M. Tech. in Electronics & Communication Engineering (ECE)

M. Tech. (Electronics & Communication Engineering Dept.)
Specialization- Communications
Curriculum & Syllabus

1st Year 1st Semester:

A. Theory							
Sl. No.	**Course Code**	**Course Name**	**Contact Hours/Week**				**Credit Points**
			L	**T**	**P**	**Total**	
1	**MATH5103**	Advanced Mathematics	4	0	0	4	4
2	**ECEN5101**	Advanced Digital communication	4	0	0	4	4
3	**ECEN5102**	Advanced Digital Signal Processing	4	0	0	4	4
4	**ECEN5103**	Advanced Microwave Communication	4	0	0	4	4
5		**Elective - I**	4	0	0	4	4
	ECEN 5131	Advanced Computer Communication & Networking					
	ECEN5132	Telecommunication Systems & Engineering					
	ECEN5133	Statistical Communication					
	ECEN5134	Microwave Systems and Applications.					
	ECEN5135	Remote sensing techniques and application					
Total Theory						**20**	**20**

B. Practical							
6	**ECEN5111**	Advanced Communication Laboratory	0	0	3	3	2
7	**ECEN5112**	Design and Simulation of Communication Systems Laboratory	0	0	3	3	2
Total Practical						**6**	**4**

C. Sessional							
8	**ECEN5121**	Seminar-I	0	0	2	2	1
Total Sessional						**2**	**1**
Total of Semester						**28**	**25**

1st Year 2nd Semester:

A. Theory							
Sl. No.	**Course Code**	**Course Name**	**Contact Hours/Week**				**Credit Points**
			L	**T**	**P**	**Total**	
1	**ECEN5201**	Photonics & Optical Communication	4	0	0	4	4
2	**ECEN5202**	Error Control and Coding	4	0	0	4	4
3	**ECEN5203**	Mobile Communication	4	0	0	4	4
4		**Elective – II**	4	0	0	4	4
	ECEN5231	Cryptography & network security					
	ECEN5232	Artificial intelligence & soft Computing					
	ECEN5233	Integrated Circuits & Design					
	ECEN5234	Microwave measurement and Instrumentation					
5		**Elective- III**	4	0	0	4	4
	ECEN5241	Satellite communication					
	ECEN5242	Image processing & pattern Recognition					
	ECEN5243	Multimedia communication					
	ECEN5244	Advanced Antenna Engineering					
Total Theory						**20**	**20**

	B. Practical						
6	**ECEN5211**	Lab III: Communication systems Laboratory	0	0	3	3	2
		Total practical					2

	C:Sessional						
7	**ECEN5221**	Term Paper leading to Thesis	0	4	0	4	3
Total Sessional						**4**	**3**
Total of Semester						**27**	**25**

2nd Year 1st Semester:

A. Theory							
Sl. No.	**Course Code**	**Course Name**	**Contact Hours/Week**				**Credit Points**
			L	**T**	**P**	**Total**	
1	**HMTS6101**	Research Methodology and Project Management	4	0	0	4	4
2		Elective - IV	4	0	0	4	4
	ECEN6131	EMI/EMC					
	ECEN6132	Ad-hoc and Sensor Networking					
	ECEN6133	Convergence in communication Technology					
3		Elective -V	4	0	0	4	4
	ECEN6141	Cognitive Radio Technology					
	ECEN6142	Design of Communication equipments and Systems					
						12	12

	Sessional						
4	**ECEN6121**	Thesis (Progress) and Seminar/ Presentation				12	4 + 4
		Total of semester				24	20

2nd Year 2nd Semester:

A. Sessional							
Sl. No.	**Course Code**	**Course Name**	**Contact Hours/Week**				**Credit Points**
			L	**T**	**P**	**Total**	
1	**ECEN6221**	Thesis (Final)	0	0	0	18	12
2	**ECEN6222**	Thesis Viva Voce					4
3	**ECEN6223**	Grand Viva					4
		Total of semester:				18	20

M. Tech. in Electronics & Communication Engineering
Specialization- Communications
First Year Syllabus

1st year 1st Semester:

Course Name: ADVANCED MATHEMATICS					
Course Code : MATH5103					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module I: [4 L]

Probability and Stochastic Process: Recapitulation of basic Probablity concepts - Bayes theorem, Random variables, probability mass function and probability density function, Specific distributions: Binomial, Poisson, Normal.
Definition of Discrete Time Markov Chain. Examples Including Random Walk, Ehrenfest Chain and Birth-Death Chain, Transition Matrix, Chapman-Kolmogorov Equation and its application.

Module II: [10 L]

Graph Theory : Tree, Binary Tree, Spanning Tree, Steiner Tree,Greedy, Divide and Conquer, Walk, Path, Cycle, Hamiltonean Graph ,The Travelling Salesman Problem, Euler Graph, The Chinese Postman Problem , Planar Graph, Euler's Formula for Planar Graph and Related Problems, Matchings and Augmenting Paths, Hall's Marriage Theorem and Related Problems, Vertex Colouring, Chromatic Polynomial.

Module III: [10 L]

Linear Algebra : Definition of Field, Vector Spaces, Subspaces, Linear Dependence, Basis and Dimension, Inner Product Space, Gram-Schmidt Orthogonalization Process, Linear Transformations, Kernels and Images, Matrix Representation of Linear Transformations, Change of Basis, Eigen Values and Eigen Vectors

Module IV: [10 L]

Optimization : Classification of Optimization Problems, Single Variable Optimization, Multivariate Optimization Without Constraints : Semidefinite Case, Saddle Point, Multivariate Optimization with Equality Constraints: Method of Constrained Variation and Lagrange Multipliers, Solution of LPP using Simplex Method.

References :

1. Stochastic Processes : J. Medhi (New Age International)
2. Introduction to Stochastic Processes : Paul G. Hoel, Sidney C. Port, Charles J. Stone (Universal Book Stall)
3. Stochastic Processes : Sheldon M. Ross (Wiley Series in Probability and Mathematical Statistics)
4. Graph Theory with Applications to Engineering and Computer Science : N. Deo (PHI Learning Pvt. Ltd.)
5. A First Look at Graph Theory : John Clark and Derek Allan Holton (Allied Publishers Ltd.)
6. Linear Algebra : Kenneth M. Hoffman, Ray Kunze (Prentice-Hall)
7. Linear Algebra : Seymour Lipschutz, Marc Lipson (SCHAUM'S Outlines, Mc Graw Hill)
8. Matrices and Linear Transformations : Charles G. Cullen (Dover)
9. Engineering Optimization : Singiresu S. Rao (New Age International Publishers)
10. Introductory Operations Research : H.S.Kasana, K.D.Kumar (Springer-Verlag)

Course Name: ADVANCED DIGITAL COMMUNICATION					
Course Code : ECEN 5101					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module – I [10 L]
Review of random variables and random processes
Review of baseband digital signal transmission –PCM DM ADM ADPCM. Inter Symbol Interference (ISI)
Nyquist criteria for no ISI in bandlimited channel
Parametric decoding: Sub-band coding APC LPC voice excited vocoder
Synchronization – Symbol and Frame synchronization
Equalizer: Linear equalization Decision feedback equalizer iterative equalizer and decoding

Module – II [10 L]
Digital Modulation:
Review of modulation schemes – BPSK DPSK QPSK M-ary PSK QASK MSK BFSK M-ary FSK – principles transmitters receivers signal space presentation bandwidth efficiency
GMSK Orthogonal frequency division multiplexing (OFDM) – principle generation and detection
Bit error performance of bandpass signal – Narrow band noise model Error performance of BASK BPSK
BFSK MSK Comparison of bandwidth efficiency and error performance of modulation schemes

Module – III [9 L]
Multiplexing and multiple access : TDM/TDMA FDM/FDMA Space DMA ALOHA –slotted ALOHA and
reservation ALOHA CSMA-CD CSMA- CA basic techniques and comparative performances
Spread spectrum modulation: Principle of DSS, processing gain jamming margin single tone interference
probability of error
Principle of frequency hopped spread spectrum (FHSS) – slow frequency and fast frequency hopping
Principle of CDMA Multiple access interference (MAI) and limit of simultaneous users
Digital cellular CDMA system – forward and reverse link error rate performance

Module – IV [9 L]
Optimum Detection and Estimation:
Noise vector in signal space Bayes detection of received signal, optimum M-ary receiver design
Decision region and minimum error probability
Optimum detection of 16 QAM signal, MPSK signal orthogonal and bi orthogonal signal
Decision criterion: maximum likelihood Neyman Pearson and Minimax decision criterion
Estimation: Linear estimation – simple mean Linear mean squared error Wiener filter
Non linear estimation: Bayes estimation MAP ML estimates
Introduction to source coding (Hofmann and Shanon).
Introduction to error control coding (Linear Block Code and Convolution).

References:

1. Digital Communications 4th edition J G Proakis MGH international Edition
2. Principle of Communication Systems Taub and Schilling 7th edition TMH
3. Digital Communications :Fundamentals and Applications 2nd edn 2008 Bernard Sklar and Pabitra Kumar Ray Pearson Education
4. Principle of Digital Communications Simon Haykin Wiley Student Edition
5. Digital Communications Zeimer and Tranter CRC Press
6. Analog and digital Communication, B.P. Lathi, Oxford University Press.

Course Name: ADVANCED DIGITAL SIGNAL PROCESSING (DSP)					
Course Code : ECEN 5102					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Prerequisite: The student must be conversant with frequency domain analysis of discrete time signals and systems. They will be familiar with the various kind of adaptive filter design technique. Multirate Signal Processing fundamentals and applications of Wavelet Transforms will be covered.

Module I: [10 L]

Frequency Domain Analysis of Discrete Time Domain Signals and Systems: 6L
The concept of frequency in continuous time and discrete time signals. Fourier series for discrete periodic signals, Fourier Transform of discrete aperiodic signals, Power spectral densities of discrete aperiodic signals, Relationship between Fourier Transform and Z-Transform. Properties of Fourier Transform in discrete time domain; Time reversal, convolution, correlation, Wiener-Khintchine theorem, frequency shifting, modulation, windowing theorem, differentiation in digital frequency domain.
Symmetry property for various types of signals.

Module II: [10 L]
Frequency Domain Characteristics of LTI Systems
Response to complex exponential signals, steady state and transient response to sinusoidal signals, steady state response to periodic signals, response to aperiodic signals. Relation between system function H (z) and frequency response function h
(w). Input-output correlation function and spectra, correlation functions and power spectra for random input signals.
Invertibility of LTI systems, minimum/maximum/mixed phase systems, homomorphic systems and homomorphic deconvolution.
DFT & FFT
Computation of DFT and it's properties, computation of DFT via FFT, chirp z-transform.

Module III: [9 L]

Design of Digital Filters
Design of FIR filters, Effect of various windows, Effect of finite register length, statistical analysis, stability effect, frequency sampling, Optimization Algorithm.
Adaptive Filters design, Single input, multiple input, State-Space Kalman Filter, Extended Kalman Filter, Unscented Kalman Filter Sample-Adaptive Filters,
Recursive Least Square (RLS) Adaptive Filters, The Steepest-Descent Method, LMS Filter.
Power Spectrum
Estimation of Power Spectrum and Correlation, Non-parametric and Parametric methods, Minimum Variation Estimation methods, Eigen Analysis algorithm, Power Spectrum analysis using DFT, Maximum Entropy Spectral Estimation, Model-Based
Power Spectral Estimation.

Module IV: [9 L]

Multirate Signal Processing
Sampling Rate Conversion; Decimation and Interpolation; Time and Frequency Domain Characterization; Filters in Sampling
Rate Alteration Systems; Multi-rate Design of Decimator and Interpolator; Poly-phase Techniques; Poly-phase Down-sampler
and Interpolator; Poly-phase Filter Design; Two-channel QMF Banks. Alias free FIR and IIR QMF Banks; Perfect Reconstruction
Two-channel FIR Filter Banks; M-Channel Filter Banks Design; Cosine-Modulated M-channel Filter Banks Design;
Wavelet Transforms
Fourier Transform and its limitations, Short Time Fourier Transform, Continuous Wavelet Transform, Discretization of the Continuous Wavelet Transform, Multiresolution Approximations; Wavelet and Scaling Function Coefficients, Orthonormality of

Compactly Supported Wavelets, Bi-orthogonal Decomposition, Harr Wavelets, The Daubechies Wavelets Construction, Fast Wavelet Transform and Image Compression, Denoising using Wavelets, Perfect Reconstruction Filter bank design using Wavelets.

References:

1. Discrete – Time Signal Processing by A.V. Oppenheim and R. W. Schafer, with J. R. Buck (Prentice- Hall, 1998)
2. Digital Signal Processing Using MATLAB by V. K. Ingle and J. G. Proakis (Books/Cole,2000)
3. Digital Signal Processing: A Computer Based Approach by S.K. Mitra (Second edition , McGraw-Hill, 2001)
4. Digital Signal Processing: Principles, Algorithms and Applications by J. G. Proakis and D. G. Manolakis.
5. Digital Filter Design and Analysis, Antino, TMH.
6. Digital Signal Processing- Rabiner and Gold, PHI.

Course Name: ADVANCED MICROWAVE COMMUNICATION					
Course Code : ECEN 5103					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module1 I [10 L]

Microwave and millimeter wave devices:

- Limitations of microwave vacuum tubes.
- Advances in microwave and millimeter wave solid state devices, Gunn devices, oscillator using Gunn diode, and injection locked oscillators, IMPATT devices, and microwave and mm wave performance of IMPATT.
- Other solid state devices like Tunnel diode, BARITT and TRAPAT, MESFET.

Module II [10 L]

Microwave and mm wave circuits:

- Review of scattering matrix concept in the light of vector network analyzer, impedance matching network, couplers, power dividers, resonators and filters.
- Detectors, mixers, attenuators, phase shifters, amplifier and oscillator
- Ferrite based circuits.
- Switch, mixer circuits using PIN diodes.

Module III [9 L]

Antennas:

- Hertzian dipole, loop antenna, helical antenna, frequency independent antenna: log spiral and log periodic dipole antenna array.
- Babinet principle, waveguide slot antenna, microstrip antenna, horn antenna, parabolic reflector.
- Antenna arrays and phased array antenna.

Module IV [9 L]

Microwave and mm wave propagation:

- Overview of basic radio wave propagation mechanisms, Friis transmission formula, plane earth propagation model, troposcatter systems, ionosphere propagation, duct propagation, microwave radio link and calculation of link budget.
- Effect on radio wave propagation due to rain, fog, snow, ice, atmospheric gases, Earth's magnetic field.

References:

1) P Bhartia & I J Bahl, Millimeter wave engineering and Applications, John Wiley & Sons
2) David M Pozar, Microwave Engineering, John Wiley & Sons
3) R E Collin, Antenna & Radio wave Propagation, McGraw Hill Book Co.
4) C A Balanis, Antenna Theory: Analysis and Design, John Wiley & Sons
5) U.S.N Raju, Antenna and Wave propagation- Pearson.
6) M.L.Sisodia, Microwave vacuum and semiconductor devices, New Age Publishers.

Course Name: ADVANCED COMPUTER COMMUNICATION & NETWORKING					
Course Code : ECEN 5131					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module I: [10 L]

Introduction - Motivation, goals, applications and classification of computer networks, common networks and standard organizations
Network Structure and Architecture- Network structure-concept of subnet, backbone and local access, Channel sharing techniques- FDM, TDM. Circuit and packet switching. Topological Design of a network.
Network architecture layering concept, OSI Reference Model, OSI Services and protocols
Physical layer - bit communication between DTE and DCE, RS232, transmission media, modems.

Module II: [12 L]

Data link layer - error detection and correction, retransmission strategies, stop and wait protocol, sliding window protocols, pure Aloha protocols, slotted Aloha protocol, CSMA protocols, CSMA / CD and CSMA / CA protocol, HDLC.
LANs and their Interconnection - Basic concepts and IEEE standards, Architecture, protocol, management and performance of Ethernet, token ring and token bus LANs, WLAN, Bluetooth, LAN interconnection - repeaters and bridges, Transparent and
source routing bridges and their relative advantages and disadvantages.
Network layer - basic design issues, network layer services, connection oriented and connection less services, routing – static, dynamic, stochastic, flow based routing, optimal routing, Quality of service, congestion control, Leaky Bucket Algorithm
Transport layer- process to process delivery, TCP, UDP.

Module III: [8 L]

Internetworking- motivation, goals and strategies, Routers and gateways, TCP / IP model, IP addressing, important features of IPv6.
Application layer – DNS, SMTP, FTP, HTTP, WWW

Module IV: [8 L]

Network security -Cryptographic principle, DES, AES, RSA, Digital signature, Security in internet, VPN, Firewalls.
Network management system - SNMP.
Advance Protocol-RTP, SIP.

References:

1. B. A. Forouzan, Data Communication and Networking, Tata Mc-Graw Hill.
2. W. Stallings, Data and Computer Communication, 5th Ed. PHI, 1998.
3. A. S. Tanenbaum, Computer Networks, Prentice-Hall India.
4. Miller, Data Communication and Networks, Vikas.
5. A. Leon-Garcia, Communication networks, Tata Mc-Graw Hill.
6. G. E. Keiser: Local Area Network, McGraw Hill. 1989.
7. D. Bertsekas and R. Gallagher: Data Networks, 2nd Ed. PHI, 1992.
8. F. Halshall: Data Communication, Computer Network and Open Systems, 3rd Ed. Addison Wesley, 1992.
9. D. Russell: The Principles of Computer Networking, Cambridge University Press, 1989.
10. M. Schwartz: Computer Communication network Design and Analysis, PHI, 1977

Course Name: TELECOMMUNICATION SYSTEMS & ENGINEERING					
Course Code : ECEN 5132					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module I: Telephone Network [12 L]

• Introductory terminology;
Grade of Service, QoS, Blocking Network, Lost call handling. Erlang and Poisson Traffic formulas one-way and both-way circuits.
• Local Networks – subscriber loop design, shape and size of a serving area, voice Frequency Repeaters, Tandem Routing, Dimensioning of Trunks
• Switching & Signaling for analog Telephone networks: Switching concepts – Cross-bar switching . Signaling concepts: Supervisory signaling – E & M signaling – In-band & out-of-band signaling
• Design of long distance links: Design essentials for LOS Microwave systems, Path analysis or Link Budget, Fading , Diversity and Hot stand-by operation, VSAT networks, concept of Last Mile
Broadband connectivity – ADSL & HDSL

Module II: Digital Telephone Systems [12 L]

• PCM – PCM line Codes – Regenerative repeaters – Signal to noise ratio for PCM signals – North American DS1 – the European E1 digital hierarchy – Filter – distortion – echo – cross talk – SONET and SDH – PCM Switching :'Time – space – Time Switch – 'Space – Time – Space' Switch – Digital Network Synchronization – Digital loss

Module III: Local Area Networks [6 L]

• LAN topologies – overview of IEEE / ANSI LAN protocols – WLANS – different 802.11standards

Module IV: ISDN [8 L]

• ISDN - background & goals of ISDN – protocols – structures – ISDN and OSI
• ATM and B-ISDN – User-Network interface (UNI) configuration and architecture – ATM cell structure – cell delineation algorithm – ATM layering & B-ISDN . Advantages of BISDN

References:

1. Wiley Series in Telecommunications and Signal Processing by Roger L. Freeman
2. Telecommunication System Engineering, By N. N. Deb.
3. Telecommunication Switching, Viswanathan.
4. Telecommunication, Fraser.

Course Name: STATISTICAL COMMUNICATION					
Course Code : ECEN 5133					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module I: [10 L]

Revision of linear algebra:
Special matrix forms – diagonal matrix, exchange matrix, triangular matrix, Toeplitz matrix, Hankel matrix, symmetric matrix,
parametric matrix, centro symmetric matrix.
Eigen values, Eigen value solutions.
Random process:
Definition and description of random processes with practical examples.
Time average, ensemble average, covariance, autocorrelation, cross correlation. Stationary process, ergodic process, WSS process, power spectrum of random processes. Filtering of random processes – filtering of white noise, spectral shaping filter, spectral factorization. Special random processes – Autoregressive moving average process, autoregressive process, moving average process, harmonic process.

Module II: [10 L]

Signal modeling:
Least square method, Pade approximation method, filter design using Pade approximation, Prony's method of signal
modeling, filter design using Prony's method, FIR least square inverse filter, iterative prefilters,
Stochastic models – ARMA model, AR model, MA model.

Module III: [9 L]

Binary symmetric channel:
Principle, properties, bit error properties.
Theories and hypothesis:

Decision theory, Bay's likelihood ratio, ideal observer strategy, Neyman-Pearson strategy, Bay's strategy for single and multiple
sample values, optimum linear estimation composite hypothesis testing, optimum detection with incomplete knowledge of
the signal, adaptive detection and estimation.

Module IV: [9 L]

Filters:
Principle of optimum filter, matched filter, achievable bit error rate.
FIR Wiener filter – principle and design.
Linear prediction in noise, noise cancellation
IIR Wiener filter – causal, non causal.Kalman filter.

References:

1. Digital communication, 4th ed. - J. G. Proakis, MGH International edition.
2. Digital and Analog Communication Systems, 7th ed. – Leon W. Couch, PHI.
3. Digital Communication – Zeimer, Tranter.
4. Statistical digital signal processing and modeling, - Monson N. Hays – Wiley.

Course Name: MICROWAVE SYSTEMS AND APPLICATIONS					
Course Code : ECEN 5134					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module I: [10 L]

Applications in satellite communication:
Evolution of communication satellites , orbital and altitude control , satellite transponder and other subsystems , satellite link design , system noise temperature , G/T ratio , downlink design , spectrum allocation and bandwidth consideration

Module II: [10 L]

Digital transmission modulation and demodulation , Multiple access techniques –FDMA , TDMA , VSAT , Coding : Error Detection and correction method ,Earth station technology .

Module III: [9 L]

Application in RADAR:
Introduction to basic radar system , radar equation , detection of signal in noise , receiver noise & SNR , Probability of detection & false alarm , Radar cross-section of target & its fluctuation

Module IV: [9 L]

MTI & Doppler radar , Tracking radar , Radar clutter & Radar antenna , Radar transmitter & receiver , Monopulse radar

References:

1. MONOJIT MITRA : Satellite communications , Prentice Hall of India
2. S. KINGLEY & S. QNEGAN: Understanding radar systems , Standard Publisher & Distribution .
3. SKOLNIK : Introduction to radar systems , TMH

Course Name: REMOTE SENSING TECHNIQUES AND APPLICATION					
Course Code : ECEN 5135					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module I: [10 L]

Transmission of Solar Radiation through the Atmosphere : Solar radiation spectrum; Radio infrared and optical windows of the earth's atmosphere; Spectrum of solar radiation transmitted through the atmosphere, Emissions from the disturbed sun, Reflection, Absorption and Emission from Earth and Atmosphere.
Variation of the earth's reflectivity with angle of incidence, wavelength and geographical location

Module II: [10 L]

Seasonal variation of reflectivity; Solar radiation reflected from the earth; Absorption of solar radiation by the earth; Thermal radiation from the earth; Thermal radiation from the atmospheric constituents; Thermal emission from cloud, rain, snow and fog; Radio noise and interference at satellite heights.
Sensors and Cameras: Optical and infrared detectors and filters, Optical and infrared cameras; Microwave and Millimetrewave radiometers; Scanning systems, Mechanical and Electronic systems; Scatterometer; Altimeter.

Module III: [9 L]

Remote Sensing Satellites: Orbits of remote sensing satellites; Remote sensing satellites – LANDSAT; Indian Remote Sensing (IRS) Satellites; INSAT, NOAA Series; NASA's Upper Atmosphere Research Satellites (UARS); TRMM satellite.
Remote Sensing of Atmosphere and Sea State: Passive and active remote sensing; Side Looking Airborne Radar (SLAR); Synthetic Aperture Radar (SAR); Along Track Scanning Radiometer (ATSR)

Module IV: [9 L]

Laboratory measurements of remote sensing parameters; Tropical rainfall measurements; Microwave sensing of sea surface.
Interpretation of Sensing Data : Photo-interpretation, image and pattern recognition; Spectral interpretation of remote sensing imagery; Interpretation of thermal maps; Colour coding and enhancement; Computer interpretation of images.

References:

1. Remote sensing of the environment: J.R.Jenson
2. Global Navigation Satellite systems: B.S. Rao
3. Remote sensing: R.A. Schowengerdt

Course Name: ADVANCED COMMUNICATION LABORATORY					
Course Code : ECEN 5111					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	3	3	2

Experiments on hardware/ kits in order to acquire sufficient knowledge and understand practical limitations/ implications of
various communication techniques.
Suggested topics are (not exclusive),
1. Detailed receiver and transmitter parameters of a typical radio communication system – SINAD, fidelity, image
rejection, modulation sensitivity, transmission bandwidth etc.
2. Data communication through fiber optic link – losses, power budget, stability etc.
3. Sampling, quantization, coding – sampling rate, quantization error, signal bandwidth etc.
4. QPSK, MPSK – signal bandwidth, distinguishability, effect of noise etc.
5. Binary symmetric channel – noise & Pe etc.
6. PC2PC communication – protocol standards, frame/ packet/ UDP structure etc.
7. Multiple channel DSSS – spreading, dispreading, decoding etc.
8. Important characteristics of different types of transmission lines.
9. Impedance measurement of microwave window applying Smith chart.
10. Microwave phase shifter – calibration.

Course Name: DESIGN AND SIMULATION OF COMMUNICATION SYSTEMS LABORATORY					
Course Code : ECEN 5112					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	3	3	2

Designing graphical user interfaced models of various communication systems/ subsystems with the help of suitable
advanced software e.g. MATLAB/ LABVIEW/ NS/ PUFF/ IE3D/ ANSOFT/ HFSS/ CST/ QUALNET/ MICROWAVE OFFICE etc. for
detail study of their operating principle and their performance vis-a-vis practical limitations like, channel bandwidth, noise,
attenuation etc.
Suggested topics are
1. ADPCM – granular noise & quantization noise.
2. MPSK – signal bandwidth, PSD, distinguishability, scatter plot etc.
3. Digital filters – ripples in pass band & stop band, slope in transition band, poles & zeros etc.
4. Optimum filters for receiving base band random binary data – Pe vs. S/N.
5. Signal bandwidth and Pe vs. S/N in different modes of line coding.
6. Signal bandwidth and Pe vs. S/N in different modes of modulation.
7. Error rates in error control for different types of error control coding.
8. Throughput vs. input density in different MAC protocols.
9. DSSS – error rate due to different types of chip code.
10. Fading channel/ multipath transmission and Rake receiver.
11. Cellular architecture, WiFi, WiMAX using QUALNET.
12. OFDM using QUALNET.
13. Different routing algorithms & protocols.
14. Characterization of micro strip antenna.
15. Characterization of transmission lines.
16. Study of important parameters and practical considerations in microwave circuits.

Second Semester

1st Year 2nd Semester:

Course Name: PHOTONICS AND OPTICAL COMMUNICATION					
Course Code : ECEN 5201					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module I: Photonics: [12 L]

o Introduction to Photonic materials and Photonic Devices.
o Optical waveguides., Optical Fiber Modes and Configurations
o Optical fibers - application specific optical fibres, Photonic Bandgap Optical Fibers.
o Graded Index and Single Mode Fibers.
o Optical couplers;
o Fiber.Bragg gratings
o Electro-optic devices
o Semiconductor lasers and light-emitting diodes
o Photodetectors PIN, Photodiodes and Avalanche Photodiodes.
o Optical Amplifiers- doped fiber amplifier.

Module II: Optical Communication: [8 L]

o Analog and Digital Optical Transmitters and Receivers concepts,
o Loss- limited and dispersion- limited lightwave systems,
o Long-haul systems with In-Line Amplifiers,
o Dispersion compensation techniques in optical communication systems,
o Power budget and rise-time.

Module III: Coherent lightwave systems: [8 L]

o Modulation and Demodulation schemes for coherent communication,
o System performance issues.
Multichannel Lightwave systems:
o WDM components and devices,
o Multiplexing techniques and system performance considerations.

Module IV: Optical Networks: [10 L]

o Network topologies,
o SONET/SDH,
o Broadcast-and- Select WDM Networks- single-hop networks, multihop Networks,
o Wavelength routed networks,
o Photonic packet switching
o Soliton Communication

References:

1. Keiser, G. , Optical Fiber Communications, Mcgraw Hill
2. John Senior, Optical Fiber Communications: Principles and Practice, Prentice Hall
3. Ajoy Ghatak & K. Thyagarajan, Cambridge University Press
4. Govind R. Agrawal, Fiber Optic Communication Systems, Wiley

Course Name: ERROR CONTROL AND CODING					
Course Code : ECEN 5202					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

MODULE – I: [12 L]

Brief description of a digital communication system. Role of Information Theory on digital communication system. Cause of digital signal error and need for error control coding for detection and correction of errors.
Information Theory : Review of topics : Measure of Information Self and Mutual Information Entropy Huffman coding Shannon-Fano coding Channel capacity Shannon's theorem on source coding and channel coding. Relation between Information Theory and error Control Coding
Linear algebra:
Groups – Definition Order of a group modulo-m addition and multiplication table, modulo-m subtraction and division
Fields – Definition Binary field and Galois field
Polynomials– Concept of polynomial expression, addition/subtraction/multiplication/division of polynomials over GF(2). Irreducible polynomials, primitive polynomials. Vector space, sub space, dual space – their properties and interrelations.

MODULE-II: [10 L]

Block Code:
Linear Block Code Generator matrix Generator polynomial Syndrome calculation and error detection Standard array Hamming code Bit error rate performance of Block code Cyclic code Cyclic encoder
Syndrome circuit Decoding of Cyclic code Cyclic redundancy check code Golay code Shortend cyclic code Burst error correcting code
BCH code – Construction of Galois field GF(2m), properties of GF(2m) field conjugate roots, minimal polynomials Description of BCH code encoding parity check matrix error hopping and decoding

MODULE – III [8 L]

Reed Solomon (RS) code: RS code in systematic form Syndrome decoding of RS code Barlekamp – Massey algorithm practical application (compact disk)
Convolutional code: Convolutional encoder generator sequence generator matrix, code rate, constraint length Distance properties of convolutional code Finite state machine analysis of coder code tree trellis and state diagram
Principle of maximum likelihood decoding of convolutional code Viterbi algorithm

MODULE – IV [8 L]

Trellis coded modulation (TCM) :
TCM code construction by set partitioning TCM decoder TCM performance analysis
Turbo code :
Turbo encoder Distance properties, BCJR decoding algorithm Interleavers performance analysis of
Turbo code
Low Density Parity Check (LDPC) code :
Description and construction of LDPC code LDPC decoder performance analysis of LDPC code

References:

1. Error Control Coding Fundamentals and Applications Shu Lin and Daniel J Costello Jr Prentice Hall
2. Introduction to Error Control Codes Salvatore Gravano Oxford University Press.
3. Information Theory Coding and Cryptography Ranjan Bose THM Publications
4. Digital Communications 2nd 2008 Bernard Sklar and Pabitra Kumar Ray Pearson Education
5. Essentials of Error Control Coding J C Moreira and P G Farrel Wiley Student Edition
6. Digital Communication, S. Haykin, Wiley Student Edition.

Course Name: MOBILE COMMUNICATION					
Course Code : ECEN 5203					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module I: [10 L]

Introduction - evolution of mobile radio communications, mobile radio systems around the world, trends in cellular radio and personal communication, first generation (1G), second generation (2G), third generation (3G) and 4G mobile cellular networks, Concept of SDR and UMTS.
Cellular concept – Limitations of conventional mobile system, Introduction to mobile cellular communication, concept of frequency reuse, cluster size, cellular system architecture, channel assignment strategies, call handoff strategies - hard
handoff and soft handoff, prioritizing handoff; interference and system capacity, improving capacity in cellular systems – cell splitting, sectoring, microcell zone concept.

Module II: [12 L]

Different mobile communication systems – GSM services and features, system architecture, GSM radio subsystem, GSM channel types, location updating and call setup, WAP, SCSD, GPRS, EDGE, 3G W-CDMA; CDMA digital cellular standard, comparison between GSM and CDMA, 3G CDMA 2000, IMT-2000.

Module III: [10 L]

Radio Channels and their Characterisation – Different propagation models – Hata , Okimura models, Free space propagation, Multipath propagation, diversity techniques, Co-channel interference, Propagation effects - scattering, ground reflection, fading, Log-normal shadowing.
Wireless networks – Advantages and applications of Wireless LAN, WLAN technology – RF and IR wireless LAN, diffuse, quasi diffuse and point-to-point IR wireless LAN, IEEE802.11 and its architecture, Physical layer, MAC layer, Introduction to WIFI, HIPERLAN2, Bluetooth – Bluetooth architecture.

Module IV: [6 L]

Mobile network and transport layer – Introduction to Mobile IP, requirements, IP packet delivery, Agent discovery, Registration, Tunneling and encapsulation, Optimization, Reverse tunneling; Mobile adhoc networks – Routing, Destination sequence distance vector, Dynamic source routing and Alternative metrics; Traditional TCP – Congestion control, Slow start, Fast retransmit / fast recovery, Implications of mobility; classical TCP improvements – Indirect TCP, Snooping TCP, Mobile TCP,Fast retransmit.
Future of mobile communication – 3G to 4G.

References:

1. Theodore S. Rappaport, Wireless communications: principles and practice, PHI / Pearson education.
2. J. Schiller, Mobile communications, Addison-Wesley.
3. William C. Y. Lee, Mobile cellular telecommunication – analog and digital systems, McGraw Hill, 2nd ed.
4. Wang, Wireless communication System, Pearson Education
5. Talukdar, Mobile computing, TMH
6. J.W.Mark, W. Zhuang, Wireless Communication and Networking, PHI
7. A. Santamaria et al, Wireless LAN systems, Artech House.
8. Stallings, Wireless Communication & Networks, Pearson Education
9. K. Feher, Wireless digital communications, Prentice Hall of India.
9. Roy Blake, Wireless communication technology, Thomson Delmer.

Course Name: CRYPTOGRAPHY AND NETWORKING SECURITY					
Course Code : ECEN 5231					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module I: [12 L]

Introduction: Principles of security, Overview of network security and cryptography, OSI Security architecture, model for network security, classification of attacks (Reply, Reflection, Man – in – the – middle), Virus, Worm, Trojan Horse, Spam etc.
Symmetric ciphers: Algorithm types and modes, classical encryption techniques, block ciphers and Data Encryption Standard (DES), Advanced Encryption Standard (AES), Contemporary Symmetric Ciphers, and confidentiality using symmetric encryption

Module II: [9 L]

Public Key Cryptography: Public key Infrastructure (PKI), RSA, key management, Diffe-Hellman key exchange, elliptic curve arithmetic, elliptic curve cryptography.
Message Authentication and Hash Functions: Authentication requirements, authentication functions, message authentication codes

Module III: [9 L]

Hash functions, security of Hash functions and MACs.Hash Algorithms: MD5 Message Digest Algorithm, Secure Hash Algorithm, Digital Signature Algorithm, Digital Signature Standard. Network Security Applications: Authentication Applications (Kerberos), Electronic Mail Security (SMIME), IP Security (IPSec)

Module IV: [8 L]

Web Security (SSL and TLS), E – cash and Secure Electronic Transaction (SET), System security using Firewalls and VPNs. Advance Applications of Network Security: Smart cards and security, Enterprise Application Security, Biometric Authentication, Database Access Control, Security and Privacy Issues in RFIDs

.

References:

1. William Stallings, Cryptography and Network Security—Principles and Applications, Pearson Edu.
2. Atul Kahate, Cryptography and Network Security, Tata McGraw Hill.
3. Trappe & Washington, Introduction to Cryptography with Coding theory, Pearson Education.
4. William Stallings, Network Security Essentials, Pearson Education.
5. Kaufman, Perlman & Speciner, Network Security, Pearson Education.
6. Behrouz A. Forouzan, , Cryptography and Network Security, McGraw – Hill Education.

Course Name: ARTIFICIAL INTELLIGENCE AND SOFT COMPUTING					
Course Code : ECEN 5232					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module I: [10 L]

Introduction: Definition of AI, The disciplines of AI, Application of AI techniques.
General Concepts of Knowledge: Definition and importance of knowledge, components of a knowledge-based system.
Dealing with Inconsistencies and Uncertainties: Nonmonotonic reasoning, Truth Maintenance System (TMS), Default Reasoning and closed world assumption, Fuzzy Logic and natural language computation, Fuzzy sets, various operations,
reasoning with Fuzzy logic.

Module II: [10 L]

Problem solving by intelligent search: General problem solving approaches: Breadth first search, Depth first search, Hill
climbing, Simulated Annealing Learning: Supervised Learning-Inductive learning, unsupervised learning-Reinforcement learning, learning automata.
Basics of pattern recognition: Concept of a pattern: feature, feature vectors and classifiers. Importance of pattern recognition. Fuzzy pattern recognition.
Classifiers: Classifiers based on Baye's decision theory: Bayesian classification for normal distribution, Bayesian inference.

Module III: [9 L]

Estimation of unknown probability distributions. Baye's error. Linear classifiers: linear discriminant functions and decision hyperplanes. The peceptron algorithm. Suport Vector Machine (SVM): separable and nonseparable classes. An introduction
to nonlinear classifiers: the XOR problem, the two layer perceptron and radial basis function (RBF) network. Context dependent classification.
Clusterings: Basic concept of cluster analysis. Applications of cluster analysis. Proximity measures: between two points, Proximity function: between a point and a set. Different clustering algorithms: Sequential, Hierarchical, Schemes based on
function optimization . Cluster validity.

Module IV: [9 L]

Evolutionary algorithms: Genetic Algorithm: Cycle of genetic algorithms, crossover, mutation, fitness function, schema, fundamental theorem of GA (Schema theorem). Differential Evolution (DE), Modified Differential Evolution(MoDE). Multiobjective
optimization using evolutionary algorithms. Hybridization with clustering. Genetic programming.
Application Areas: Qualitative discussions on different application areas of A.I and Soft Computing e.g. Image pattern recognition: Image classification using clustering (hard and fuzzy). etc.

References:

1. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, Prentice Hall of India.
2. Nils J. Nilsson, Artificial Intelligence: A new Synthesis, Harcourt Asia PTE Ltd., Morgan Kaufmann

Course Name: INTEGRATED CIRCUITS AND DESIGN					
Course Code : ECEN 5233					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module I: [10 L]

Integrated circuit devices and modeling: Semiconductors and p-n junction, advanced MOS modeling, bipolar junction transistors MOS devices in weak inversion.

Basic current mirrors and single stage amplifiers: Simple CMOS current mirror, common source amplifier, source follower, common gate amplifier, source generated current mirrors, high output impedance current mirrors, cascade gain stages, MOS differential pairs, bipolar current mirrors, bipolar gain stages, class AB output stages.

Module II: [10 L]

Internal amplifiers: Switched capacitor amplifiers, switched capacitor integrators. 6 L
Non linear circuits: Phase locked loop. MOS inverter: Switching characteristics, static and dynamic behaviors delay.
Combinational MOS logic circuits: pseudo NMOS, dynamic logic, domino logic, NORA, differential CMOS gates, X-gate and pass transistors.

Module III: [9 L]

Sequential MOS logic circuits: CMOS clocked latches, static and dynamic CMOS latches, D, SR, JK, T and edge triggered SR flip-flop.

Digital integrated system building blocks: Multiplexers and decoders, barrel shifters, counters, digital adders, modified booth multipliers

Module IV: [9 L]

CMOS timing and I/O considerations: Delay of CMOS circuits, junction capacitors, interconnect capacitors, delay of CMOS logic gates, input protection circuits, output circuits and driving large capacitors, three state outputs.

Noise in integrable circuits: Noise in circuits, types of noise, time domain analysis, frequency domain analysis, noise models for circuit elements – resistors, capacitors, diode, BJT and MOSFET.

References:
1. Analog integrated circuit design, David Johns and Ken Martin, John Wiley and sons (UK), 2002
2. Digital integrated circuit design, Ken Martin, Oxford University Press, New York, 2000
3. Analysis and Design of Analog Circuits, Paul Grey, Paul Hurst, Stephen Lewis and Robert Mayer, John Wiley and Sons (UK), 4th edition.
4. Digital Integrated Circuits - A Design Perspective, Rabaey, Chandrakasan and Nokolic, PHI (2nd Edition), 2008
5. CMSO Digital Integrated Circuits - Analysis and Design, Sung-Mo Kang & Yusuf Lablebici, Tata McGraw Hill, (New Delhi), 2003

Course Name: MICROWAVE MEASUREMENT AND INSTRUMENTATION					
Course Code : ECEN 5234					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

MODULE I : [10 L]

Introduction to Radio Frequency and Microwave Measurement.
: Microwave Detectors and Sensors. Different types of microwave detectors, their functions and applications. Microwave sensors – working principles and applications
Microwave Power Measurement- Low Power Measurement- Bolometer technique. High Power Measurement – Calorimetric method

MODULE II : [10 L]

Microwave Attenuation Measurement
Microwave Frequency Measurement. Slotted Line technique. Wave meter method - Absorption and Transmission type wave meter
Microwave Impedance Measurement – Slotted Line technique to measure VSWR and unknown Load Impedance. Application of Smith chart in transmission line measurement

MODULE III : [9 L]

Microwave Cavity parameter measurement. – Cavity Q measurement by Slotted Line technique. Swept Frequency method Decrement methodMeasurement of Dielectric constant of a solid and liquid at microwave frequency by Waveguide method.
Cavity perturbation method

MODULE IV : [9 L]

Introduction to Microwave Instrumentation:
Spectrum Analyzer ; Block diagram of a spectrum analyzer – operational features of functional units and applications of Spectrum Analyzers.
Vector Network Analyzer (VNA) : Block diagram of VNA operational aspects of different functional units comprising VNA. Measurement of Scattering parameters and other applications.
Time Domain Reflectometer (TDR) : Block diagram of TDR and its working principle
Reflection coefficient measurement and interpretation of Time domain Reflected waveform.
Industrial applications of TDR.

References:

1. G.H.Bryant- Principles of Microwave Measurements- Peter Peregrinus Ltd.
2. T.S.Laverghetta- Hand book on Microwave Testing
3. S.F.Adam- Microwave Theory & Application- Prentice Hall, Inc
4. A.E. Bailey, Ed. Microwave Measurements- Peter Peregrinus Ltd
5. Annapurna Das and S K Das Microwave Engineering TMH Publications
6. HP Application Notes

Course Name: SATELLITE COMMUNICATION					
Course Code : ECEN 5241					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module I: [10 L]
Introductory topics:

A brief history of satellite communication, future scope and present scenario..
Orbital Mechanism: Orbits, look angle, orbital period and velocity, azimuth and orbital inclination, coverage angle, orbital perturbation, mechanism of satellite placement in geostationary orbit. Indian Satellite scenario.
Satellite Subsystems:
Communication, telemetry, tracking & command, power, attitude & orbital control, antenna subsystems.

Module II: [10 L]

Earth Station: Fundamentals & general system architecture, Earth station antenna, gain, pointing loss, G/T variation and it's measurement, antenna tracking, power amplifier, low noise amplifier, up converter, down converter, transponder hopping, polarization hopping, redundancy configuration.
Satellite transponder: transponder model, transponder channelization, Transponder frequency plans, Effect of fading.
Satellite Link Design: Basic link analysis, interference analysis and attenuation due to rain, link with and without frequency reuse.

Module III: [9 L]

Multiple Access Techniques:
Frequency Division Multiple Access: SPADE, FDM-FM-FDMA, Companded FDM-FM-FDMA and SSB-AM-FDMA, intermodulation products in FDMA, optimized carrier-to-intermodulation plus noise ratio.
Time division Multiple Access: Principle, TDMA frame structure, TDMA Burst structure, TDMA Superframe structure, Frame acquisition and synchronization. TDMA timing. Demand Assignment Multiple Access and Digital Speech interpolation. ERLANG B Formula. Type of demand assignment, DAMA characteristics, Real time frame reconfiguration, DAMA interfaces, SCPC-DAMA, Digital Speech interpolation. Satellite packet communication.

Module IV: [9 L]

Propagation effects: Propagation effects and their impact on satellite earth link.

Introduction to VSAT systems: low earth orbit and non-geostationary satellite systems. Direct broadcast Television and Radio. Satellite Navigation and the global positioning system. Network configuration, multi-access and networking, network error control, poling VSAT network.
Mobile satellite network: Operating environment. MSAT network concept, CDMA MSAT relink.

References:

1. Tri T. Ha, Digital Satellite Communication, TMH.
2. Timothy Pratt, Charles Bostian, Teremy Allnutt, Satellite Communication, John Wiley & Sons.
3. J. J. Spilker, Jr., Digital Communication by Satellite, Prentice Hall.
4. Bruce R. Elbert, Satellite Communication Applications Hand Book, Artech House.

Course Name: IMAGE PROCESSING AND PATTERN RECOGNITION					
Course Code : ECEN 5242					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module I: [10 L]

Image Processing Basics: Image definition, a simple image formation model, basic concepts of image sampling and quantization, representing a digital image, concept of pixel/ pel, spatial and gray level resolution, some basic relationships between pixels : Neighbors of a pixel, Adjacency, Connectivity, Path, Connected component, Connected component labeling. Distance measures: the three essential properties, Euclidean, City-Block and Chess-Board distance, concept of image operations on a pixel basis.
Popular image processing methodologies: Spatial domain technique : contrast stretching, basic point processing, thresholding function, concept of mask/ sub image, mask processing/ filtering, gray-level slicing, bit-plane slicing.
Basics of spatial filtering : convolution mask/kernel, concept of sliding mask throughout the image-space, smoothing(averaging) filter/ low pass filter. Image segmentation by global and local gray level thresholding, region growing, region splitting and merging techniques. Morphological algorithms: thinning, thickening, skeletons.
Color image processing: Perception of color: color fundamentals. Two popular color models: RGB & HSI, concept of RGB & HSI space and their conceptual relationships, mathematical conversion from RGB to HSI space and vice versa.

Module II: [10 L]

Pattern Recognition
Basics of pattern recognition: Concept of a pattern: feature, feature vectors and classifiers. Importance of pattern recognition. Basic concept of fuzzy pattern recognition, linearly separable and inseparable classes, classes with some overlapping regions, convex and non-convex paradigm in this aspect.
Clustering: Basic concept of cluster analysis. Similarity (Proximity) metrics (indices) and clustering criteria. Partitional clustering: Extraction of natural groups that are inherent in some data set by hard c-means (k-means), fuzzy cmeans.
Concept of getting stuck to a local optimum (in objective functional space) by k-means and fuzzy c-means due to their initiation/ starting point. Fuzzy cluster validity index: Xie-Beni index.
Classification and prediction: Definition of classification and prediction. Basic task of a classifier. Concept of training & testing data and overfitting. Bayes classification: Bayes' Theorem, Naïve Bayesian classification. Classification by Backpropagation: Multilayer Perceptron (MLP) neural network and Backpropagation algorithm.

Global optimization techniques: Genetic Algorithms (Gas): Cycle of genetic algorithms, selection (Roulette wheel and Tourment) crossover, mutation, evaluation of fitness function, incorporation of elitism in GAs. Multi-objective
optimization using GAs. Simulated Annealing (SA): Analogy with physical annealing process, concept of energy and mechanism of energy minimization using SA, Necessity of an uphill movement during the process. Hybridization with partitional clustering techniques.

Module III: [9 L]

Image clustering applications: Mechanism of extracting pixel-patterns from a gray-scale image in various ways: e.g. forming feature space (like a two column matrix) treating the gray-value of center-pixel (of a local window) as the first feature and averaged value over a square-shaped local window (3x3 or 5x5 or like that) as the second feature, construction of high-dimensional feature space: e.g. treating all the pixel-gray-values of a local window as features (i.e. for 3x3 window 9-dimensional feature space will result). Application of partitional clusterings in the above mentioned feature-space to recognize the objects in the concerned image.

Module IV: [9 L]

Applications in multispectral and multitemporal remotely sensed imagery: Identification of different land cover types from multispectral remote image data using supervised/ unsupervised classification: Clustering by Histogram peak selection & and its limitation in this context (i.e. remote image analysis). Unsupervised Change Detection using
squared-error clustering methodologies: The algorithm, process, key challenges, error estimations like missed alarms, false alarms and overall error, need of ground truth.
Image mining: Need, Image search and retrieval. Bottleneck of Text based image mining/ retrieval, Visual feature based image mining: Content-based image retrieval (CBIR).
Image based face recognition: Basic technique for Eigen face generation & recognition.

References:

1. R. C. Gonzalez and R. E. Woods, Digital Image Processing, Pearson Education Asia, 2004
2. S.K. Pal, A.Ghosh, and M.K. Kundu, Soft Computing for Image Processing, Physica
3. Verlag, (Springer), Heidelberg,1999.
4. R. O. Duda, P.E. Hart and D. G. Stork, Pattern Classification, John Wiley & Sons (Low Priced Edition).
5. Anil K. Jain and R.C.Dubes, Algorithms for Clustering Data, Prentice Hall.
6. S. Theodoridis and K. Koutroumbus, Pattern Recognition, Elsevier.
7. A. Ghosh, S. Dehuri, and S. Ghosh (editors). Multi-Objective Evolutionary
8. Algorithms for Knowledge Discovery from Databases. Springer, Berlin,
9. 2008.
10. Anil K. Jain, Fundamentals of Digital Picture Processing, Prentice Hall.

Course Name: MULTIMEDIA COMMUNICATION					
Course Code : ECEN 5243					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module I: [10 L]

Multimedia Introduction: Media and Data Streams, Classification of media and Properties of multimedia system. Sound, Images & Video : Speech synthesis, Speech Recognition, Raster display, Image recognition, TV, HDTV, Speech transmission, Image transmission.

Module II: [10 L]

Compression : Huffman Coding, Runlength coding, JPEG, MPEG, DVI, H.261
Storage Media : CDDA, CDROM, CDROM (XA)
Multimedia Operating system: Resource Management, Process Management: EDF

Module III: [9 L]

Rate monotonic Algorithms. System Architecture: Quick Time, MDBMS.
Synchronization: Lip & Pointer Synchronization, Synchronization Reference Model, Case Study.

Module IV: (9 L)
Multimedia Communications: Delay compensation, QoS negotiation protocols, Architectures and Issues for Distributed Multimedia Systems, Prototype Multimedia systems: Video-on-Demand, Video conferencing. Multimedia Information: Delay-sensitive and Time-based Media data Modeling

References:

1. Ralf Steinmetz and KlaraNahrstedt, "Multimedia: Computing, Communications and Applications", Prentice Hall PTR, 1995.
2. Franklin Kuo, Wolfgnag and J.J. Garsia, "Multimedia Communications, Protocols and Applications", Prentice Hall PTR 1998.

Course Name: ADVANCED ANTENNA ENGINEERING					
Course Code : ECEN 5244					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Module I: [10 L]
Antenna:
Wire antennas, Aperture Antennas, Antenna gain, Antenna Temperature and other Antenna parameters. Relationships between antenna parameters. Reciprocity, Review of microwave antennas-Parabolic Reflector, Cassigrain feeds, Horn Antennas, Open-ended wave guides, lens antennas, Dielectric rod Antennas, Antennas for mobile communication. Applications of

reaction concept and vocational principles in antennas and propagation, Frequency-independent antennas, Scattering and diffraction. Selected topics in microwave antennas, Internal-equation methods, current distribution: Self and mutual impedances: arrays: design and synthesis.

Module II: [10 L]

Full wave analysis of Microstrip Antenna(MSA),Active Integrated MSA, Compact MSA with enhanced gain, Broadband Antenna(MSA), Dual frequency & Dual polarized MSA Application of broadcasting, microwave links, satellite communication and radio astronomy.

Module III: [9 L]

Antenna Measurements: Standardization and characterization of antennas, Anechoic Chamber, Open-air test range.
Propagation:
Review of modes of propagation: Surface wave, Ground wave, Sky wave, Space wave, Troposphere propagation.
Propagation over plane-Earth, Spherical Earth, Refraction, Anomalous Propagation, Diffraction, Modified refractive index- Its effects on wave propagation, Duct and other nonstandard propagation. Environmental noise

Module IV: [9 L]

EMI - EMC, Radiation Hazards.
Microwave & millimeter wave propagation, Effects on atmospheric precipitations: Rain, Fog, Snow, Ice, and other atmospheric gases.
Low frequency propagation, Propagation through seawater, Sea clutter, Land clutter, Surface clutter, Radar equation, o Microwave link considerations- multi-path Fading, its characteristics- Techniques for more link availability, Earth space systems
.
References:

1. R.E Collin, Antennas & Radio wave propagation (McGraw-Hill Book Co.)
2. Jordan and Balmain, Electromagnetic Waves and Radiating Systems (PrenticeHall of India)
3. M.L Skolink, Introduction to radar systems (McGraw-Hill Book Co.)
4. P Bhartia and I.J. Bhal, Millimeter wave Engineering & Applications
5. Albart Smith, Radio Engineering Principle and Applications
6. M. Dolukhanov, Propagation of Radio Waves (Mir Publication)
7. R.Garg,P.Bhartia,Indu Bhal,A.Ittipibom ; Microstrip Antenna Design hand book –Artech House
8. Girish Kumar & K.P.Roy—Broad band Microstrip Antenna-=Artech. House
9. Kin. Lu. Wong ; Compact and Broadband Microstrip Antenna—John Willey & Sons.

Course Name: COMMUNICATION SYSTEMS LABORATORY					
Course Code : ECEN 5211					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	3	3	2

Experiments on complete systems to acquire an overall knowledge about the system architecture, its important GOS parameters and its detail working principle.
Suggested topics are (not exclusive),

1. GPS
2. ISDN
3. Satellite communication system
4. GSM system
5. CDMA mobile system
6. Optical data communication system
7. Bluetooth communication system
8. Wireless channels.

2nd Year 1st Semester (PG)

Course Name : Research Methodology and Project Management					
Course Code : HMTS6101					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	4	**0**	**0**	**4**	**4**

Course outcome:

1.Idea about research methodology
2. Project – implementation and appraisal
3.Project planning

Module 1

Meaning of Research, Types of Research, process of Research, Formulation of Research Problem and Development of Research Hypotheses, Data Collection — Primary and Secondary Data, Types of Measurement Scale, Sample Designing, Sampling vs. Non sampling Error, Different types of Sample designing, Determination of Sample Size.

Testing of Hypotheses, Null and Alternate hypothesis, One tailed and two-tailed test, Type I and Type II error, Steps in Testing Hypothesis, Level of Significance and Critical region, Z test, t Test, P Test, ANOVA, Correlation and Regression Analysis, Chi-Square test.

Module 2

Concepts of a Project, Characteristics of a Project, Project Life Cycle Phases, Difference between Project Management and Functional Management, Roles and Responsibilities of a Project Manager, Matrix organization of a Project.

Module 3

Project Appraisal: DPR - Technical, Marketing, Environment, Social, Financial Appraisal [Non Discounted Cash Flow Technique like Payback and Accounting Rate of return (ARR); Discounted Cash Flow technique like Profitability Index (P/I) or Benefit Cost ratio (BCR), Net Present Value (NPV), Internal Rate of return (IRR)]

Module 4

Project Planning, Work Breakdown Structure (WBS), Networking Concepts, Network Analysis, Difference between PERT and CPM, Calculation of Floats, Concept of Crashing, Gantt Chart, LOB.

Case Study on Project Management

Recommended Books: Research Methodology Concepts and Cases by Chawla & Sondhi,Vikas Publishing House.

Project Management by S Choudhury, TMH

Projects: Planning, Analysis, Selection, Implementation & Review by Prasanna Chandra, TIvll-I.

Course Name : EMI/EMC					
Course Code : ECEN 6131					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	4	**0**	**0**	**4**	**4**

Course outcomes:

1.An ability to understand the concept and importance of EMI/EMC.

2.An ability to analyze circuits like SMPS from the perspective of EMI.

3.An ability to design proper shielding and grounding mechanism for circuits like RC filter

4.An ability to apply the concepts of EMI/EMC in measurement of radiation from system like PCB board using reverberating chamber, anechoic chamber etc.

5.An ability to set EMC standards for a particular circuit based on EMI/EMC measurements.

Module I **(8L)**

Introduction: History and concept of EMI, Definitions of EMI/EMC, Electro magnetic environment, Practical experiences and concerns, frequency spectrum conservations.

Natural and manmade sources of EMI/EMC: Sources of Electromagnetic noise, typical noise paths, modes of noise coupling, designing for EM compatibility, lightening discharge, electro static discharge (ESD), electromagnetic pulse (EMP), electromagnetic interference due to radiation.

Module I I (10L)

EMI from circuits:

a) *Analog Circuits:*
EMI in analog circuits, basic noise entry modes for the analog circuits, noise calculation in each case with examples, ground loop problems with examples.

b) *Digital Circuits:*
EMI issues in digital circuits, power distribution in digital circuits, power rail equivalent circuit, frequency response of power rail.

c) *Power Circuits:*
EMI issues in power circuits, conducted noise emission from SMPS, reduction methods, conducted noise emission, calculation in frequency domain using graphical methods, conducted noise emission standards, power supply induced noise and the design of RC filter for the circuits with examples.

Module I V **(16L)**

Signal Integrity:

a) PCB design:
Power distribution issues in PCB using different converters. Filtering techniques, Reflection and cross talk issues in PCB for high speed circuits. Cross talk calculations. Issues due to reflections. Calculation of induced noise. Calculation of PCB track impedance.

b) *Shielding and Bonding:*
effectiveness of shielding, near and far fields / impedances, methods of analysis, use of instrumentation amplifier for ground noise reduction, use of shielded cable for the instrumentation amplifier, circulating current reduction techniques, use of Isolation amplifier, noise reduction characteristics, example with bio-medical amplifier.

c) *Grounding and cabling:*
Safety and signal grounds, low and high frequency grounding methods, grounding of amplifiers and cable shields, isolation, neutralizing transformers, shield grounding at high frequencies, digital grounding, types of cables, mechanism of EMI emission / coupling in cables.

Module V **(4L)**

EMC Standards and test equipment ~~s~~ : EMI standards and regulations, anechoic chamber, TEM cell, reverberating chamber, GTEM cell, comparison of test facilities,

Reference Text books:

1. Engineering Electromagnetic Compatibility by Dr. V.P. Kodali, IEEE Publication, Printed in India by S. Chand & Co. Ltd., New Delhi, 2000.
2. Electromagnetic Interference and Compatibility IMPACT series, IIT-Delhi, Modules 1-9.
3. Introduction to Electromagnetic Compatibility, Ny, John Wiley, 1992, by C.R. Paul.
4. Radar hand book by Skolink.
5. Ott. H.W. Noise reduction techniques in Electronic system, 2nd edition, John Wiley Interscience, New York (1988).
6. Electromagnetic Interference & Electromagnetic Compatibility, Tata McGraw Hill, New Delhi (1996) by G K Dev.

Course Name : AD HOC AND SENSOR NETWORKING					
Course Code : ECEN 6132					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Course outcomes:

1. An ability to apply knowledge of mathematics, science and engineering in the areas of communication engineering.

2. An ability to analyze a situation and interpret a data in ad hoc networks.

3. An ability to learn and apply modelling based approach through the extensive use of simulator tools.

4. An ability to understand and participate in new path breaking research work in new areas of communication engineering.

5. Imbibement of a passion to pursue new areas of research.

Module I: [12 L]

Ad hoc wireless Network: Introduction, Basic concept on ad hoc network, static and mobile ad hoc network, transmitter-receiver constraints, Applications.
MAC protocol: Hidden terminal, Exposed terminal, IEEE802.11 in ad hoc mode.
Routing protocols: Proactive, Reactive and hybrid routing protocol, Destination sequenced distance vector algorithm, Dynamic source routing, Ad hoc on-demand routing, Location aided routing, Link reversal routing.

Module II: [10L]

Analysis of TCP performance in wireless ad hoc network: TCP window management and problems, different solution schemes, QoS in wireless ad hoc network – analysis of degradation of receiver sensitivity, practical solutions.
Achieving energy efficiency in wireless ad hoc network: Different schemes to increase the lifetime of the node in ad hoc network – MAC layer protocol, Routing protocol.

Module III: [8 L]

Localization Management: Location acquisition technique, location sensing technique, location aware routing protocol. Primary and secondary source , Different principles like weighted centriod algorithm to locate sources. Security for wireless ad hoc network: Security goals, threats and challenges, Different schemes of security in ad hoc network, routing security. Spectrum utilization – Generic Access Network (GAN) and other methods

Module IV: [6 L]

. Sensors- sensor networking, WSN, hardware and software platforms, OS for WSN, distributed sensor network, healthcare monitoring, environmental sensing, industrial monitoring, smart city concept.

Reading:

1.”Ad Hoc Wireless Networks – Architectures and Protocols” - C.Siva Ram Murthy and B.S. Manoj – Pearson Education

2.Mobile Ad Hoc Networking – Stefano Basagni, Marco Conti, Silvia Giardano, Ivan Stojmenovic – Wiley India

3.”Ad Hoc Mobile Wireless Networks : Principles Protocols and Applications” – Basavaraju – Aurbach Publications

4.Security and Quality of Service in Ad Hoc Wireless Networks – Amitabh Misra – Cambridge University Press

5.”Ad Hoc Mobile Wireless Networks – Protocols and Systems” - Chai K. Toh – Prentice Hall

Course Name : CONVERGENCE IN COMMUNICATION TECHNOLOGY					
Course Code : ECEN 6133					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	4	**0**	**0**	**4**	**4**

Course outcomes:

1.High speed links using new technologies
2.concepts about routing protocols
3. concepts about cloud computing etc

Module I: [8 L]

Human – Machine Interfaces – Embedded devices, EM spectrum, Multiplexing media – carrier vice twisted pair, co-ax cable, microwave, satellites, Fiber optics. Circuit switching, Packet switching, PDH & SDH/SONET, SS7 & intelligent networks.

Module II: [10 L]

Data Communication Traffic, Data transmission, OSI & TCP/IP models, LAN Transport and standard, LAN access, switches, VLANs & Bridges, ISDN, X.25, Frame Relay & ATM, Internet & Routing protocols, sub netting: IPV4, IPV6, DNS, QoS – VoIP call signaling protocols, IP Voice & IPTV, Telepresence.

Module III: [10 L]

Digital TV standards, Broadband infrastructure, Cloud computing, optical networking elements, switches, edge, core, DSL, Cable TV, Packet Cable, Wireless Broadband, HAN, PANs, CANs, MANs, Broadband PLT, Antennas, Spread spectrum.

Module IV: [10 L]

Cellular – 26, 2.5G, 3G, 4G, WiMAX, mobile security, Digital cellular Radio, UMTS, TD – SCDMA, BFWA, WLANs, IEEE 802.11 a,b,g,n, IEEE 802.16 WiMAX, Interpration of WLANs & cellular networks, RFID, IP multimedia subsystem, Mobile Video, Mobile TV.

Rea ding:

1. "Telecommunications Essentials elearning" by Lillian Goleniewski, ISBN, 13: 9780970741202
2. "Telecommunications Essentials" by Lillian Goleniewski, 2nd edition, Addison-Wesley Professional ISBN 13 : 9780321427618.
3. "Network & Guide to Networks" – Tamera Dean, March 2009. Publisher: Course Technology. ISBN 13 : 9781423902454
4. Telecommunications and Signal Processing – Roger L. Freeman, Wiley Series.
5. Telecommunication- Fraser.

Course Name : COGNITIVE RADIO TECHNOLOGY					
Course Code : ECEN 6141					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	4	**0**	**0**	**4**	**4**

The following outcomes (COs) are expected from the students after completion of the course – ECEN6141.

a) An ability to apply knowledge of mathematics, science and engineering in the emerging areas of RF communication.

b) An ability to analyze a situation.

c) An ability to learn and apply modular approach.

d) An ability to understand research work in new areas of cognitive radios and spectrum hole sensing.

e) Development of a passion to pursue next generation wireless communication.

Module I: [10 L]

INTRODUCTION TO SOFTWARE DEFINED RADIO

Definitions and potential benefits, software radio architecture evolution, technology tradeoffs and architecture implications. Differences between software enable radio and software defined radio. Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules.

Module II: [8 L]

COGNITIVE RADIO TECHNOLOGY

Introduction – Radio flexibility and capability – Aware – Adaptive – Comparison of Radio capabilities and Properties – Available Technologies – IEEE 802 Cognitive Radio related activities – Application, position awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques.

Module III: [10 L]

COGNITIVE RADIO DESIGN AND CHALLENGES

Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture. Design Challenges associated with CR – Hardware requirements – Hidden primary user problem – detecting spread spectrum primary users – sensing duration and frequency – security **Module IV:**

[8 L] SPECTRUM

SENSING

Spectrum sensing, spectrum management, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design, applications of cognitive radios to optimize spectrum utilization, to reduce transmit power reduction and to improve data rate even in noisy conditions. Matched filter – waveform based sensing – cyclostationary based sensing – Energy detector based sensing – Radio Identifier – Cooperative sensing-other sensing methods.

TOTAL: 36 PERIODS

Reading:

1. Joseph Mitola III, “Software Radio Architecture: Object-Oriented Approaches to wireless system Engineering”, John Wiley & Sons Ltd. 2000
2. Thomas W. Rondeau, Charles W. Bostain, “Artificial Intelligence in Wireless communication”, ARTECH HOUSE. 2009.
3. Bruce A. Fette, “Cognitive Radio Technology”, Elsevier, 2009.
4. Ian F. Akyildiz, Won- Yeol Lee, Mehmet C. Vuran, Shantidev Mohanty, “Next generation / dynamic spectrum access / cognitive radio wireless networks: A Survey” Elsevier Computer Networks, May 2006
5. Simon Haykin, “Cognitive Radio: Brain-Empowered Wireless Communication”, IEEE Journal on selected areas in communications, Feb 2005.
6. Markus Dilinger, Kambiz Madani, Nancy Alonistioti, “Software Defined Radio”, John Wiley, 2003
7. Huseyin Arslan,”Cognitive Radio, SDR and Adaptive System”, Springer, 2007.
8. Bruce A. Fette, “Cognitive Radio Technology”, Elsevier, 2009.

Course Name : DESIGN OF COMMUNICATION EQUIPMENTS AND SYSTEMS					
Course Code : ECEN 6142					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

The following outcomes (COs) are expected from the students after completion of the course – ECEN6142.

a) An ability to apply knowledge in designing electronics for communication engineering.

b) An ability to analyze and interpret data.

c) An ability to learn and apply modelling based approach through the extensive use of simulator tools.

d) An ability to pursue research work in new areas of communication equipments and systems.

Module I: [10 L]

Design Considerations of Communication equipments and systems: Implementing Radio Link, Path profile, RF path loss calculations, Transmitter / Receiver parameters and their significance – SNR, SINAD, sensitivity, Hum and Noise, Quieting, Distortion, Rated RF power, RF power, Fade Margin.
Study and evaluation of Performance parameters for data communication like Bit and symbol error rates, Spectral Bandwidth calculations.

Module II: [10 L]

Design of various blocks of communication equipments such as PLL, Equalizer, Interleaver, Interference consideration in processor / controller enabled radios-desensitization problem, means to mitigate the problem – detailed study of clock speed & shape, PCB design.

Module III: [10 L]

PCB Design and EMI/EMC
PCB design practices for Analog and Mixed signal circuits- Ground loops, Precision circuits, supply isolation, shielding and guarding – different techniques. PCB design practices for High Speed Digital circuits, signal integrity and EMC. EMI/EMC testing standards and compliance.

Module IV: [8 L]

Types of antenna – selection procedure for correct antenna, measurement of the network performance – different techniques.
Emulation of testing procedure in laboratory, test procedures for Receiver / Transmitter parameters with different standards like CEPT, EIA.

Rea ding:

1. “High-speed Digital Design- A Handbook of Black Magic” – Howard Johnson, Martin Graham- Prentice Hall.
2. “EMC for Product Designers” – Tim Williams – Elsevier 2007.
3. “Digital Communication” – B. Sklar – Pearson Ed.
4. “Circuit Design for RF Transceiver” – D. Leenaerts, Johan van dar Tang, Cicero S. Vaucher – kluwer Academic Publishers, 2003
5. “Practical Radio Engineering & Telemetry for Industry“ – David Bailey – Elsevier, ISBN 0750658037.