FIRST SEMESTER *Contact Hours: 20 Hrs.*

Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
ECL-101	Research Methodology	3	1	0	40	60	100	4
ECE-(1XX)	Elective-1	3	1	0	40	60	100	4
ECL-102	Information Theory & Coding	3	1	0	40	60	100	4
ECL-103	Wireless Communication	3	1	0	40	60	100	4
ECE-(1XX)	Elective-II	3	1	0	40	60	100	4
TOTAL		15	5	0	200	300	500	20

SECOND SEMESTER *Contact Hours: 24 Hrs.*

Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
ECL-201	Advanced Wireless Communication	3	1	0	40	60	100	4
ECL-202	Simulation of Wireless Communication Systems	3	1	0	40	60	100	4
ECL-203	Soft Computing Techniques	3	1	0	40	60	100	4
ECE (2XX)	Elective-III	3	1	0	40	60	100	4
ECE (2XX)	Elective-IV	3	1	0	40	60	100	4
ECP-201	Design & Wireless Simulation Laboratory	0	0	4	60	40	100	2
TOTAL		15	5	4	260	340	600	22

THIRD SEMESTER *Contact Hours : 18 Hrs.*

Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
ECE-(3XX)	Elective-V	3	1	0	40	60	100	4
ECE-(3XX)	Elective-VI	3	1	0	40	60	100	4
ECS-301	Seminar	0	0	2	100	00	100	2
ECD-301	Dissertation (Part-1)	0	0	8	60*	40	100	8
TOTAL		6	2	10	240	160	400	18

FOURTH SEMESTER *Contact Hours: 24 Hrs.*

Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
ECD-401	Dissertation (Part-II)	24 Hours per week			60*	40**	100	20
TOTAL					60	40	100	20

***To be evaluated by Department Research Committee.**

****To be evaluated by Department Research Committee along with external examiner.**

Elective-I, II, III, IV, V and VI is to be chosen from the set list of elective.

DEPARTMENTAL ELECTIVE

Elective	M. Tech. (Wireless Communication)	
Elective-I	ECE-101	Advanced Digital Signal Processing
	ECE-102	Wireless Sensor Networks
	ECE-103	RF MEMS for Wireless Communications
	ECE-104	Audio and Video Signal Processing
	ECE-105	Adaptive Signal Processing
Elective-II	ECE-106	Advanced Communication Systems
	ECE-107	Detection and Estimation Theory
	ECE-108	Mobile Adhoc Networks
	ECE-109	Optical Network and Photonic Switching
Elective-III	ECE-201	Smart Antennas
	ECE-202	Wireless Network Planning, Optimization and Management
	ECE-203	Microwave and RF Design
	ECE-204	Intellectual Property Rights
Elective-IV	ECE-205	Cryptography and Wireless Security
	ECE-206	Software Defined Radio & Cognitive Radio
	ECE-207	Emerging Technologies in Wireless Communication
	ECE-208	Mobile Network Power Management
Elective-V	ECE-301	Millimeter Wave Communication and Technology
	ECE-302	Space Time Wireless Communication
	ECE-303	Advance Techniques for Wireless Reception
	ECE-304	Coding Techniques for Spread Spectrum Communications
Elective-VI	ECE-305	Semiconductor Millimeter-Wave Devices
	ECE-306	Stochastic Processes and Queuing Theory
	ECE-307	Multimedia Communication and Technology

First Semester

ECL-101 RESEARCH METHODOLOGY

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Overview of Research: Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, completely randomized, randomized block, Latin Square, Factorial, response surfaces.

Unit II Methods of Data Collection: Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules.

Unit III Sampling Methods: Probability sampling: simple random sampling, systematic sampling, stratified sampling, cluster sampling and multistage sampling. Non-probability sampling: convenience sampling, judgement sampling, quota sampling. Sampling distributions.

Unit IV Processing and analysis of Data: Statistical measures and their significance: Central tendencies, variation, skewness, Kurtosis, time series analysis, correlation and regression, Testing of Hypotheses: Parametric (t, z and F) Chi Square, ANOVA, and non-parametric tests.

Unit V Multivariate Analysis: Multiple Regression, Factor Analysis, Discriminant Analysis, Cluster Analysis, multidimensional scaling.

Unit VI Reliability and Validity: Test-retest reliability, alternative-form reliability, internal-comparison reliability, and scorer reliability. Content validity, criterion-related validity, and construct validity, essential of report writing.

Note: Application and use of various softwares for case studies should be essential.

Suggested Readings/ Books:

- Levin R. I., Rubin D.S., *Statistics for Management*, 7th Edition, Pearson Education, New Delhi
- Malhotra N.K., *Marketing Research An Applied Orientation*, 4th Edition, Pearson Education, New Delhi
- Zikmund W. G., *Business Research Methods*, 7th Edition, Thomson South-Western
- Krishnaswami K. N., Sivakumar A. I., Mathirajan M., *Management Research Methodology*, Pearson Education, New Delhi
- Kothari C. R., *Research Methodology Methods and Techniques*, 2nd Edition, New Age International Publishers

ECL-102 INFORMATION THEORY & CODING

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Information Theory: Information ï Entropy, Information rate, classification of codes, Kraft McMillan inequality, Source coding theorem, Shannon-Fano coding, Huffman coding, Extended Huffman coding - Joint and conditional entropies, Mutual information - Discrete memoryless channels ï BSC, BEC ï Channel capacity, Shannon limit.

Unit II Source Coding: Text, Audio And Speech: Text: Adaptive Huffman Coding, Arithmetic Coding, LZW algorithm ï Audio: Perceptual coding, Masking techniques, Psychoacoustic model, MEG Audio layers I,II,III, Dolby AC3 - Speech: Channel Vocoder, Linear Predictive Coding

Unit III Source Coding: Image and Video: Image and Video Formats ï GIF, TIFF, SIF, CIF, QCIF ï Image compression: READ, JPEG ï Video Compression: Principles-I, B, P frames, Motion estimation, Motion compensation, H.261, MPEG standard

Unit IV Error Control Coding: Block Codes: Definitions and Principles: Hamming weight, Hamming distance, Minimum distance decoding - Single parity codes, Hamming codes, Repetition codes - Linear block codes, Cyclic codes - Syndrome calculation, Encoder and decoder - CRC

Unit V Error Control Coding: Convolutional Codes: Convolutional codes ï code tree, trellis, state diagram - Encoding ï Decoding: Sequential search and Viterbi algorithm ï Principle of Turbo coding

Suggested Readings/ Books:

- R Bose, *Information Theory, Coding and Crptography*, TMH 2007
- Fred Halsall, *Multidedia Communications: Applications, Networks, Protocols and Standards*, Perason Education Asia, 2002
- K Sayood, *Introduction to Data Compression*, 3rd Edition, Elsevier 2006
- S Gravano, *Introduction to Error Control Codes*, Oxford University Press 2007
- Amitabha Bhattacharya, *Digital Communication*, TMH 2006

ECL-103 WIRELESS COMMUNICATION

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Physical modelling for wireless channels: Free space, fixed transmit and receive antennas, Free space, moving antenna, Reflecting wall, fixed antenna, Reflecting wall, moving antenna, Reflection from a ground plane, Power decay with distance and shadowing, Moving antenna, multiple reflectors

Unit II Input /output model of the wireless channel: The wireless channel as a linear time-varying system, Baseband equivalent model, discrete-time baseband model, Additive white noise

Unit III Time and frequency coherence: Doppler spread and coherence time, delay spread and coherence bandwidth

Unit IV AWGN channel capacity: Repetition coding, Packing spheres, Capacity-achieving AWGN channel codes, Reliable rate of communication and capacity, Resources of the AWGN channel-Continuous-time AWGN channel, Power and bandwidth, Bandwidth reuse in cellular systems

Unit V Linear time-invariant Gaussian channels: Single input multiple output (SIMO) channel, Multiple input single output (MISO) channel, Frequency-selective channel

Unit VI Capacity of fading channels: Slow fading channel, Receive diversity, Transmit diversity, Transmit and receive diversity, Time and frequency diversity, Outage for parallel channels, Fast fading channel, Transmitter side information, Frequency-selective fading channels

Unit VII Uplink and Downlink AWGN channel: Capacity via successive interference cancellation, Comparison with conventional CDMA, Comparison with orthogonal multiple access, General K-user uplink capacity, Symmetric case: two capacity achieving schemes, General case: superposition coding achieves capacity

Unit VIII Uplink and Downlink fading channel: Slow fading channel, Fast fading channel, Full channel side information, Channel side information at receiver only, Full channel side information, Frequency-selective fading channels

Unit IX Multiuser diversity: Multiuser diversity gain, Multiuser versus classical diversity, Fair scheduling and multiuser diversity, Channel prediction and feedback, Opportunistic beam forming using dumb antennas, Multiuser diversity in multicell systems

Unit X Physical modeling of MIMO channels: Line-of-sight SIMO channel, Line-of-sight MISO channel, Antenna arrays with only a line-of-sight path, Geographically separated antennas, Line-of-sight plus one reflected path, MIMO multipath channel, Angular domain representation of signals, Angular domain representation of MIMO channels, Statistical modeling in the angular domain, Degrees of freedom and diversity, Dependency on antenna spacing.

Suggested Readings/ Books:

- Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005
- David Tse, Pramod Viswanath, Fundamentals of Wireless Communications, Cambridge University Press 2005

ECE-101 ADVANCED DIGITAL SIGNAL PROCESSING

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Review: Fourier Transforms, Z-Transforms, Discrete Fourier Transform, Fast Fourier Transform, Convolution And Correlation.

Unit II Design of digital filters: Introduction to filter design, types of digital filters,choosing between, fir and iir filters, filter design steps, effect of finite register length in filter design, realization of iir digital filters and fir digital filter, design of iir filters from continuous time filters, design of fir filters by windowing.

Unit III Digital signal processors: General and special purpose digital signal processors, computer architecture for signal processing, selecting digital signal processors, architecture and programming of ADSP 2181 processor.

Unit IV Spectrum estimation: non-parametric methods correlation method, co-variance estimator, performance analysis of estimators, consistent estimators, ar, ma, ARMA signal modeling parameter estimation using Yule-walker method.

Unit V Linear estimation and predication: Maximum likelihood criterion efficiency of estimator, least mean squared error criterion, recursive estimators, and linear predications.

Unit VI Multirate digital signal processing: Mathematical description of change of sampling rate, interpolation and decimation, continuous time model, direct digital domain approach, interpolation and decimation by an integer factor, single and multistage realization, applications of sub band coding.

Unit VII Adaptive Filters: Applications Of Adaptive Filters, Adaptive Direct Form FIR Filters: The LMS Algorithm, Adaptive Lattice Ladder Filters, Recursive Least Squares Lattice Ladder Algorithms.

Suggested Readings/ Books:

- Monson H. Hayes, *Statistical Digital Signal Processing and Modeling*, John Wiley and Sons, New York, 1996
- Emmanuel C. Ifeachor Barrie W. Jervis, *Digital Signal Processing*, Pearson Education, Asia
- Proakes Manolakis, *Digital Signal Processing principles, algorithms, and applications*, Prentice Hall India
- *ADSP 2181 manuals*
- Keshab K. Parhi, *VLSI DSP Systems; Design & implementation*, Wiley Inter Science Publishers
- Moonen, Ian k. Proudler, *Algorithms for statistic*

ECE-102 WIRELESS SENSOR NETWORKS

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Introduction: Introduction to Wireless sensor networks, Definitions and background, Challenges and constraints, Single-sink single-hop WSN, Single-sink multi-hop WSN, Multi-sink multi-hop WSN, Advantages of sensor networks.

Unit II Applications of WSNs: Positioning and animals tracking, Entertainment, Logistics, Transportation, Industrial Control and Monitoring, Home Automation and Consumer Electronics, Security and Military Sensing, Asset Tracking and Supply Chain Management, Intelligent Agriculture and Environmental monitoring, Health Monitoring.

Unit III Node Structure: The Sensing Subsystem, Analog-to-Digital Converter, The Processor Subsystem, Architectural Overview, Microcontroller, Digital Signal Processor, Application-specific Integrated Circuit, Field Programmable Gate Array, Comparison Communication Interfaces, Serial Peripheral Interface, Inter-Integrated Circuit, Prototypes, The IMote Node Architecture, The XYZ Node Architecture, The Hogthrob Node Architecture

Unit IV Technologies for WSNs: ZigBee technology, Ultrawide bandwidth technology, Bluetooth technology, Comparison among technologies

Unit V The Physical Layer: Introduction, Wireless Propagation Models: The Free Space Propagation Model, The Two-Ray Ground Model, The Log-Distance Path Model, Energy Dissipation Model, Error Models: The Independent Error Model, The Two-State Markov Error Model, Sensing Models: The Binary Sensing Model, The Probabilistic Sensing Model

Unit VI Communication Protocols for WSNs: MAC protocols: Scheduled protocols, LEACH protocol, Guo protocol, TRAMA protocol, Contention-based protocols, Zhong protocol, DMAC protocol, PAMAS protocol, SMAC protocol.

Unit VII Routing Protocols: Issues in designing routing protocols, Classification of routing protocols, Flat routing, Flooding and gossiping, SPIN protocol, Directed diffusion protocol, Rumour routing, Gradient-based routing, Hierarchical routing, LEACH protocol, PEGASIS protocol, TEEN protocol, MECN protocol, SPAN protocol, Location-based routing protocols, GAF protocol, GEAR protocol, GeRaF protocol, Rugin protocol.

Suggested Readings/ Books:

- Kazem Sohraby, Daniel Minoli, Taieb Znati, *Wireless Sensor Networks: Technology, Protocols, and Applications*, Wiley Inter Science
- Edgar H. Callaway, *Wireless Sensor Networks: Architectures and Protocols*, Jr. Auerbach Publications, CRC Press
- C. S Raghavendra, Krishna M, Sivalingam, Taieb Znati, *Wireless Sensor Networks*, Springer
- Bhaskar Krismachari, *Networking Wireless Sensors*, Cambridge University Press
- Victor Lesser, Charles L. Ortiz, Milind Tambe, *Distributed Sensor Networks: A Multiagent Perspective*, Kluwer Publications
- Feng Zhao, Leonidas Guibas, *Wireless Sensor Networks: An Information Processing Approach*, Morgan Kaufmann Series in Networking 2004
- Waltenegus Dargie, Christian Poellabauer, *Fundamentals of Wireless Sensor Networks: Theory And Practice*, John Wiley & Sons, August 2010

ECE-103 RF MEMS FOR WIRLESS COMMUNICATIONS

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Introduction: Spheres of wireless activities, the home and office, the ground fixed/mobile platform, the space platform, wireless standards, systems and architectures, wireless standards, conceptual wireless systems, wireless transceiver architectures, power and bandwidth-efficient wireless systems & challenges, MEMS based wireless appliances enable ubiquitous connectivity. Physical aspects of RF circuit design, skin effect, transmission lines on thin substrates, self-resonance frequency, quality factor packaging, practical aspects of RF circuit design, dc biasing, impedance mismatch effects in RF MEMS.

Unit II Enabled Circuit Elements: RF/Microwave substrate properties, Micro machined ï enhanced elements ï capacitors, inductors, varactors, MEM switches ï shunt MEM switch, low voltage hinged MEM switch approaches, push-pull series switch, folded ï beam ï springs suspension series switch.

Unit III Resonators & Enabled Circuits: transmission line planar resonators, cavity resonators, micromechanical resonators, film bulk acoustic wave resonators, MEMS modeling ï mechanical modeling, electromagnetic modeling. Enabled circuits ï reconfigurable circuits ï the resonant MEMS switch, Capacitors, inductors, tunable CPW resonator, MEMS microswitch arrays.

Unit IV Reconfigurable Circuits: Double ï stud tuner, Nth ï stub tuner, filters, resonator tuning system, massively parallel switchable RF front ends, true time-delay digital phase shifters, Reconfigurable antennas ï tunable dipole antennas, tunable microstrip patch-array antenna. Phase shifters-fundamentals, X-Band RF MEMS Phase shifter for phased array applications, Ka-Band RF MEMS Phase shifter for radar systems applications.

Unit V Filters & Oscillators: Film bulk acoustic wave filters ï FBAR filter fundamentals, FBAR filter for PCS applications, RF MEMS filters ï A Ka-Band millimeter-wave Micromachined tunable filter, A High-Q 8-MHz MEM Resonator filter, RF MEMS Oscillators ï fundamentals, A 14-GHz MEM Oscillator, A Ka-Band Micromachined cavity oscillator, A 2.4 GHz MEMS based voltage controlled oscillator.

Suggested Readings/ Books:

- Hector J. De Los Santos, RF MEMS Circuit Design for Wireless Communications, Artech House, 2002
- Vijay K. Varadan, K. J. Vinoy, K. A. Jose., RF MEMS and their Applications, John Wiley and sons, Ltd., 2002
- Gabriel M. Rebeiz, RF MEMS Theory, Design & Technology, Wiley Interscience, 2002

ECE-104 AUDIO AND VIDEO SIGNAL PROCESSING

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I: Limitation of natural reverberation by electronic devices, circuit solutions of Schroeder reverberators based on DSP. Systems of audio signal processing for home theatres 3D sound, Dolby Pro Logic, Dolby Digital, DTS, THX , coding and decoding of audio signals.

Unit II: Systems of synthesis of natural and unnatural sounds, sound paradoxes. Properties, algorithms of computation, application of wavelet transform and wavelet systems to separate noise and undesirable components of audio signals and video signals. Methods a algorithms of preprocessing and post processing of images in spatial and frequency domain with application of discrete orthogonal 2D transformations.

Unit III: Modern methods of digital coding of images and video sequences entropic, predictive, transform, hybrid, hierarchical, subband, wavelet. Intraframe and predictive interframe source coding of video sequences with movement estimation. Nonlinear and invariant transforms in applications of image processing and coding and movement estimation in video sequences.

Unit IV: International standardized codecs in systems DVB T,C,S a DVB H for mobile communication systems 31/2 a 4G. Methods of channel coding and decoding of digital video signals, digital modulations and demodulations in systems DVB T,C,S,H.

Suggested Readings/ Books:

- Branderburg K., Kahrs M., *Applications of Digital Signal Processing to Audio and Acoustics*, New York, Kluwer Academic Publishers, 2002
- Russ, M., *Sound Synthesis and Sampling*, Amsterdam, Focal Press, 2004
- Vaseghi S., *Multimedia Signal Processing - Theory and Applications in Speech, Music and Communications*, Chichester, England, John Wiley & Sons, 2007
- Zözler U., *Digital Audio Signal Processing*, Chichester, England, John Wiley & Sons, 2008
- Park T., *Introduction to Digital Signal Processing Computer Musically Speaking*, New Jersey, World Scientific Publishing Co., 2010

ECE-105 ADAPTIVE SIGNAL PROCESSING

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit 1 introduction to Adaptive Filters: Adaptive filter structures, issues and examples, Applications of adaptive filters, Channel equalization, active noise control, Echo cancellation, beam forming.

Unit II Discrete time stochastic processes: Re-visiting probability and random variables, Discrete time random processes, Power spectral density ï properties, Autocorrelation and covariance structures of discrete time random processes, Eigen-analysis of autocorrelation matrices.

Unit III Wiener filter, search methods and the LMS algorithm: Wiener FIR filter (real case), Steepest descent search and the LMS algorithm, Extension of optimal filtering to complex valued input, The Complex LMS algorithm.

Unit IV Convergence and Stability Analyses: Convergence analysis of the LMS algorithm, Learning curve and mean square error behavior, Weight error correlation matrix, Dynamics of the steady state mean square error (MSE), Misadjustment and stability of excess MSE.

Unit V Variants of the LMS Algorithm: The sign-LMS and the normalized LMS algorithm, Block LMS, Review of circular convolution, Overlap and save method, circular correlation, FFT based implementation of the block LMS Algorithm.

Unit VI Vector space framework for optimal filtering: Axioms of a vector space, examples, subspace, Linear independence, basis, dimension, direct sum of subspaces, Linear transformation, examples, Range space and null space, rank and nullity of a linear operator, Inner product space, orthogonality, Gram-Schmidt orthogonalization, Orthogonal projection, orthogonal decomposition of subspaces, Vector space of random variables, optimal filtering as an orthogonal projection computation problem.

Unit VII The lattice filter and estimator: Forward and backward linear prediction, signal subspace decomposition using forward and backward predictions, Order updating the prediction errors and prediction error variances, basic lattice section, Reflection coefficients, properties, updating predictor coefficients, Lattice filter as a joint process estimator, AR modeling and lattice filters, Gradient adaptive lattice.

Unit VIII RLS lattice filter: Least square (LS) estimation, pseudo-inverse of a data matrix, optimality of LS estimation, Vector space framework for LS estimation, Time and order updating of an orthogonal projection operator, Order updating prediction errors and prediction error power, Time updating PARCOR coefficients.

Suggested Readings/ Books:

- S. Haykin, *Adaptive Filter Theory*, Prentice Hall, Englewood Cliffs, NJ, 1991
- B. Farhang, *Boroujeny, Adaptive Filters - Theory and Applications*, John Wiley and Sons, 1999

ECE-106 ADVANCED COMMUNICATION SYSTEMS

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Introduction: Introduction to communications systems, analog and digital communication systems, Applications of communication systems.

Unit II Digital Communication: Introduction, Digital Modulation techniques, BPSK, QPSK, PCM, DPCM, Delta Modulation, Digital Transmission and Transmission Impairments.

Unit III Optical Networks: WDM, TDM, Telecommunication Infrastructure, Switching, 3G systems, SONET, SDH, Architecture of Optical Transport Network, Link Management Protocols, Solutions.

Unit IV Satellite Communication: Basic Transmission Theory, System Noise Temperature and G/T Ratio, Design Of Down Links, Domestic Satellite Systems Using Small Earth Stations, Uplink Design, Design Of Satellite Link For Specified (C/N). Multiple Access Techniques, Frequency Division Multiple Access(FDMA), TDMA, CDMA, Estimating Channel Requirements, Practical Demand Access Systems, Random Access, Multiple Access With On Board Processing. VSAT

Unit V Mobile Communications: Mobile telephone service, Transmission protocols, Introduction to GSM, GPRS, CDMA, Switching techniques, Fading, Quality of service (QOS).

Suggested Readings/ Books:

- Wayne Tomasi, *Advanced Communication Systems,* Pearson
- Proakis J. G., *Digital Communication*, PHI
- Uyless Black, *Optical Networks*, Pearson
- Timothy Pratt, *Satellite Communication,* Addison Wesley
- Related IEEE/IEE publications

ECE-107 DETECTION AND ESTIMATION THEORY

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Background: Review of Gaussian variables and processes; problem formulation and objective of signal detection and signal parameter estimation in discrete-time domain.

Unit II 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.

Unit III Detection of Deterministic Signals: Matched filter detector and its performance; generalized matched filter; detection of sinusoid with unknown amplitude, phase, frequency and arrival time, linear model.

Unit IV Detection of Random Signals: Estimator-correlator, linear model, general Gaussian detection, detection of Gaussian random signal with unknown parameters, weak signal detection.

Unit V Nonparametric Detection: Detection in the absence of complete statistical description of observations, sign detector, Wilcoxon detector, detectors based on quantized observations, robustness of detectors.

Unit VI Estimation of Signal Parameters: Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, sufficient statistics, minimum statistics, complete statistics; linear models; best linear unbiased estimation; maximum likelihood estimation, invariance principle; estimation efficiency; Bayesian estimation: philosophy, nuisance parameters, risk functions, minimum mean square error estimation, maximum a posteriori estimation.

Unit VII Signal Estimation in Discrete-Time: Linear Bayesian estimation, Weiner filtering, dynamical signal model, discrete Kalman filtering.

Suggested Readings/ Books:

- H. L. Van Trees, *Detection, Estimation and Modulation Theory: Part I, II, and III,* John Wiley, NY, 1968
- H. V. Poor, *An Introduction to Signal Detection and Estimation*, Springer, 2nd Edition, 1998
- S. M. Kay, *Fundamentals of Statistical Signal Processing: Estimation Theory*, Prentice Hall PTR, 1993

ECE-108 MOBILE AD HOC NETWORKS

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Introduction: Introduction to adhoc networks ï definition, characteristics features, applications, Charectristics of Wireless channel, Adhoc Mobility Models:- Indoor and outdoor models.

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

Unit III Network Protocols: Routing Protocols: Design issues, goals and classification. Proactive Vs reactive routing, Unicast routing algorithms, Multicast routing algorithms, hybrid routing algorithm, Energy aware routing algorithm, Hierarchical Routing, QoS aware routing.

UNIT IV End-End Delivery and Security: Transport layer : Issues in desiging- Transport layer classification, adhoc transport protocols. Security issues in adhoc networks: issues and challenges, network security attacks, secure routing protocols.

UNIT V Cross Layer Design and Integration of Adhoc For 4G: Cross layer Design: Need for cross layer design, cross layer optimization, parameter optimization techniques, Cross layer cautionary prespective. Intergration of adhoc with Mobile IP networks.

Suggested Readings/ Books:

- C. Siva Ram Murthy, B. S. Manoj, *Ad hoc Wireless Networks Architectures and protocols*, 2nd Edition, Pearson Education, 2007
- Charles E. Perkins, *Ad hoc Networking*, Addison, Wesley, 2000
- Stefano Basagni, Marco Conti, Silvia Giordano, Ivan Stojmenovic, *Mobile Adhoc Networking,* Wiley-IEEE Press, 2004
- Mohammad Ilyas, *The handbook of Adhoc Wireless Networks,* CRC press, 2002

ECE-109 OPTICAL NETWORK AND PHOTONIC SWITCHING

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

UNIT I Ray Theory Analysis & Transmission Characteristics: Fibre Optic Guides, Light wave generation systems, systems components, optical fibers, SI, GI fibre, modes, Dispersion in fibers limitations due to dispersions, fibre loss, non liner effects.

UNIT II Optical Transmitters & Receivers: Optical Transmitters and Fibres, Basic concept, spectral distribution, semiconductor lasers, gain coefficients, modes. Transmitter design, Receive PIN and APD diodes,SNR. Switches, Coherent, homodyne and Hetro dyne keying formats, BER in synchronous and Asynchronous.

UNIT III Compensation Techniques: Amplifiers, Basic concepts, Semiconductor laser amplifiers Raman and Brillouin-fibre amplifiers, Erbium doped-fibre and amplifiers, pumping phenomenon Dispersion Compensation Limitations, post and pre-compensation techniques, equalizing filters, SONET/SDH.

UNIT IV Passive Optical Networks: Architectures And Protocols: PON Architectures, Network Dimensioning and operation, Power Budget, FTTx , Broadband PON: architecture, protocol and Service, Bandwidth allocation. Gigabit-Capable PON. Burst switching, Ethernet PON Architecture, 10GEPON PMD Architecture.

UNIT V Wire Line Techniques: Wire line Narrowband, XDSL, Wire line broad band, Very High Bit Rate Digital Subscriber Line (VDSL), Cable MODEM Home Networks, & VDSL Transmission Protocols. DOCSIS-Standards.

Suggested Readings/ Books:

- G. Keiser, *Optical Communications Essentials*, 1st Reprint, Tata McGraw Hill, 2008
- G. Keiser, *Optical Fibre Communication System*, McGraw Hill, New York, 2000
- J. M. Pitts & J. A. Schormans, *Introduction to IP and ATM Design and Performance*, 2nd Edition, Wiley, 2000
- G. P. Agarwal, *Fibre Optic Communication System*, 2nd Edition, John Wiley & b sons, New York 1997
- Franz, Jain, *Optical Communication System*, Narosa Publications, New Delhi, 1995
- Leonid G. Kazovsky, Ning Cheng, Wei-Tao Shaw, David Gutierrez, Shing-Wa Wong, *Broadband Optical Access Networks*, John Wiley and Sons, New Jersey, 2011

Second Semester

ECL–201 ADVANCED WIRELESS COMMUNICATION

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Review of Fundamentals of Wireless Communication: Multipath fading, multipath channel models, and capacity of wireless channels.

Unit II Performances of Digital Modulation over Wireless Channels: AGWN channels signal to noise power ratio and bit/symbol energy, error probability for BPSK, QPSK, MPSK, MPAM, MQAM- their comparison.

Unit III Multicarrier Modulation: Data transmission using multiple carriers, multicarrier modulatuion with overlapping sub channels, mitigation of subcarrier fading, discrete implementation of multicarrier modulation, challenges in multicarrier systems.

Unit IV Introduction to Wireless OFDM: OFDM principles, system model, generation of sub carrier using IFFT, guard time, cyclic extension, windowing, OFDM parameters, OFDM signal processing, coherent and differential detection

Unit V OFDMA: frequency hopping in OFDMA, difference between OFDMA and MC-CDMA, OFDMA system description-channel coding, frequency synchronization, initial modulation timing and frequency offset synchronization accuracy, random frequency hopping operation, applications of OFDMA.

Suggested Readings/ Books:

- Goldsmith, *Wireless Communications*, Cambridge Univ. Press, 2005
- R. Vannee, R. Prasad, *OFDM for Wireless Multimedia Communication*, Artech House, 2000
- M. Engels, *Wireless OFDM systems*, Klumer Academic Publishers, 2002

ECL-202 SIMULATION OF WIRELESS COMMUNICATION SYSTEMS

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Introduction to simulation approach: Methods of performance evaluation-simulation approach-Advantages and limitations. System model steps and its types involved in simulation study. Error sources in simulation. Role of simulation in communication system and random process. Introduction to random variables - univariate models (discrete and continuous) and multi-variate models.

Unit II Review of Stochastic process and parameter estimation: Stochastic process: Definitions, properties ï stationarity, time averaging and ergodicity, random process models. Parameter estimation: Quality of an estimator, estimating average power probability density function, estimation of power spectral density of a process, delay and phase. SNR estimation and importance sampling.

Unit III Numerical methods for wireless Communication Systems: numerical differentiation, integration, differential equation.

Unit IV Monte Carlo simulation: concepts and integration, Application in wireless Communication Systems.

Unit V Modelling of Communication systems: properties, generation and techniques for generating random numbers and processes. Introduction to modeling of communication systems - Information sources, source coding, base band modulation, channel coding, RF and optical modulation, filtering, multiplexing, detection/demodulation- carrier and timing recovery for BPSK and QPSK. Modeling considerations for PLL.

Unit VI Communication channel models

Statistical characterization of multipath channels and time-varying channels with Doppler effects, models for multipath fading channels. Finite state channel models ï channels with and without memory. Methodology for simulating communication systems operating over fading channels.

Suggested Readings/ Books:

- M. C. Jeruchim, Philip Balaban, K. Sam shanmugam, *Simulation of communication systems*, Plenum Press, New York, 1992
- M. Law, W. David Kelton, *Simulation Modelling and analysis*, McGraw Hill, New York, 1999
- K. Hayes, *Modelling and Analysis of computer communication networks*, Plenum press, New York, 1984
- Banks, J. S. Carson, Nelson, D. M. Nicol, *Discrete –Event system simulation*, Prentice Hall of India, 4th Edition, 2005
- Z. Peebles , *Probability, Random Variable and Random Signal Principles*, Tata McGraw Hill, 4th Edition 2002

ECL-203 SOFT COMPUTING TECHNIQUES

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Artificial Neural Network: Basic concept of Soft Computing; Basic concept of neural networks, Mathematical model, Properties of neural network, Typical architectures: single layer, multilayer, competitive layer; Different learning methods: Supervised, Unsupervised & reinforced; Common activation functions; Feed forward, Feedback & recurrent N.N; Application of N.N; Neuron. Pattern Recognition: Pattern Classification, Pattern Association, Clustering, Simple Clustering algorithm, k-means & k-medoid based algorithm. Models Of Neural Network: Architecture, Algorithm & Application of -- McCulloh-Pitts, Hebb Net, Perceptron (with limitations & Perceptron learning rule Convergence theorem), Back propagation NN, ADALINE, MADALINE, Discrete Hopfield net, BAM, Maxnet , Kohonen Self Organizing Maps, ART1, ART2.

Unit II Fuzzy Sets & Logic: Fuzzy versus Crisp; Fuzzy setsð membership function, linguistic variable, basic operators, properties; Fuzzy relationsð Cartesian product, Operations on relations; Crisp logicð Laws of propositional logic, Inference; Predicate logicð Interpretations, Inference; Fuzzy logicð Quantifiers, Inference; Fuzzy Rule based system; Defuzzification methods; FAM

Unit III Genetic Algorithm: Basic concept; role of GA in optimization, Fitness function, Selection of initial population, Cross over(different types), Mutation, Inversion, Deletion, Constraints Handling; Evolutionary Computation; Genetic Programming; Schema theorem; Multiobjective & Multimodal optimization in GA; Applicationð Travelling Salesman Problem

Unit IV Hybrid soft computing Techniques: GA based BPNN(Weight determination, Application); Neuro Fuzzy Systemsð Fuzzy BPNN--fuzzy Neuron, architecture, learning, application; Fuzzy Logic controlled G. A.

Suggested Readings/ Books:

- S. N. Sivanandam,S.N. Deepa, *Principles of Soft Computing*, Wiley India
- Simon Haykin, *Neural Networks- A Comprehensive foundation*, 2nd Edition Pearson
- T. S. Rajasekaran, G. A. Vijaylakshmi Pai, *Neural Networks, Fuzzy Logic & Genetic Algorithms – Synthesis & applications*, PHI
- Sanchez, Takanori, Zadeh, *Genetic Algorithm & fuzzy Logic Systems*, World Scientific
- Goldberg David E., *Genetic Algorithm*, Pearson
- Zimmermann H. J., *Fuzzy Set Theory & Its Applications*, Allied Publishers

ECP-201 DESIGN & WIRELESS SIMULATION LABORATORY

Internal Marks	External Marks	Total Marks	Credits
60	40	100	2

L	T	P
-	-	4

List of Experiments:

1. Generation of Voice, Data and Video traffic.
2. Simulation of the Radio Channel.
3. Simulation of Hand off mechanisms.
4. Simulation of CDMA Transmitter and Receiver.
5. Coding Techniques for Wireless Communication.
6. Link Budget.33
7. Simulation of Security Algorithms.
8. Study of Glomosim and NS2.

ECE-201 SMART ANTENNAS

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Introduction to Smart Antennas: Why smart antennas, benefits of smart antennas, spatial processing for wireless systems, wideband smart antennas, historical development

Unit II Antenna Fundamentals: Antenna field regions, power density, radiation intensity, antenna nomenclature, friis transmission formula, linear antennas, loop antennas.

Unit III Array Fundamentals: Linear arrays, array weighting, circular arrays, rectangular arrays, fixed beam and retrodirective arrays.

Unit IV Beam Forming Basics: Maximum signal to interference ratio, minimum mean square ratio, minimum variance, adaptive beamforming, description of new SDMA receiver, software radios for smart antennas.

Unit V Smart Antenna Techniques for CDMA: Non-coherent CDMA spatial processors, coherent CDMA spatial processors and the spatial processing rake receiver, multi-user spatial processing, dynamic re-sectoring using smart antennas, downlink beam forming for CDMA.

Suggested Readings/ Books:

- Gross F. B., Smart Antennas for Wireless Communications with MATLAB, McGraw-Hill, New York, 2005.
- Balanis A., Antenna Theory Analysis and Design, John Wiley and Sons, New York, 1982
- Joseph C. Liberti, Theodore S. Rappaport, Smart Antennas for Wireless Communications: IS95 and third generation CDMA Applications, Prentice Hall Communications Engineering and Emerging Technologies Series

ECE-202 WIRELESS NETWORK PLANNING, OPTIMIZATION AND MANAGEMENT

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Introduction to Radio Network Planning and Optimisation - Future Trends -Towards a Service-driven Network Management - Wireless Local Area Networks (WLANs) - Next-generation Mobile Communication

Unit II WCDMA Radio Network Planning: WCDMA Radio Network Planning: Dimensioning - Detailed Planning - Verification of Dimensioning with Static Simulations - Verification of Static Simulator with Dynamic Simulations - Optimisation of the Radio Network Plan.

UNIT III WCDMA–GSM Co-Planning Issues: WCDMAï GSM Co-planning Issues - Radio Frequency Issues ï Radio Network Planning Issues; Coverage and Capacity Enhancement Methods - Techniques for Improving Coverage - Techniques for Improving Capacity

Unit IV Radio Resource Management: Radio Resource Utilisation: Introduction to Radio Resource Management - Power Control - Handover Control - Congestion Control ï Resource Management; RRU for High-speed Downlink Packet Access (HSDPA) - Impact of Radio Resource Utilisation on Network Performance.

Unit V Radio Network Optimisation: Radio Network Optimisation Process - Introduction to Radio Network Optimisation Requirements - Introduction to the Telecom Management Network Model - Tools in Optimisation; Advanced Analysis Methods and Radio Access Network Autotuning - Advanced Analysis Methods for Cellular Networks - Automatic Optimisation.

Suggested Readings/ Books:

- Jaana Laiho, Achim Wacker, Tomas Novosad, *Radio Network Planning and Optimisation*, John Wiley, 2006
- Morten Tolstrup, *Indoor Radio Planning: A Practical Guide for GSM, DCS, UMTS and HSPA*, John Wiley, 2008
- IanaSiomina, *Radio Network Planning and Resource Optimization*, LiU-Tryck, Link¨oping, Sweden, 2007

ECE-203 MICROWAVE & RF DESIGN

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Networks and Matrices: Scattering and chain scattering matrices, Generalized scattering matrix, Analysis of two port networks, Interconnection of networks. Positive real concepts, scattering matrix, representation of microwave components (directional coupler, circulators, hybrids and isolators).

Unit II High Frequency Circuit Design: Tuned Circuits, Filter design- Butterworth filter, Chebyshev filter, impedance matching. High frequency amplifier, BJT and FET amplifier, Broadband Amplifiers RF Oscillators, Colpitts, Hartley Oscillators, PLL. High Frequency Integrated Circuits.

Unit III Microwave Amplifier Design: Types of amplifiers, Power gain equations. Introduction to narrow band amplifiers basic concepts, Maximum gain design, Low noise design. High power design, Negative resistance, reflection amplifiers ï various kinds ï stability considerations, Microwave transistor amplifier design ï input and output matching networks ï constant noise figure circuits.

Unit IV Microwave Transistor Oscillator Design: One port and two port negative resistance oscillators. Oscillator configurations, Oscillator design using large signal measurements, Introduction to Microwave CAD packages, Microwave integrated circuits, MIC design for lumped elements.

Unit V RF and Microwave Antennas: Radiation from surface current and line current distribution, Basic Antenna parameters, Feeding structure-Patch Antenna, Ring Antenna, Micro strip dipole, Micro strip arrays, Traveling wave Antenna, Antenna System for Mobile Radio-Antenna Measurements and Instrumentation. Propagation characteristics of RF and Microwave signals, Introduction to EBG structures.

Suggested Readings/ Books:

- Matthew M. Radmanesh, *RF and Microwave Design Essentials*, Author House, Bloomington, 2007
- Daniel Dobkin, *RF Engineering for Wireless Networks*, Elsevier, London, 2005
- Reinhold Ludwig, Gene Bogdanov, *RF Circuit Design – Theory and Applications*, 2nd Edition, Pearson, 2012
- E.da Silva, *High Frequency and Microwave Engineering*, Butterworth Heinmann Publications, Oxford, 2001.
- David M. Pozar, *Microwave Engineering*, John Wiley and Sons,3rd Edition, 2005
- Kraus J. D, Marhefka. R. J. Khan A. S. *Antennas for All Applications*, 3rd Edition, Tata McGraw Hill, 2006
- Balanis A, *Antenna Theory Analysis and Design*, John Wiley and Sons, New York, Third Edition, 2005

ECE-204 INTELLECTUAL PROPERTY RIGHTS

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Overview of Intellectual Property: introduction and the need for intellectual property right (IPR) IPR in India ï Genesis and Development IPR in abroad Some important examples of IPR

Unit II Patents: Macro economic impact of the patent system, Patent and kind of inventions protected by a patent, Patent document, How to protect your inventions? Granting of patent, Rights of a patent, How extensive is patent protection? Why protect inventions by patents? Searching a patent, Drafting of a patent, Filing of a patent, The different layers of the international patent system, (national, regional and international options), Utility models, Differences between a utility model and a patent? Trade secrets and know-how agreements

Unit III Copyright: What is copyright? What is covered by copyright? How long does copyright last? Why protect copyright? RELATED RIGHTS What are related rights? Distinction between related rights and copyright? Rights covered by copyright?

Unit IV Trademarks: What is a trademark? Rights of trademark? What kind of signs can be used as trademarks? types of trademark function does a trademark perform How is a trademark protected? How is a trademark registered? How long is a registered trademark protected for ? How extensive is trademark protection? What are well-known marks and how are they protected? Domain name and how does it relate to trademarks?

Unit V Geographical Indications: What is a geographical indication? How is a geographical indication protected? Why protect geographical indications?

Unit VI Industrial Designs: What is an industrial design? How can industrial designs be protected? What kind of protection is provided by industrial designs? How long does the protection last? Why protect industrial designs?

Unit VII Unfair Competition: What is unfair competition? relationship between unfair competition and intellectual property laws?

Unit VIII Enforcement of Intellectual Property Rights: Infringement of intellectual property rights Enforcement Measures

Suggested Readings/ Books:

- T. M Murray, M. J. Mehlman, *Encyclopedia of Ethical, Legal and Policy issues in Biotechnology*, John Wiley & Sons 2000
- Ajit Parulekar, Sarita DôSouza, *Indian Patents Law – Legal & Business Implications;* Macmillan India Ltd. 2006
- B. L.Wadehra, *Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications;* Universal law Publishing Pvt. Ltd., India 2000
- P. Narayanan, *Law of Copyright and Industrial Designs*, Eastern Law House, Delhi, 2010

ECE-205 CRYPTOGRAPHY AND WIRELESS SECURITY

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Number Theory and Cryptography: Mathematics of cryptography - integer arithmetic, modular arithmetic, linear congruence, GF (2n), algebraic structures, primes, Eulerʹs phi & totient functions, Fermatʹs and Eulerʹs theorem, primality testing, factorization, CRT, quadratic congruence, exponentiation and logarithm, elliptic curve cryptosystem, symmetric key cryptography - substitution, transposition, modern block ciphers, and its applications.

Unit II Integrity, Authentication and Key Mangement: Introduction to message integrity, hash functions and digital signature, SHA-512, MAC & MDC, HMAC, CMAC, digital signature- DSA,ECDSA, Entity authentication-passwords, challenge-response, zero-knowledge, key management-PKI, symmetric key agreement, RSA ,ElGammal, information theory, and elementary probability, complexity of algorithm.

Unit III Security Practice & System Security: Electronic Mail Security ï PGP, S/MIME, IPSec, Secure Electronic Transaction, web security considerations ï SSL, TLS, IDS-password management, viruses and related threats, viruses counter measures, firewalls design principles, types of firewalls, configurations, trusted systems.

Unit IV Wireless Threats: Introduction to wireless technologies- history, challenges, risks, advances in wireless security, Radio Frequency ï RF Terminology, interference, covert channels, and hardware. Hacking 802.11 wireless technologies- eavesdropping, jamming - wireless channel vulnerability analysis, Wi-Fi cyber crimes and awareness- countermeasures - wireless security standards wireless setup, risks and security controls.

Unit V Wireless Security: 802.11i - Attacks, WPA-EAP, Attacking 802.11 Networks- Basic Types Of Attacks, Security Through Obscurity, Defeating WEP, WEP attacks, 802.11 Authentication Types, Attacking WPA-Protected 802.11, Breaking WPA, LEAP,EAP-TLS, Tunneling EAP Techniques, Hacking Attacking 802.11i wireless technologies- Hacking hotspots, client attacks resources, threats of Bluetooth-advanced attacks- layer 2 fragmentations breaking the silence, layer 2 and layer 3 resolutions.

Suggested Readings/ Books:

- Behrouz Forouzan, Cryptography & Network Security, Tata McGraw Hill, 2008
- Johnny Cache, Vincent Liu, Hacking Exposed Wireless: Wireless Security secrets And Solutions, Tata McGraw Hill, 2007
- William Stallings, Cryptography & Network Security ï Principles and Practices, Pearson Education, Fourth Edition, 2006
- Doughas R. Stinson, Cryptography-Theory and Practice, CRC Press,1995
- Wolfgang Osterhage, Wireless Security, CRC Press, 2011
- Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Cengage Learning, 4th Edition, 2011

ECE-206 SOFTWARE DEFINED RADIO AND COGNITIVE RADIO

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I SDR concepts & history, Benefits of SDR, SDR Forum, Ideal SDR architecture, SDR Based End-to-End Communication, Worldwide frequency band plans, Aim and requirements of the SCA. Architecture Overview, Functional View, Networking Overview, Core Framework, Real Time Operating Systems.

Unit II Common Object Request Broker Architecture (CORBA), SCA and JTRS compliance, Radio Frequency design, Baseband Signal Processing, Radios with intelligence.

Unit III Smart antennas, Adaptive techniques, Phased array antennas, Applying SDR principles to antenna systems, Smart antenna architectures, Low Cost SDR Platform, Requirements and system architecture, Convergence between military and commercial systems, The Future For Software Defined Radio.

Unit IV Cognitive Radio, concepts & history, frequency spectrum allocation, vacant spectrum sensing techniques. Efficient utilization of vacant holes in cognitive radio networks

Suggested Readings/ Books:

- Dillinger, Madani, Alonistioti (Eds.), *Software Defined Radio, Architectures, Systems and Functions*, Wiley, 2003
- Reed, *Software Radio*, Pearson
- Paul Burns, *Software Defined Radio for 3G*, 2002
- Tafazolli (Ed.), *Technologies for the Wireless Future*, Wiley 2005
- Bard, Kovarik, *Software Defined Radio, the Software Communications Architecture*, Wiley, 2007

ECE-207 EMERGING TECHNOLOGIES IN WIRELESS COMMUNICATION

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Introduction to Wireless Communication: The Cellular concept, System design, Capacity improvement in cellular systems, Co channel interference reduction. Intelligent cell concept and applications. Technical Challenges.

Unit II Mobile Radio Propagation: Reflection, Diffraction. Fading. Multipath Propagation. Channel modeling, Diversity Schemes and Combining Techniques. Design parameters at the base station, Practical link budget design using path loss models. Smart antenna systems, Beam forming. MIMO Systems. RAKE receiver.

Unit III Multiuser Systems: CDMA- Principle, Network design, Link capacity, Power control, CDMA Network planning, MC-CDMA, OFDM.

Unit IV Cellular mobile communication beyond 3G: GSM, IS-95, GPRS, UMTS, WiFi, WiMAX, Ultra Wideband communications, 4G and beyond 4G.

Suggested Readings/ Books:

- F. Molisch, *Wireless Communications*, Wiley, 2005
- Goldsmith, *Wireless Communications*, Cambridge University Press, 2005
- P. Muthu Chidambara Nathan, *Wireless Communications,* PHI, 2008
- Ke-Lin Du, M. N. S. Swamy, Wireless Communication Systemsò, Cambridge University Press, 2010
- K. Fazel, S. Kaiser, *Multi-carrier and Spread Spectrum Systems*, Wiley, 2003
- S.G. Glisic, *Advanced Wireless Communications, 4G Technologies*, Wiley, 2004
- W. C. Y.Lee, *Mobile Communication Engineering*, 2nd Edition, McGraw- Hill, 1998.
- S.G. Glisic, *Adaptive CDMA*, Wiley, 2003

ECE-208 MOBILE NETWORK POWER MANAGEMENT

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Introduction: Overview of Data Communication and Network Management ï Goals, Organization and Functions; Network Management ï Architecture and Organization; Network Management Perpestives; Current Status and Future of Network Management. Network Topology, Network Node Components, Transmission Technology.

Unit II SNMP and Network Management: Network Management Standards, Network Management Models, Organizational Model, Information Model, Communication Model. **SNMPv1 –**History of SNMP, Internet Organization and Standards, SNMP Model, Organizational Model, System Overview, Information Model. SNMP Communication Model, Functional Model.SNMPv2 and SNMv3.

Unit III Telecommunications Management Network: TMN Conceptual Model, TMN Standards, TMN Architecture, TMN Management Service Architecture, TMN Integrated View, TMN Implementation.

Unit IV Network Management Applications: Configuration Management, Fault Management, Performance Management, Security Management, Service Level Management, Accounting Management, Report Management, Policy- Based Management.

Unit V Web Based Management and IP Network Management: Setting-UP LAN Access, SNMP configuration, Switched Port Analyzer, Web Browser / Web Server Communication.IP Network Management ï Configuration, Management Information Base, Simple Network Management Protocol, IP-Based Service Implementation- Network Management Issues, OSS Architecture.

Suggested Readings/ Books:

- Mani Subramanian, *Network Management – Principles and Practice,* Addison- Wesley, 2000
- Salah Aiidarons, Thomas Plevayk, *Telecommunications Network Technologies and Implementations*, Eastern Economy Edition IEEE Press, New Delhi, 1998
- Lakshmi G Raman, *Fundamentals of Telecommunication Network Management,* Eastern Economy Edition IEEE Press, New Delhi
- J. Richard Burke, *Network Mamagement: Concepts and Practice, A Hands-on Approach,* Pearson Education, 2008

Third Semester

ECE-301 MILLIMETER WAVE COMMUNICATION AND TECHNOLOGY

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Multi Gigabit 60-GHz Millimeter Wave Radios: Millimeter wave characteristics-Channel performance at 60GHz, Gigabit wireless communication, Standards- WiGig,IEEE 802.11ad, IEEE 802.15.3c,WirelessHD,ECMA-387/ISO/IEC 13156,Coexistence with wireless backhaul, Millimeter wave applications- WLAN, WPAN, Outdoor point to point.

Unit II Millimeter Wave Antennas: Path loss and antenna directivity, Antenna beamwidth, Maximum possible gain to Q, Polarization, Beam steering antenna, Millimetre wave design consideration.

Unit III Millimeter Wave Transceivers: Millimeter wave link budget, Transceiver architecture, Receiver without local oscillator, Millimeter wave calibration, Modulation techniques-OOK, PSK, FSK, QAM, OFDM.

Unit IV Advanced Beam Steering and Beam Forming: Need for beam steering and beam forming, Adaptive frame structure- Advanced beam steering technology, Advanced beam forming technology, Advanced antenna ID technology.

Unit V Millimeter Wave MIMO: Spatial diversity of antenna arrays, Multiple antennas, Multiple transceivers, Noise coupling in MIMO system.

Suggested Readings/ Books:

- Kao-Cheng Huang, Zhaocheng Wang, *Millimeter wave communication systems,* John Wiley & Sons, Hoboken, New Jersey, 2011
- Jonathan Wells, *Multi-Gigabit Microwave and Millimeter-Wave Wireless Communications,* Artech House, 2010
- Su-Khiong Yong, Pengfei Xia, Alberto Valdes-Garcia, *60GHz Technology for Gbps WLAN and WPAN: From Theory to Practice*, Wiley 2010

ECE-302 SPACE TIME WIRELESS COMMUNICATION

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Multiple Antenna Propagation and ST Channel Characterization: Wireless channel, Scattering model in macrocells, Channel as a ST random field, Scattering functions, Polarization and field diverse channels, Antenna array topology, Degenerate channels, reciprocity and its implications, Channel definitions, Physical scattering model, Extended channel models, Channel measurements, sampled signal model, ST multiuser and ST interference channels, ST channel estimation.

Unit II Capacity of Multiple Antenna Channels: Capacity of frequency flat deterministic MIMO channel: Channel unknown to the transmitter, Channel known to the transmitter, capacity of random MIMO channels, Influence of ricean fading, fading correlation, XPD and degeneracy on MIMO capacity, Capacity of frequency selective MIMO channels.

Unit III Spatial Diversity: Diversity gain, Receive antenna diversity, Transmit antenna diversity, Diversity order and channel variability, Diversity performance in extended channels, Combined space and path diversity, Indirect transmit diversity, Diversity of a space-time- frequency selective fading channel.

Unit IV Multiple Antenna Coding and Receivers: Coding and interleaving architecture, ST coding for frequency flat channels, ST coding for frequency selective channels, Receivers (SISO, SIMO, MIMO), Iterative MIMO receivers, Exploiting channel knowledge at the transmitter: linear pre-filtering, optimal pre-filtering for maximum rate, optimal pre-filtering for error rate minimization, selection at the transmitter, Exploiting imperfect channel knowledge.

Unit V ST OFDM, Spread Spectrum and MIMO Multiuser Detection: SISO-OFDM modulation, MIMO-OFDM modulation, Signaling and receivers for MIMO- OFDM,SISO-SS modulation, MIMO-SS modulation, Signaling and receivers for MIMO- S.MIMO-MAC,MIMO-BC, Outage performance for MIMO-MU,MIMO-MU with OFDM,CDMA and multiple antennas.

Suggested Readings/ Books:

- Paulraj, Rohit Nabar, Dhananjay Gore, *Introduction to Space Time Wireless Communication Systems*, Cambridge University Press, 2003
- Sergio Verdu, *Multi User Detection*, Cambridge University Press, 1998
- Andre Viterbi, *Principles of Spread Spectrum Techniques*, Addison Wesley 1995

ECE-303 ADVANCED TECHNIQUES FOR WIRELESS RECEPTION

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I: Wireless signalling environment, Basic signal processing for wireless reception. Linear receivers for synchronous CDMA. Blind and group-blind multiuser detection methods.

Unit II: Robust multiuser detection for non Gaussian channels; asymptotic performance. Adaptive array processing in TDMA systems. Optimum space-time multiuser detection.

Unit III: CDMA- Encoder and decoder, difference between IS-95 and WCDMA, RAKE receiver- basic idea, propagation of transmitted signal, multipath, applications of RAKE receiver.

Unit IV: OFDM system and principle, multicarrier modulation, guard interval and inter symbol interference, cyclic prefix, equalization, advantages and disadvantages.

Unit V: MIMO multi input multi output, history, wireless channel and its characteristics, capacity of MIMO system, MIMO design criterion, diversity, space time for wireless communication, variants of multiple antenna system.

Suggested Readings/ Books:

- X. Wang, H. V. Poor, *Wireless Communication Systems*, Pearson, 2004
- R. Janaswamy, *Radio Wave Propagation and Smart Antennas for Wireless Communication*, Kluwer, 2001
- Mohamed Ibnkahla, *Signal Processing for Mobile Communications*, CRC Press, 2005
- V. H. Sheikh, *Wireless Communications Theory & Techniques*, Kluwer Academic Publications, 2004
- Paulraj, *Introduction to Space-time Wireless Communications*, Cambridge University Press, 2003

ECE-304 CODING TECHNIQUES FOR SPREAD SPECTRUM COMMUNICATIONS

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Introduction: Introduction to Spread Spectrum, Direct Sequence Code Division Multiple Access, Advantages and Drawbacks of DS-CDMA, Applications of Spread Spectrum. Multi-Carrier Spread Spectrum - Principle of Various Schemes, Advantages and Drawbacks Examples of Future Application Areas.

Unit II Multicarrier Spread Spectrum: MC-CDMA - Signal Structure, Downlink Signal, Uplink Signal, Spreading Techniques, Pre-Equalization, Combined Equalization, Soft Channel Decoding, Flexibility in System Design, Performance Analysis.MC-DSCDMA.

Unit III Hybrid Multiple Access Schemes: Multi-Carrier FDMA- Orthogonal Frequency Division Multiple Access (OFDMA), OFDMA with Code Division Multiplexing: SS-MC-MA, Distributed DFT-Spread OFDM: Interleaved FDMA (IFDMA), Localized DFT-Spread OFDM.Ultra Wideband Systems, Pseudo-Random PPM UWB Signal Generation, UWB Transmission Schemes

Unit IV Implementation Issues: Multi carrier modulation and demodulation, synchronization, channel estimation, Channel coding and decoding. Signal Constellation, Mapping, De-mapping and equalization, Adaptive technique in multi carrier transmissions, RF Issues.

Unit V Applications: 3GPP Long Term Evolution (LTE) -Requirements on LTE, Radio Access Network, Architecture, Radio Protocol Architecture, Downlink Transmission Scheme, Uplink Transmission Scheme, Performance. WiMAX - Scope, From IEEE 802.16x and ETSI BRAN HIPERMAN Towards WiMAX , System Architecture . Broadband Wireless Access Standards: HIPERMAN and IEEE 802.16x ,Transmit Diversity / MIMO in WiMAX.

Suggested Readings/ Books:

- K. Fazel, S. Kaiser, *Multi Carrier and Spread Spectrum Systems*, John Wiley & Sons, 2nd edition, 2008
- Ramjee Prasad, *OFDM for Wireless Communications Systems*, Artech House, 2004
- Richard Van Nee, Ranjee Prasad, *OFDM for Wireless Multimedia Communication*, Artech House, 2000
- Rodger E. Ziemer, Roger W. Peterson, *Introduction to Digital Communication*, 2nd Edition, Prentice Hall, 2001
- Valery P. Ipatov, *Spread Spectrum and CDMA Principles and Applications*, John Wiley, 2005

ECE-305 SEMICONDUCTOR MILLIMETRE-WAVE DEVICES

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I: Transient and ac behaviour of P-N junctions, effect of doping profile on the capacitance of p-n junctions, noise in p-n junctions, high-frequency equivalent circuit, varactor diode and its applications; Schottky effect, Schottky barrier diode and its applications; Heterojunctions.

Unit II: Tunneling process in p-n junction and MIS tunnel diodes, V-I characteristics and device performance, backward diode. Impact ionization, IMPATT and other related diodes, small signal analysis of IMPATT diodes.

Unit III: Construction and operation of microwave PIN diodes, equivalent circuit, PIN diode switches, limiters and modulators. Two-valley model of compound semiconductors, Vd-E characteristics, Gunn effect, modes of operation, small-signal analysis of Gunn diode, power frequency limit.

Unit IV: High frequency limitations of BJT, microwave bipolar transistors, Heterojunction bipolar transistors; Operating characteristics of MISFETs and MESFETs, short-channel effects, high electron mobility transistor.

Unit V: Design considerations for microwave and Millimeter wave amplifiers and oscillators, circuit realization, noise performance. Introduction to MEMS for RF applications: micromachining techniques for fabrication of micro switches, capacitors and inductors.

Suggested Readings/ Books:

- S. Ahmad, *Microwave and Millimeter Wave Semiconductor Material*, Tata McGraw Hill
- Wolf W., *Modern VLSI Design System on Silicon*, 2nd Edition, Pearson Education, 2000
- Sarrafzadeh M., Wong C. K., *An Introduction to VLSI Physical Design*, 4th Edition, McGraw-Hill, 1996
- Lim S. K., *Practical problems in VLSI physical Design Automation*, Springer, 2008

ECE-306 STOCHASTIC PROCESS AND QUEING THEORY

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Probability Review and Introduction to Stochastic Processes (SPs): Probability spaces, random variables and probability distributions, expectations, transforms and generating functions, convergence, LLNs, CLT, definition, examples and classification of random processes according to state space and parameter space.

Unit II Stationary Processes: Weakly stationary and strongly stationary processes, moving average and auto regressive processes

Unit III Discrete-time Markov Chains (DTMCs): Transition probability matrix, Chapman-Kolmogorov equations; n-step transition and limiting probabilities, ergodicity, stationary distribution, random walk and gamblerôs ruin problem, applications of DTMCs.

Unit IV Continuous-time Markov Chains (CTMCs): Kolmogorov differential equations for CTMCs, infinitesimal generator, Poisson and birth-death processes, stochastic Petri net, applications to queueing theory and communication networks.

Unit V Martingales: Conditional expectations, definition and examples of martingales, applications in finance. Brownian Motion: Wiener process as a limit of random walk; process derived from Brownian motion, stochastic differential equation, stochastic integral equation, Ito formula, Some important SDEs and their solutions, applications to finance.

Unit VI Renewal Processes: Renewal function and its properties, renewal theorems, cost/rewards associated with renewals, Markov renewal and regenerative processes, non Markovian queues, applications of Markov regenerative processes.

Unit VII Branching Processes: Definition and examples branching processes, probability generating function, mean and variance, Galton-Watson branching process, probability of extinction.

Suggested Readings/ Books:

- J. Medhi, Stochastic Processes, 3rd Edition, New Age International, 2009
- S. M. Ross, Stochastic Processes, 2nd Edition, Wiley, 1996
- S. Karlin, H. M. Taylor, A First Course in Stochastic Processes, 2nd Edition, Academic Press, 1975

ECE-307 MULTIMEDIA COMMUNICATION AND TECHNOLOGIES

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Unit I Multimedia System Design: An Introduction: Multimedia Elements, Multimedia Applications, Multimedia System Architecture, Evolving Technologies for Multimedia Systems, Multimedia Databases

Unit II Compression and Decompression Techniques: Types of Compression, Binary Image Compression Schemes, Color, gray scale, still-video image compression, Discrete Cosine Transform, Video Image compression, MPEG Coding methodology, Audio Compression, Data and File format standards- RTF, TIFF,RIFF, MIDI, JPEG, AVI, JPEG, TWAIN Architecture.

Unit III Multimedia Input and Output Technologies: Key Technology Issues, Pen Input, Video and Image Display Systems, Print Output Technologies, Image Scanners, Digital Voice and Audio, Video Images and Animation, Full Motion Video.

Unit IV Storage and Retrieval Technologies: Magnetic Media Technology, RAID-Level-0 To 5, Optical Media, WORM optical drives, Hierarchical Storage Management, Cache Management for storage systems.

Unit V Multimedia Application Design: Types of Multimedia systems - Virtual Reality Design - Components of Multimedia system - Distributed Application Design Issues ï Multimedia Authoring and User Interface - Hypermedia Messaging ï Distributed Multimedia Systems.

Suggested Readings/ Books:

- Andleigh P. K., Thakrar K., *Multimedia Systems*, Addison Wesley Longman, 1999
- Fred Halsall, *Multimedia Communications*, Addison Wesley, 2000
- Ralf Steinmetz, Klara Nahrstedt, *Multimedia, Computing, Communications and Applications*, Prentice Hall, 1995
- Tay Vaughan, *Multimedia making It work*, TMH, 5th Edition 2001
- Weixel, Fulton, Barksdale.Morse, *Multimedia Basics*, Easwar Press, 2004