical Networks, Optical Packet Switching, Transmission Basics, Network Evolution.

2. **Optical Amplifiers**

Stimulated Emission, Spontaneous Emission, Erbium Doped Fiber amplifiers, Raman amplifiers, Semiconductor Optical Amplifiers, Cross talk in SOAs.

3. **Multiplexers and Filters to Wavelength Converters**

Gratings, Diffraction Pattern, Bragg Gratings, Fiber Gratings, Fabry-Perot filters, Multilayer Dielectric Thin-Film Filters, Mach-Zehnder Interferometers, Arrayed Waveguide Grating, Acousto-Optic Tunable Filter, High channel Count Multiplexer Architectures, Optoelectronics Approach, Optical Gating, Interferometric Techniques, Wave Mixing.

4. **Transmission System Engineering**

System Model, Power Penalty, Transmitter, Receiver, Optical Amplifiers, Cross talk, Dispersion, Fiber Nonlinearities, Wavelength Stabilization Design of Soliton Systems, Design of Dispersion –Managed Soliton Systems.

5. **Client Layers of the Optical Layer**

SONET/SDH, ATM, IP, Storage Area Networks, Gigabit and 10-Gigabit Ethernet.

6. **WDM Network Elements & Design**

Optical Line Terminals, Optical Line Amplifiers, Optical Add/Drop Multiplexers, Optical Cross connects. Cost Trade-Offs: A Detailed Ring Network Example, LTD and RWA Problems, Dimensioning Wavelength-Routing Networks, Statistical Dimensioning Models, Maximum Load Dimensioning Models

7. **Access Networks**

Network Architecture Overview, Enhanced HFC, and fiber to the Curb (FTTC).

Textbooks/References

1. Optical Networks: A practical Perspective. Ramaswami & K.N. Sivarajan Morgan Kaufmann 2nd Edition. *G.P*. Agarwal, "Fiber optic communication systems ", 2nd Edition, John Wiley & Sons, New York, 1997.
2. Franz and Jain, "Optical communication system ", Narosa Publications, New Delhi, 1995.
3. G.Keiser, "Optical fiber communication ", Systems, McGraw-Hill, New York, 2000.
4. Franz & Jain, "Optical communication ", Systems and components, Narosa Publications, New Delhi, 2000.

EC-615 DIGITAL SIGNAL PROCESSING

1. **Discrete time signals and systems**

2. **Time Domain Representation of Signals & Systems**

   Discrete Time Signals, Operations on Sequences, the sampling process, Discrete-Time systems, Time-Domain characterization of LTI Discrete-Time systems, state-space representation of LTI Discrete-Time systems, random signals.

3. **Transform-Domain Representation of Signals**

   The Discrete-Time Fourier Transform, Discrete Fourier Transform, DFT properties, computation of the DFT of real sequences, Linear Convolution using the DFT. Z-transforms, Inverse z-transform, properties of z-transform

4. **Transform-Domain Representation of LTI Systems**

   The frequency response, the transfer function, types of transfer function, minimum-phase and maximum-Phase transfer functions

5. **Digital Processing of Continuous-Time Signals**

   Sampling of Continuous Signals, Analog Filter Design, Anti-aliasing Filter Design, Sample-and-hold circuits, A/D & D/A converter, Reconstruction Filter Design.

6. **Digital Filter Structure**

   Block Diagram representation, Signal Flow Graph Representation, Equivalent Structures; bone FIR Digital Filter Structures, IIR Filter Structures, State-space structure, all pass filters, tunable IIR Digital filters, cascaded Lattice realization of IIR and FIR filters, Parallel all pass realization of IIR transfer function

7. **Digital Filter Design**

   Impulse invariance method of IIR filter design, Bilinear Transform method of IIR Filter Design, Design of Digital IIR notch filters, FIR filter Design based on truncated fonner sens, FIR filter design based on Frequency Sampling approach.

8. **Applications of DSP in communication systems**

Textbooks/References

1. Sanjit K. Mitra, “Applications DSP a Computer based approach” , TMH.
2. Proakis, “ Digital Signal Processing” PHI, Second edition
3. Allan Y. Oppenhein & Ronald W. Schater , "Digital Signal Processing”, PHI
4. Monson H. Hayes, “ Schaum’s Outline of Digital Signal Processing”, Mcgraw Hill, 1999.
5. Lars Wanhammar, “ DSP Integrated Circuits”, Academic Press, First edition, 1999.

EC-616 MODELING AND SIMULATION OF COMMUNICATION SYSTEM AND NETWORKS

1. **Univariate and Multivariate Models**

   Probability Density and Distribution functions, Random variables, independence of random variables, transformations between random variables, expectations and moments, Conditional expectation and Conditional Variance, bi- and multi-variate distributions, random processes, covariance and spectral density, Application of different probability models. Bounds and approximation of random variables, Introduction to Simulation and Modeling : Steps in Simulation and Modeling.

2. **Simulation Of Random Variables And Random Process**

   Properties of random Numbers, Generation of random numbers, techniques for generating Random numbers: Linear Congruential Method and Combined Linear Congruential Method, Validation of random number generators: KS Test, Chi-square test, Runs test, Autocorrelation Test.

3. **Random Variate Generators**

   Inverse transform technique for generating discrete random and continuous random variables(examples for exponential, uniform, triangular, poisson, binomial distributed random variables), Acceptance-Rejection technique for generation of Discrete and Continuous random variables, Some special generators: Box Muller method, Sum-of-12 method for generating Normally distributed random variables, Validation of the generation methods using goodness of fit tests.

4. **Estimation Of Performance Measures**

   Quality of an estimator, estimator of SNR, Probability density functions of analog communication system, BER of Digital communication systems, Unbiased estimation of expected value, Unbiased estimation of Variance, Monte Carlo method and Importance sampling method for estimating the integral (Crude Monte Carlo Method, Acceptance- rejection Monte Carlo, Stratified sampling, Importance sampling Methods and their performance Comparison)

5. **Queuing Models**

   Characteristics of Queuing models, Queuing notation, Long Run Performance measures of Queuing Systems, Steady state behavior of M/M/I and M/M/I/N queuing models, little formula, Burke’s theorem M/G/I queuing Model, Embedded Markov Chain analysis of TDM systems, Polling, Random access systems.

Textbooks/References

1. M.C.Jeruchim, Philip Balaban and K.Sam Shanmugam, "Simulation of communication systems", Plenum Press,New York,1992

2. A.M.Law and W.David Kelton, "Simulation Modelling and analysis", Mc Graw Hill Inc., New York ,1991

3. Jerry Banks and John S.Carson, Discrete-event system Simulation", Prentice Hall,Inc.,NewJersey,1984

EC-617 CDMA Technology and Systems

1. **Principles of CDMA**

   The concept of spreading, cellular mobile network, Capacity of CDMA system, spreading codes and their properties, pseudo-random sequences, maximal length linear shift register sequence, randomness properties of MLSR sequence.

2. **Theory and application of Pseudorandom Sequence**

   Galois Field and primitive polynomials, mechanization of linear feedback shift register binary irreducible polynomial, state vector variations for PN sequence phase shifts, shift register generator with special loading vectors, use of mask to select a sequence phase shift, P-N sequence specified in IS-95, Auto correlation and cross correlation properties of binary sequence in CDMA.

3. **Spread Spectrum Techniques for CDMA**

   Direct Sequence CDMA, Power spectral density of DSS-CDMA, Link performance of direct sequence spread spectrum CDMA in (i) Additive White Noise Channel (ii) Multipath fading channel. Concept of Rake receiver,performance of RAKE receiver in multipath fading channel.

4. **Spreading Code Acquisition and Tracking**

   Initial code acquisition, Acquisition strategy: serial search, parallel search, multi-dwell detection, False alarm and miss probability for matched filter receiver, False alarm and miss probability for radiometer, mean overall acquisition time for serial search.

5. **CDMA Systems:**

   IS-95: Forward link channels, Reverse link channels, Power controls and handoff procedure in IS-95. Concept of 2 G and 3-G systems, CDMA-2000 and WCDMA: channel allocation, Power control and handoff procedures.

6. **Overview of OFDM**

   LTE systems, OFDMA and SC-OFDMA, implementation and signal processing aspect for OFDM, synchronization and channel estimation aspect, interleaving and channel diversity.

Textbooks/References

1. Andrew J. Viterbi, “CDMA: Principles of Spread Spectrum Communication”, Addison-Wesley Publishing Company.
2. Jhong S. Lee and Leonard E. Miller, “CDMA Systems Engineering Handbook”, Artech House Publishers.
3. Mosa Ali Abu-Rgheff, “Introduction to CDMA Wireless Communications”, Elsevier Academic Press.
4. Henrik Schulze & CristionLuders, “Theory application of OFDM and CDMA wideband wireless communication.” John Wiley & Son Ltd.

EC-725 ADVANCED DIGITAL COMMUNICATION

1. **Introduction**

   Functional architecture coded and encoded digital communication system architecture

2. **Digital Modulations Techniques**

   BPSK, BFSK and DPSK, QPSK, M-ary PSK, MSK, M-ary FSK, GMSK.

3. **OPTIMUM RECEIVERS FOR AWGN CHANNEL**

   Optimum receiver for signals corrupted by AWGN, performance of optimum receiver for memory less modulation, optimum receiver for CPM signals, optimum receiver for signals with random phase in AWGN channel.

4. **CARRIER AND SYMBOL SYNCHRONIZATION**

   Signal Parameter estimation, carrier phase estimation, symbol timing estimation, Joint estimation.

5. **Band Limited Channels:**

   Optimum pulse shape design, optimum demodulations of digital signals in the presence of ISI and AWGN, equalization techniques, diminishing and detection I-Q modulation, QAM, QPSK, QBM, CPM, FSK, MSK

6. **Recent advancements of Digital communication Systems**

Textbooks/References

1. H. Taub and D.L. Schilling, Principle of Communication Systems, 2nd Ed., McGraw Hill, 1986.
2. J.G. Proakis, Digital Communication, McGraw-Hill Publications, 2000.
3. B.P.Lathi,Modern Digital and analog communication systems,3rd Edition, Oxford University Press,1998.

EC-726 Soft Computing

1. **Artificial Neural Networks**

   Basic-concepts-single layer perception-Multi layer perception-Supervised and un supervised learning back propagation networks, Application.

2. **Fuzzy Systems**

   Fuzzy sets and Fuzzy reasoning-Fuzzy matrices-Fuzzy functions-decomposition-Fuzzy automata and languages- Fuzzy control methods-Fuzzy decision making, Adaptive Control, Applications.

3. **Neuro-Fuzzy Modelling**

   Adaptive networks based Fuzzy interfaces-Classification and Representation trees-algorithms –Rule base structure identification-Neuro-Fuzzy controls.

4. **Genetic Algorithm**

   Survival of the fittest-pictures computations-cross over mutation-reproduction-rank method-rank space method, Application.

5. **Soft Computing and Conventional AI**

   AI Search algorithm-Predicate calculus rules of interface - Semantic networks-frames-objects-Hybrid models; Applications.

Textbooks/References

1. Neuro Fuzzy and Soft computing- Jang J.S.R., Sun C.T and Mizutami E, Prentice Hall;
2. Fuzzy Logic Engineering Applications- Timothy J.Ross; McGraw Hill;
3. Neural Networks- Simon Haykin, pearson Education
4. Fuzzy Sets and Fuzzy Logic- George J.Klir and Bo Yuan, Prentice Hall ;
5. Artificial Intelligence- Nih.J.Ndssen Harcourt Asia Ltd.,Singapore

EC-727 Computer Communication And Networks

Communication Model, Data Communications, Computer Communication Architecture, Standard Making Organisations. Concepts and Terminology, Asynchronous and Synchronous Data Communications, Multiplexing Techniques. Communication Networking Techniques, Circuit Switching, Packet Switching, Local Area Networks. Protocols, Layered Approach, TCP / IP Protocol Suite, System Network Architecture. The Bridge and Routing, Connectionless internetworking, Connection oriented internetworking. Transport and Network Services TCP / UDP. Session Characteristics, OSI Session and Service Protocol. Presentation Concepts, Encryption and Authentication Codes, Virtual Terminal Protocols. Network Management, File Transfer and Electronic Mail. Communication Switching Techniques, Frame-mode Bearer Service, Frame Relay Congestion Control, Synchronous Transfer Mode.

Textbooks/References

1. W. Stallings, *Data and Computer Communications*, PHI, New Delhi, 2006.
2. A.S. Tanenbaum, *Computer Networks*, 2nd Ed.; PHI, New Delhi, 2002.
3. Halsall, *Data Communications, Computer Networks and Open Systems*, Pearson Education, 2003.

EC-733 MICROWAVE DEVICES & CIRCUITS

1. Introduction to Microwaves

Frequency allocations & allocation plans, letter designation for microwave band

2. Active microwave devices

Multi cavity Klystron, Reflex Klystron, Magnetron, Traveling Wave Tube, Tunnel diode, Gunn Diode, PIN diode, Avalanche Diodes

3. Passive microwave devices

Wave-guides, Scattering matrix, **Passive microwave devices:** attenuator, resonators, ferrite devices circulators, isolators, gyrator, directional coupler, microwave tees

4. Active & Passive Microwave Circuits

Introduction to Active & Passive Microwave circuits, Noise in microwave circuits, Detectors & Mixers, PIN diode control circuits.

5. MMIC technology

Introduction, types of MICs and their technology, Fabrication process of MMIC, Hybrid MICs, Configuration, Dielectric substances, thick and thin film technology, Encapsulation and mounting of Devices. , Design and Fabrication of Lumped elements for MICs, Comparison with distributed circuits

6. Recent advancements in Microwaves

Textbooks/References

1. Liao S.Y. : Microwave Circuits & Devices. PHI.
2. David M. Pozar: Microwave engineering, John WILEY & Sons.
3. K.C Gupta, & A Singh: Microwave Integrated Circuits, Eastern WILEY.

EC- 734 Wi-Fi, Bluetooth and Zigbee Technology

1. **Wi-Fi: Architecture and Functions**

   WLAN Roadmap via IEEE 802.11 Family Evolutions, IEEE 802.11 Architecture, Different Physical Layers, Data Link Layer, Medium Access Control Layer, Mobility, Security, IEEE 802.11 Family and its Derivative Standards

2. **Bluetooth: Architecture and Functions**

   Introduction, Architecture and Throughputs, Physical Layer and Physical Channels, Baseband Layer, Link Manager Protocol, Logical Link Control and Adaptation Protocol, RFCOMM Protocol, Service Discovery Protocol, Profiles, Host Control Interface, Bluetooth Network Encapsulation Protocol.

3. **IEEE 802.15.4 and ZigBee**

   General Architecture, Physical Layer, 2450 MHz Physical Layer, 868/915 MHz Physical Layer, PDU Packet Format, MAC Layer, Channel Access, Energy Detection, Active and Passive Scan, Association Procedure, Guaranteed Time Slot, Security, Frame Structures, Beacon Frame , Data Frame.

Textbooks/References

1. H. Labiod, H. Afifi, C. De Santis: WI-FI, BLUETOOTH , ZIGBEE and WIMAX-Springer-2007
2. “Bluetooth Technology”, C.S.R. Prabhu and A.P. Reddi, PHI.
3. “Bluetooth Demystified”, Nathan J. Muller, Tata McGraw Hill

EC-735 Advanced Antenna Design

1. **Basics Concepts of Radiation**

   Radiation from surface current and current line current distribution, Basic antenna parameters, Radiation mechanism-Current distribution of Antennas, Impedance concept-Balanced to Unbalanced transformer.

2. **Radiation from Apertures**

   Field equivalence principle, Rectangular and circular apertures, Uniform distribution on an infinite ground plane, Aperture fields of Horn antenna-Babinets principle, Geometrical theory of diffraction, Reflector antennas, Design considerations - Slot antennas.

3. **Synthesis of Array Antennas**

   Types of linear arrays, current distribution in linear arrays, Phased arrays, Optimization of Array Patterns, Continuous aperture sources, Antenna synthesis techniques.

4. **Micro Strip Antennas**

   Radiation mechanisms, Feeding structure, Rectangular patch, Circular patch, Ring a ntenna. Input impedance of patch antenna, Micro strip dipole, Micro strip arrays.

5. **EMI S/EMC/Antenna Measurements**

   Log periodic, Bi-conical, Log spiral ridge Guide, Multi turn loop, Traveling Wave antenna, Antenna measurement and instrumentation, Amplitude and Phase measurement, Gain, Directivity, Impedance and Polarization Measurement, Antenna range; Design and Evaluation.

6. **Smart Antennas systems**

   Generalized array signal processing; Beam forming concepts-DOB, TRB & SSBF, Switched beam antennas, spatial diversity, and fully adaptive antennas for enhanced coverage, range extension & improvement in frequency refuse, interference nulling for LOS & Multipath systems, SDMA concepts and Smart antennas implementation issues.

Textbooks/References

1. Antennas- Kraus, John Wiley and Sons;
2. Antenna Theory Analysis and Design- Balanis, John Wiley and Sons
3. Antenna Theory- Collin and Zucker, McGraw Hill,
4. Smart Antennas for Wireless Communication: IS-95 and Third Generation CDMS applications- Liberti, Rappaport, PHI
5. Third-Generation Systems and Intelligent Wireless Networking: Smart Antennas and Adaptive Modulation- Blogh&Hanzo, Willey-IEEE Press;

EC-741 Wireless Sensor Networks

1. **Introduction**

   Wireless sensor networks: the vision, Networked wireless sensor devices Applications of wireless sensor networks, Key design challenges

2. **Network deployment**

   Structured versus randomized deployment,Network topology, Connectivity in geometric random graphs, Connectivity using power control, Coverage metrics, Mobile deployment

3. **Localization and Time synchronization**

   Key issues, Localization approaches, Coarse-grained node localization using minimal information, Fine-grained node localization using detailed information, Network-wide localization, Theoretical analysis of localization techniques, Key issues of time synchronization,Traditional approaches, Fine-grained clock synchronization, Coarse-grained data synchronization

4. **Wireless characteristics and Medium-access**

   Wireless link quality, Radio energy considerations, The SINR capture model for interference, Traditional MAC protocols, Energy efficiency in MAC protocols, Asynchronous sleep techniques, Sleep-scheduled techniques, Contention-free protocols.

5. **Sleep-based topology control and Energy-efficient routing**

   Constructing topologies for connectivity, Constructing topologies for coverage, Set K-cover algorithms, Cross-layer issues, Metric-based approaches, Routing with diversity, Multi-path routing, Lifetime-maximizing energy-aware routing techniques, Geographic routing, Routing to mobile sinks

6. **Data-centric networking**

   Data-centric routing, Data-gathering with compression, Querying, Data-centric storage and retrieval The database perspective on sensor networks

7. **Transport reliability and congestion control**
   Basic mechanisms and tunable parameters, Reliability guarantees, Congestion control, Real-time scheduling

Textbooks/References

1. Bhaskar Krishnamachari : Networking Wireless Sensors- Cambridge University Press
2. Kazem Sohraby, Daniel Minoli, Taieb Znati : Wireless Sensor Networks:

   Technology, Protocols, and Applications- John Wiley & Sons

EC-742 Wi-Fi Telephony and VoIP

1. **Conventional Telephony and data protocols**

   The Evolution of the Telephone Network, Digitizing Speech, PSTN Architecture, Signaling in the Local Loop, Signaling in the Network, SS7, Call-Setup, Voice and Wireless Networks, The TCP/IP Transport Layer, Transmission Control Protocol (TCP), User Datagram Protocol (UDP).

2. **Voice over IP**

   Motivation for VoIP, Challenges in VoIP, Putting Voice Over Internet, VoIP Architectures, Signaling Protocols, Media Gateway Control Protocol, Megaco/H248, H323, Session Initiation Protocol (SIP)

3. **Wireless LAN and VoWLAN Challenges**

   Network Architecture, 802.11 Framing, Accessing the Medium, PHY, VoWLAN, System Capacity and QoS, Packet Sizes, Packetization Overheads, DCF Overheads, Transmission Rate, Inherent Fairness Among All Nodes, PCF, Admission Control, Security, Roaming/Handoffs in 802.11

4. **QoS and Security issues**

   802.11e, WME and "Vanilla" WLANs, Traffic Categories, Voice Data Coexistence, Achieving QoS for VoWLAN, System Capacity, Authentication in 802.1, Open System Authentication, Shared Key Authentication, Authentication and Handoffs, Confidentiality in 802.1, Data Integrity in 802.11, Loopholes in 802.11 Security, WPA.

5. **Roaming and Power Management**

   Types of Roaming, Roaming Issues, Roaming and Voice, Scanning Types, Scanning Strategies, Inter-ESS Roaming, The Need for Power Management, Power-Aware System Design, Implementing Power Management.

Textbooks/References

1. Praphul Chandra and Lide : Wi-Fi Telephony Challenges and Solutions for Voice over WLANs-2007, Elsevier Inc.
2. Comer, Douglas E. : Internetworking With Tcp/Ip : Principles, Protocols, And Architecture Vol. I- Phi Learning
3. Jonathan Davidson, James Peters, Brian Gracely : Voice over IP Fundamentals- Cisco Press

EC-743 Digital Image Processing and Pattern recognition

1. **Introduction**

   Steps in Digital Image Processing, Components of an Image Processing system, Applications. Human Eye and Image Formation; Sampling and Quantization, Basic Relationship among pixels- neighbour, connectivity, regions, boundaries, distance measures.

2. **Image Enhancement**

   Spatial Domain-Gray Level transformations, Histogram, Arithmetic/Logical Operations, Spatial filtering, Smoothing & Sharpening Spatial Filters; Frequency Domain- 2-D Fourier transform, Smoothing and Sharpening Frequency Domain Filtering; Convolution and Correlation Theorems;

3. **Image Restoration**

   Inverse filtering, Wiener filtering; Wavelets- Discrete and Continuous Wavelet Transform, Wavelet Transform in 2-D;

4. **Image Compression**

   Redundancies- Coding, Interpixel, Psycho visual; Fidelity, Source and Channel Encoding, Elements of Information Theory; Loss Less and Lossy Compression; Run length coding, Differential encoding, DCT, Vector quantization, entropy coding, LZW coding; Image Compression Standards-JPEG, JPEG 2000, MPEG; Video compression;

5. **Image Segmentation**

   Discontinuities, Edge Linking and boundary detection, Thresholding, Region Based Segmentation, Watersheds; Introduction to morphological operations; binary morphology- erosion, dilation, opening and closing operations, applications; basic gray-scale morphology operations; Feature extraction; Classification; Object recognition.

6. **Pattern recognition**

   Introduction to pattern recognition, Pattern Recognition Methods, Pattern Recognition System Design, Statistical Pattern recognition – Classification, Principle, Classifier learning, Neural networks for pattern classification.

Textbooks/References

1. Fundamentals of Digital Image processing- A. K. Jain, Pearson Education
2. Digital Image Processing- R. C. Gonzalez and R. E. Woods, Pearson Education
3. Digital Image Processing using MATLAB- R. C. Gonzalez , R. E. Woods and S. L Eddins, Pearson Education
4. Digital Image Processing and Analysis- Chanda and Mazumdar, PHI