Department of Electronics and Communication Engineering

Netaji Subhash Engineering College Kolkata – 700 152

Syllabus for
M. Tech in Communication Engineering

Affilliated to
West Bengal University of Technology
BF-142, Salt Lake, Kolkata – 700 064

COURSE STRUCTURE

1st semester

A. Theories:							
Sl. No.	**Code**	**Subject**	**Contacts periods per week**				**Credit**
			L	**T**	**P**	**Total**	
1	*One paper from general core engineering*		**3**	**1**	**0**	**4**	**4**
a	MCE101	Engineering Mathematics and Statistics	3	1	0	4	4
2	*One paper from interdisciplinary Core Subjects*		**3**	**1**	**0**	**4**	**4**
a	MCE102	Computer Communication and Networking	3	1	0	4	4
3	*Three papers from Foundation course in Field of Specialization*		**3x3**	**3x1**	**0**	**3x4**	**12**
a	MCE103A	Communication Theory	3	1	0	4	4
b	MCE103B	Advanced Digital Communication	3	1	0	4	4
c	MCE103C	Noise and Information Theory	3	1	0	4	4
d	MCE103D	Photonics and Optical Communication	3	1	0	4	4
e	MCE103E	Two Dimensional Signal Processing	3	1	0	4	4
f	MCE103F	Advanced Antenna Systems and Radio Wave Propagation	3	1	0	4	4
		Total of theory				**20**	**20**
B. Sessionals:							
Sl. No.	**Code**	**Subject**	**Contacts periods per week**				**Credit**
			L	**T**	**P**	**Total**	
1	MCE191	Telecommunication System Engineering Lab	0	0	3	3	2
2	MCE192	Design and Simulation Lab	0	0	3	3	2
		Total of sessionals:				**6**	**4**
		Total credit of 1st semester:					**24**

2nd semester

A. Theories:							
Sl. No.	**Code**	**Subject**	**Contacts periods per week**				**Credit**
			L	**T**	**P**	**Total**	
1	*Three papers from Theory of Advanced Communication Engineering*		**3x3**	**3x1**	**0**	**3x4**	**12**
a	MCE201	Mobile Communication	3	1	0	4	4
b	MCE202	Microwave and Millimeter wave Techniques	3	1	0	4	4
c	MCE203	Error Control Coding Theory	3	1	0	4	4
2	*Two papers from Application of Communication Engineering*		**2x3**	**0**	**0**	**2x3**	**6**
a	MCE204A	Satellite Communication system	3	0	0	3	3
b	MCE204B	Remote Sensing	3	0	0	3	3
c	MCE204C	Radar Signal Processing	3	0	0	3	3
d	MCE204D	Artificial Intelligence and Pattern Recognition	3	0	0	3	3
		Total of theory				**18**	**18**
B. Sessionals:							
Sl. No.	**Code**	**Subject**	**Contacts periods per week**				**Credit**
			L	**T**	**P**	**Total**	
1	MCE291	Advanced Communication Engineering Lab	0	0	3	3	2
2	MCE292	Term paper leading to thesis-I					4
		Total of sessionals:				**3**	**4**
		Total credit of 2nd semester:					**22**

3rd semester

A. Theories:							
Sl. No.	**Code**	**Subject**	**Contacts periods per week**				**Credit**
			L	**T**	**P**	**Total**	
1	*Two papers from Recent Trends in Communication Engineering*		**2x3**	**2x1**	**0**	**2x4**	**8**
a	MCE301A	Secured Communication	3	1	0	4	4
b	MCE301B	Telecommunication Network management	3	1	0	4	4
c	MCE301C	ASIC in Telecommunication	3	1	0	4	4
d	MCE301D	EMI & EMC	3	1	0	4	4
		Total of theory				**8**	**8**
B. Sessionals:							
Sl. No.	**Code**	**Subject**	**Contacts periods per week**				**Credit**
			L	**T**	**P**	**Total**	
1	MCE391	Seminar-I					4
2	MCE392	Term paper leading to thesis-II					4
3	MCE393	Grand Viva-voce					4
		Total of sessionals:					**12**
		Total credit of 3rd semester:					**20**

4th semester

B. Sessionals:							
Sl. No.	**Code**	**Subject**	**Contacts periods per week**				**Credit**
			L	**T**	**P**	**Total**	
1	MCE491	Seminar-II					4
2	MCE492	Thesis + Viva voce					12
		Total of sessionals:					**16**
		Total credit of 4th semester:					**16**
		Grand Total credit of the course					**82**

Detail Syllabus:

First Semester

Engineering Mathematics and Statistics

Code: MCE101
Contacts: 3-1-0
Credits: 4

Complex Variables: Elements of set theory, Set notations, Applications of set theory, Open & Closed Sets. Review of Complex variables, Conformal mapping and transformations, Functions of complex variables, Integration with respect to complex argument, Residues and basic theorems on residues.
Numerical Analysis: Introduction, Interpolation formulae, Difference equations, Roots of equations, Solutions of simultaneous linear and non-linear equations, Solution techniques for ODE and PDE, Introduction to stability, Matrix eigen value and eigen vector problems.
Optimization Technique: Calculus of several variables, Implicit function theorem, Nature of singular points, Necessary and sufficient conditions for optimization, Elements of calculus of variation, Constrained Optimization, Lagrange multipliers, Gradient method, Dynamic programming.
Probability and Statistics: Definition and postulates of probability, Field of probability, Mutually exclusive events, Bayes' Theorem, Independence, Bernoulli trial, Discrete Distributions, Continuous distributions, Probable errors, Linear regression, Introduction to non-linear regression, Correlation, Analysis of variance.

Reference Books:

1. Sen, M. K. and Malik, D. F.-Fundamental of Abstract Algebra, Mc. Graw Hill
2. Khanna, V. K. and Ghamdri, S. K.- Course of Abstract Algebra, Vikash Pub.
3. Halmos, T. R.-Naïve Set Theory, Van Nostrand
4. Scarborough, J. B.-Numerical Mathematical Analysis, Oxford University Press
5. Cone, S. D.-Elementary Numerical Analysis, Mc. Graw Hill.
6. Mukhopadhyay ,P.-Mathematical Statistics ,New Central Book Agency
7. Kapoor, V. K and Gupta, S.C.-Fundamental of Mathematical Statistics, Sultan Chand and Sons.
8. Uspensky, J. V.-Introduction to Mathematical Probability, Tata Mc. Graw Hill
9. Dreyfus, S. E.-The Art and Theory of Dynamic Programming –Theory and Applications, Academic Press.
10. Rao, S. S.-Optimisation Theory and Application, Wiley Eastern Ltd., New Delhi

Computer Communication and Networking

Code: MCE102
Contacts: 3-1-0
Credits: 4

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, polling and concentration. Circuit, message and packet switching and their sub categories, Topological design of a network, Network architecture layering concept, OSI Reference Model, OSI Services and protocols

Physical layer - bit communication between DTE and DCE, RS232C, transmission media, modems.

Data link layer - error detection and correction, retransmission strategies, stop and wait protocol, sliding window protocols, HDLC, pure Aloha protocols, slotted Aloha protocol, CSMA protocols, CSMA / CD and CSMA / CA protocol.

LANs and their Interconnection - Basic concepts and IEEE standards, Architecture, protocol, management and performance of Ethernet, token ring and token bus LANs, 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, flow based routing, optimal routing, Spanning Tree algorithm, Dijkstra's algorithm, Distance-vector routing protocol, congestion control, Leaky Bucket Algorithm, Token Bucket Algorithm.

Internetworking- motivation, goals and strategies, Routers and gateways, TCP / IP model, IP addressing, important features of IPv6, Transport layer protocols: UDP &TCP.

Application layer – Network security, cryptographic principle, Simple network management protocol
Evolution of ISDN services, ISDN system architecture and network terminating devices, ISDN interface, ISDN signaling, Broadband ISDN (B-ISDN), ATM, Wireless Local Area Network, VPN, Network management, mobile networking, case study of a popular network.

Reference Books:

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

Communication Theory

Code: MCE103A
Contacts: 3-1-0
Credits: 4

Decision theory fundamental: Bayes likelihood ratio test ;Ideal observer strategy; Neyman-Pearson Strategy, Bayes Strategy for single & multiple sample values; Optimum linear estimation; Composite hypothesis testing, Optimum detection with limited prior knowledge of the receive singal. Adaptive detection & estimation . Statistical description of communication problems; Optimum receiver design based on decision theory. Signal vectors concepts. Vector receiver implementation, Correlation receiver, Matched filter receiver & it's SNR. Scalar & vector communicating over the discrete & continuous memory less channel.

Binary & M-ary scalar Receivers –

M-ary multiple (diversity) vector receiver.Error probability performance of two-dimensional , M-ary vector receiver.

Coherent & noncoherent receivers –

Error probability for equivalent signal set, rectangular signal set & orthogonal signal set.
Efficient signaling of message sequence & channel capacity, bit by bit signaling, block orthogonal signaling. Time Bandwidth dimensionality; signal selection binary & multi level signaling, effects of filtering & bandpass channels, fading channel; Receiver quantization effects, linear estimation, realiable linear filter.

Advanced Digital Communication

Code: MCE103B
Contacts: 3-1-0
Credits: 4

- Spectral analysis of signals:
  - Fourier Expansion, Fourier transform, Normalized power spectrum, Power spectral density, Effect of transfer function on output power spectral density, Perseval's theorem.
  - Autocorrelation & cross correlation between periodic signals, cross correlation power.
  - Relation between power spectral density of a signal, it's autocorrelation function and it's spectrum.
  - Orthogonal & orthonormal signals. Gram-Schmidt procedure to represent a set of arbitrary signals by a set of orthonormal components; - numerical examples.
  - The concept of signal-space coordinate system, representing a signal vector by it's orthonormal components, measure of distinguishability of signals.

- Characteristics of random variables and random processes:
  - Distinction between a random variable and a random process.
  - Probability, sample space, Venn diagramme, joint probability, bay's theorem, cumulative probability distribution function, probability density function, joint cumulative probability distribution function, joint probability density function.
  - Binary symmetric channel.
  - Mean/average/expectation of a random variable and of sum of random variables.
  - Standard deviation, variance, moments of random variables, - explanation with reference to common signals.
  - Tchebycheff's inequality.
  - Common probability density functions, - Gaussian – error function & Q function, Rayleigh, Poisson, binomial, Rice, Laplacian, log-normal, etc.
  - Central limit theorem.
  - Random processes – time average, ensemble average, covariance, autocorrelation, cross correlation, stationary process, ergodic process, wide sense stationary process.
  - Power spectral density and autocorrelation, power spectral density of a random binary signal.
  - Linear mean square estimation methods.

- Noise:
  - Representation of noise in frequency domain.
  - Effect of filtering on the power spectral density of noise – Low pass filter, band pass filter, differentiating filter, integrating filter.
  - Quadrature components of noise, their power spectral densities and probability density functions.
  - Representation of noise in orthogonal components.

- Revision of source coding: Sampling theorem, instantaneous/ flat top/ natural sampling, band width of PAM signal, quantization, quantization noise, principle of pulse code modulation, delta modulation & adaptive delta modulation.

- Line codes:
  - UPNRZ, PNRZ, UPRZ, PRZ, AMI, Manchester etc.
  - Calculation of their power spectral densities.
  - Bandwidths and probabilities of error P_e for different line codes.

- Revision of digital modulation: Principle, transmitter, receiver, signal vectors, their distinguish ability (d) and signal band width for BPSK, QPSK, M-ARY PSK, QASK, MSK, BFSK, M-ARY FSK.

- Base band signal receiver and probabilities of bit error:
  - Peak signal to RMS noise output ration, probability of error.
  - Optimum filter, it's transfer function.
  - Matched filter, it's probability of error.

- Probability of error in PSK, effect of imperfect phase synchronization or imperfect bit synchronization.
- Probability of error in FSK, QPSK.
- Signal space vector approach to calculate probability of error in BPSK, BFSK, QPSK.
- Relation between bit error rate and symbol error rate.
- Comparison of various digital modulation techniques vis-à-vis band width requirement and probabilities of bit error.

- Band limited channel:
  - Characteristics of band limited channel, inter symbol interference (ISI) - it's mathematical expression.
  - Niquist's theorem for signal design for no ISI in ideal band limited channel, Niquist's criteria, raised cosine pulse signals.
  - Signal design for controlled ISI in ideal band limited channel, partial response signals, duobinary & partial duobinary signals - their methods of generation and detection of data.
  - Concept of maximum likelihood detection, log likely hood ratio.
  - Detection of data with controlled ISI by linear transverse filters.
  - Performance of minimum mean square estimation (MMSE) detection in channels with ISI.

- Spread spectrum modulation:
  - Principle of DSSS, processing gain, jamming margin, single tone interference, principle of CDMA, MAI and limit of number of simultaneous users.
  - Digital cellular CDMA system: model of forward link, reverse link, error rate performance of decoder using m-sequence chip codes.
  - Properties of m-sequences, their generation by LFSR, their PSDs, limitations of m-sequences.
  - Gold sequence, Kasami sequence – generating the sequences, their characteristic mean, cross correlation and variance of cross correlation, their merits and limitations as chip codes in CDMA.

Text Books:

1. Digital communication, 4th ed. - J. G. Proakis, MGH International edition.
2. Principle of Communication Systems – Taub, Schilling, TMH
3. Digital and Analog Communication Systems, 7th ed. – Leon W. Couch, PHI.
4. Principles of Digital Communication – Haykin
5. Digital Communication – Zeimer, Tranter.
6. Principle of Digital communication - J. Das, S. K. Mallick, P. K Chakraborty, New Age Int.
7. Communication Systems, 4th ed. – A. Bruce Carlson, Paul B. Crilly, Janet C. Rutledge, MGH International edition.
8. Digital Communications, 2nd ed. – Bernard Sklar, Pearson Education.
9. Electronic Communications, 4th ed. – Dennis Roddy, John Coolen, PHI

Noise and Information Theory

Code: MCE103C
Contacts: 3-1-0
Credits: 4

Band limited white noise: Wiener Kinchin theorem and Representation of Noise; effects of filtering; superposition and mixing involving noise : Noise Bandwidth; Quadrature components of Noise.

Basic concepts of information theory: A quantitative measure of Information and its unit. Information theory for discrete memory less schemes: Measure and justification, Formal requirements and properties, Sources and Binary sources, Joint and conditional entropies, Relationship between different entropies, Measure of Mutual capacities of various discrete channel.

Elements of minimum redundancy coding: Uniquely decodable codes, Instantaneous code and compact code. Average length of codes, Shannon Fano encoding, Hoffman encoding, Redundancy and efficiency.

Information theory for memory less continuous cases: Definition of different entropies, Mathematical difficulties involved, Infiniteness and variability of continuous entropy. Measure of Information, Maximisation of entropy, Channel capacity for Gaussian noisy channel.

Information theory for schemes with memories : Stochastic Processes: Examples, Moments and Expectations, Stationary and Ergodic Processes, Correlation coefficients & functions, Power spectrum stochastic limits and convergence, Stochastic differentiation and integration. Finite Markov chains.

Entropy of simple markov chains, Entropy of discrete stationary sources.

Fundamental Theorem of Information theory :Decision scheme and associated probability of error, Relation between error probabilities and equivocation. Eeinstein's proof on Fundamental theorem, Shannon's proof of fundamental theorem.

Photonics and Optical Communication

Code: MCE103D
Contacts: 3-1-0
Credits: 4

Photonics: 1.Introduction to Photonic materials and Photonic Devices.

2. Optical waveguides; 3. Optical fibers; application specific optical fibres, Photonic Bandgap Optical Fibers 4. Coupling of waves and modes 5. Optical couplers; 6 fibre.Bragg gratings 7. Electro-optic devices; 8. Magneto-optic devices 9. Acousto-optic devices; 10. Nonlinear optical devices; 11. Semiconductor lasers and light-emitting diodes; 11. Photodetectors;12. fibre lasers 13.Optical Amplifiers, 14.Fiber Raman Amplifiers, 15.Semiconductor laser amplifiers, 16.Doped–fiber amplifiers 17. Silicon photonics technology and devices. 13. Silicon based waveguides and Photonic integrated circuits (PIC's).

Optical Communication: Analog and Digital Optical Transmitters and Receivers concepts, loss- limited and dispersion- limited lightwave systems,long-haul systems with In-Line Amplifiers, Telecommunication fiber links. Dispersion compensation techniques in optical communication systems, power budget and rise-time.

Advanced Systems: Radio over fiber technology, Microwave photonics, System designs. Wireless optical communication system.

Coherent lightwave systems: Modulation and Demodulation schemes for coherent communication, system performance issues.

Multichannel Lightwave systems: WDM components and devices, Multiplexing techniques and system performance issues.

Soliton Communication Systems: Fiber solitons, Soliton-based communication principles, soliton amplification, Soliton system design, WDM soliton systems.

Optical Networks: Network topologies, SONET/SDH, Broadcast-and- Select WDM Networks- single-hop networks, multihop Networks,Wavelength routed networks, Optical CDMA, Photonic packet switching, Ultrahigh capacity networks Nonlinear optical effects on Network performance.

Two Dimensional Signal Processing

Code: MCE103E
Contacts: 3-1-0
Credits: 4

Signals, systems, Fourier transform and Z-transform.
Two dimensional signals and linear time-invariant systems. Fourier transform and frequency concept for two dimensional signals such as images. Sampling theorem for two dimensions. Two dimensional z-transform, convergence,

pole faces and stability. Two dimensional difference equations, recursive calculability and masks. Two dimensional DFT and FFT. The discrete cosine transform.

Multi - dimensional digital filter
FIR filter: zero phase filters, window method, frequency sampling method , frequency transformation method. Optimal filter design, IIR filters: design in spatial domain. Design in frequency domain, Implementation. Stabilization.

Spectrum Estimation
Two dimensional stochastic processes. Correlation and spectral density. Wiener filter. Methods for spectrum estimation based on Fourier transform . high resolution methods maximum probability method, maximum entropy method. Autoregressive signal modeling.

Image Processing
Basics of image processing. Representation of color images. Image improvement: Adaptive modification of local contrast and luminance, Contrast gain , histogram modification, spatial noise reduction, high pass filtering. Homo-morphic image processing. Low pass filtering. median filtering. Edge detection. Motion estimation. Image reconstruction. Wiener filtering. Spectral subtraction.

Text books:

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. Prokis (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.

Advanced Antenna Systems & Radio Wave Propagation

Code: MCE103F
Contacts: 3-1-0
Credits: 4

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 – it's effect on wave propagation, duct propagation, environmental noise, EMI – EMC, Radiation hazards

Microwave & Millimeter wave propagation, Effect on atmospheric precipitations: rain, fog, snow, ice & other atmospheric gases

Low frequency propagation, propagation through sea water, sea clutter, land clutter, surface clutter, Radar equation, Microwave link consideration – multipath fading, it's characteristics – technique for more link availability – earth space system

Advanced Antenna System

Wire antenna, Aperture antenna, antenna temperature and other antenna parameters, relationship between antenna parameters, reciprocity, review of microwave antennas – parabolic reflector, Cassigrain feeds, horn antennas, open – ended waveguides, lens antennas, dielectric rod antennas, antennas for mobile communication, radiation from apertures, general formulas for scattering & diffraction in and effective area of apertures, appropriate method for solving reflector antenna problems, primary feed system design, shaped beam antennas

Antenna array, analysis & synthesis, phased array

Antenna measurements – standardizations & characterizations of antennas, anechoic chambers, and open air test range

Reference Books

1. R.E.Collin, ***Antenna & Radio wave Propagation*** **(McGraw-Hill Book Co.)**

2. Jordon & Balman, ***Electromagnetic Waves & Radiating System***
3. M.L.Skolink, ***Introduction to Radar System***
4. P.Bhartia & I.J.Bahl, ***Millimeter Wave Engineering & Application***
5. Alberts Smith, ***Radio Engineering Principle & Application***
6. M.Dolukhanov, ***Propagation of Radio Waves***

Telecommunication System Engineering Lab

Code: MCE191
Contacts: 0-0-3
Credits: 2

List of Experiments

1) Standardization of receivers
    a. Study of Sensitivity characteristics
    b. Study of Selectivity characteristics
    c. Study of Fidelity characteristics
    d. SNR measurement
2) Studies on radiation pattern (gain & half power beam width) of different types of antennas
    a. Manual
    b. Automatic
3) Study of standing wave pattern in an RF transmission line for various types of loads.
4) Study of computer-to-computer communication using fiber optics link.
5) Studies on digital communication transmitter and receiver
    a. Line codes
    b. ASK
    c. FSK
    d. PSK
    e. QPSK
    f. Calculation of BER by introducing noise in the channel
6) Studies on PCM
7) Studies on TDM

Design and Simulation Lab

Code: MCE192
Contacts: 0-0-3
Credits: 2

The purpose of this lab is to devise and test

1) Several simple and complex communication systems using CommSim (Communication Systems Simulation)
2) Several wired and wireless networks using Network Simulator 2 (NS-2)
3) Several Digital electronics circuits using Microwind

List of Assignments (Both time domain and frequency domain analysis must be performed for all the assignments.)

1) Verification of the trigonometric expression: 2 cos a cos b = cos (a+b) + cos (a-b) in time domain and frequency domain.
2) AM generation and detection.
3) SSBSC generation and detection.
4) FM generation and detection.
5) Sampling and reconstruction
6) Quantisation noise and companding
7) Eye pattern
8) OOK

9) FSK
10) 16-QAM
11) DSSS
12) CDMA
13) WLAN
14) Mobile IP
15) Design of simple microprocessor using Microwind

Second Semester

Mobile Communication

Code: MCE201
Contacts: 3-1-0
Credits: 4

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) mobile cellular networks 2L

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. 8L

Different mobile communication systems – GSM services and features, system architecture, GSM radio subsystem, GSM channel types, location updating and call setup,
WAP, HSCSD, GPRS, EDGE, 3G W-CDMA; CDMA digital cellular standard, comparison between GSM and CDMA, 3G cdma2000, IMT-2000. 8L

Radio Channel Characterisation – Free space propagation, Multipath propagation, diversity techniques, Co-channel interference, Propagation effects - scattering, ground reflection, fading, Log-normal shadowing
4L

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, IEEE802.11 architecture, Physical layer, MAC layer, Introduction to WI-FI, HIPERLAN2, Bluetooth – Bluetooth architecture. 8L

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.
10L

Future of mobile communication – 3G to 4G 1L

Text & Reference Books:

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.

Microwave and Millimetrewave Techniques

Code: MCE202
Contacts: 3-1-0
Credits: 4

Introduction: Millimetre wave frequency ranges; Why Millimetre wave?- Advantages and disadvantages. Future of Millimetre waves.

Sources (Tubes): Review of vacuum tube microwave device physics: beam field interaction; power frequency limitation; device size limitation; Klystrons- multi-cavity, two-cavity. Reflex Klystrons. Magnetrons- operational characteristics of magnetrons; Design considerations of magnetrons. Other Cross-field Devices. Traveling Waves Tubes (TWT)- Principle of operation, Helix TWT, Coupled-cavity TWT. Design considerations for TWTs.

Sources (Solid State): General Theory of millimeter wave Solid State Oscillator- Oscillator Noise Analysis; Injection Locking. IMPATT Devices- Physics, CW & pulsed operation. Design principle and considerations. Gunn Devices- Working principle, CW and Pulsed Gunn sources. Design considerations and procedures. Other Sources- Tunnel diode, TUNNETT diode, BARITT diode, FET oscillator, etc. Tuning Techniques for oscillators- Mechanical tuning, Electronic tuning. Power combining techniques.

Propagation characteristics of millimeter waves: propagation modes; analog microwave communication systems: LOS, OTH, duct propagation, tropospheric scatters system, fading.

Transmission Line: Transmission line concepts and realization, Coaxial line, Wave-guide and components, scattering matrix concepts, Impedance matching

Passive components and Circuits: Attenuators, Matched terminations, Tunable Shorts, Hybrid Tees & Hybrid Rings, E-H Tuners, Wave guide bends, Tees & Flanges, Directional Couplers, Impedance Matching Networks, Resonators, Filters, Phase Shifters, non-reciprocal Components.

Solid State Circuits: Detectors, Mixers, Amplifiers, Frequency multipliers, switches, Phase Shifters, Attenuators, PIN attenuators, Modulators.

Antennas: Reflectors, Lens antennas, Horn antennas, Micro-strip antennas. Phased array antenna systems: electronic scanning.

Applications of Millimeter waves and Systems: Millimeter wave Radar, Millimeter wave Communication Systems,. Mobile radio communication systems

Text & Reference Books:

1. P. Bhartia & I. J. Bahl, Millimetre Wave Engineering and Applications, John Wiley & Sons..

Error Control Coding Theory

Code: MCE203
Contacts: 3-1-0
Credits: 4

- **Introduction:**
  - Causes of bit error, need for coding, present day's acceptable limit of bit error.

- **GF algebra:**
  - Groups- definition, order of a group, modulo-m addition and multiplication tables, modulo-m subtraction and division.
  - Fields- Definition, binary field, Galois field.
  - Polynomials- The concept of polynomial expression, addition/subtraction/multiplication/division of polynomials over GF(2). Numerical exercises of various arithmetic operations on polynomials using MATLAB. Irreducible polynomials, primitive polynomials, numerical exercises for determining irreducibility and primitivity using MATLAB.

- Vector space, sub space, dual space – their properties and interrelations. Numerical exercises of verifying the properties and interrelations with MATLAB.

- **Linear block code:**
  - Definition of linear block code.
  - Generator matrix, properties of generator matrix, verification of the properties using MATLAB. Numerical exercises with MATLAB to generate code words with given generator matrix and message word.
  - Parity check matrix and it's properties, Verification of the properties with MATLAB.
  - Encoding circuit- operating principle.
  - Syndrome- definition, most likelihood principle of error detection. Syndrome circuit- operating principle.
  - Hamming distance, minimum distance, minimum weight, error detecting & error correcting capabilities.
  - Standard array- construction, error detection with syndrome.
  - Decoder-operating principle.
  - Probability of error detection & correction in a binary symmetric channel using linear block code.

- **Hamming code:**
  - Construction, error detection and correction capabilities.

- **Hadamard code, Golay code**:
  - short qualitative discussion.

- **Cyclic code**:
  - Definition, generator polynomial, properties of cyclic code and generator polynomial, Numerical exercises with MATLAB.
  - Generator matrix, parity check matrix, their properties and interrelations.
  - Design of encoder.
  - Design of syndrome circuit.
  - Design & operating principle of decoder, Meggitt decoder.

- **BCH code:**
  - Construction of Galois field $GF(2^m)$- power representation, polynomial representation, n-tupple representation.
  - Properties of $GF(2^m)$, conjugate roots, minimal polynomial, determining minimal polynomials.
  - Description of BCH code, construction of parity check matrix – numerical exercises, construction of code word from a given message word – numerical exercises.

- **Reed-Solomon code**:
  - Brief qualitative discussion.

- **Convolutional code**:
  - Definition, encoder, generator sequences, generator matrix, principle of constructing code words, numerical examples, MATLAB examples, code rate, constraint length, fractional rate loss.
  - Finite state machine analysis of coder, state diagramme, code tree, Trellis.
  - Principle of maximum likelihood decoding of convolutional code, Viterbi algorithm, Numerical examples of decoding and error detection/correction using Trellis, numerical examples using Trellis by MATLAB.
  - Burst error correcting code:
  - Brief qualitative description of single burst error correcting code, interleaved code.

- **Application:**
  - Brief qualitative discussion of practical application of error control in processors, data storage, data exchange between CPU and peripherals, in CDMA etc.

Text & Reference Books:

1. Error Control Coding Fundamentals and Applications. – Shu Lin, Daniel J. Costello, Jr. - Prentice Hall.
2. Information Theory Coding and Cryptography. – Ranjan Bose, - TMH.

3. Fundamentals of Convolutional Coding. - Roft Johannesson and K. S. Zigangirov. - OUP.
4. Information and Coding Theory. – gareth A. Jones & J. Mary Jones. - Springer.
5. Error Correcting Codes. - Paterson, W. W. and Weldon, Jr. E. J. - Prentice Hall.
6. Applied Coding and Information Theory for Engineers. – Richard B. Wells. – Pearson Education
7. Introduction to Error Control Codes. – Salvatore Gravano. – Oxford.

Satellite Communication System

Code: MCE204A
Contacts: 3-0-0
Credits: 3

Introduction: A brief history of satellite communication, future scope satellite communication.

Orbital Mechanism: Orbits, look angle, orbital period and velocity, azimuth and orbital inclination, coverage angle slant range, orbital perturbation, placement of satellite in geostationary orbit.

Satellite Subsystems: Communication, telemetry, ranging & command, power, altitude control, tracking, antenna subsystems.

Earth Station: 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, frequency plans, processing transponders.

Satellite Link Design: Basic link analysis, interference analysis, attenuation due to rain, link with and without frequency reuse.

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. Satellite position determination. 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.

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, multiaccess and networking, network error control poling VSAT network.

Mobile satellite network: Operating environment. MSAT network concept, CDMA MSAT relink. Worldwide timing by satellite relay.

Text and Reference Books:

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.

Remote Sensing

Code: MCE204B
Contacts: 3-0-0
Credits: 3

SOURCES AND CHARACTERISTICS OF REMOTELY SENSED IMAGE DATA: Introduction to data sources: characteristics of digital image data, spectral range commonly used in remote sensing. Spatial data sources in general: types of spatial data, data formats. Geographic Information System (GIS). The challenge to remote sensing image processing and analysis.

REMOTE SENSING IN THE OPTICAL AND MICROWAVE REGION : Introduction to optical remote sensing systems, remote sensing in microwave region.

ERROR CORRECTION AND REGISTRATION OF IMAGE DATA : Sources of radiometric distortion, correction of radiometric distortion; Sources of geometric distortion, correction geometric distortion. Image registration.

SUPERVISED CLASSIFICATION TECHNIQUES : Steps in supervised classification. Maximum likelihood classification : Bayes classification. Minimum distance classification: the case of limited training data, decision surfaces, thresholds. Mahalanobis classifier, KNN (nearest neighbor) classification: concept of spatial context, spatio-contextual information using neural network (*e.g.* Multilayer perceptron (MLP)).

CLUSTERING AND UNSUPERVISED CLASSIFICATION : Delineation of spectral classes. Similarity metrics and clustering criteria. Classification by hard c-means (k means). Methods based on fuzzy set theory: Fuzzy c-Means and Gustafson Kessel clustering algorithms, image classification using fuzzy rules, interpretation of mixed pixels.

TEXTURE ANALYSIS : Gray Level Co-occurrence Matrix (GLCM), extracting various features using GLCM and their applicability to image analysis.

APPLICATION AREAS : Practical remote sensing image analysis examples : Identification of different land cover types from multispectral image data; Change detection : key challenges, error estimation like missed alarms, false alarms.

Text and Reference Books:

1. **Image Analysis, Classification and Change Detection in Remote Sensing by Morton J. Canty.** ***Taylor & Francis***
2. **Remote Sensing Digital Image Analysis : An Introduction by J.A Richards and Xiuping Jia.** ***Springer***
3. **Classification Methods for Remotely Sensed Data by Brandt Tso and Paul M. Mather.** ***Taylor & Francis***

Radar Signal Processing

Code: MCE204C
Contacts: 3-0-0
Credits: 3

Analysis of discrete time signal, sampling theorem, estimation of frequency content in a signal, discrete Fourier transforms, random discrete signal analysis.

Review of probability, auto and cross correlation, power spectral density, cross spectra.

Spectral analysis of random signals, sampling autocorrelation function, window function, spectral estimates, parametric and non parametric estimates.

Detection of signals in noise, optimum detection algorithms, minimum probability of error.

Neyman-Pearson criteria for radar application to air traffic control, radar sub optimum processor, detection of variable amplitude signals, matched filters, detection of random signal and estimation of signals in noise.

Linear mean square estimation, Bayes estimator, maximum likelihood estimation of parameters of linear systems.

Text & Reference Books:

1. Mark Richards, Fundamentals of Radar Signal Processing, McGraw Hill.
2. Bernard L. Lewis, Frank F. Kretschmen, Jr., Wesley W. Shelton, Aspects of Radar Signal Processing, Artech House Ind.

Artificial Intelligence and Pattern Recognition

Code: MCE204D
Contacts: 3-0-0
Credits: 3

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.

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. 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.

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). Multi-objective 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*.

Text and Reference Books:

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.
3. Elaine Rich, Kevin Knight, Artificial Intelligence, TMH.
4. Eugene Charnaik, Drew McDermott, Introduction to Artificial Intelligence, Pearson Education Asia.

5. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education.
6. A. Konar, Artificial Intelligence and Soft Computing.
7. Anil K. Jain and R.C.Dubes, Algorithms for Clustering Data, Prentice Hall
8. S. Theodoridis and K. Koutroumbus, Pattern Recognition, Elsevier
9. D. E. Goldberg, Genetic Algorithms in search, Optimization & Machine Learning, Pearson Education

Advanced Communication Engineering Lab

Code: MCE291
Contacts: 0-0-3
Credits: 2

1. Study of OTDR and using it to measure
    - Different types of losses in an optical fiber
    - Distance between splices and connectors
    - Reflectivity of connectors, mechanical splices
    - Linearity of fibers
2. Studies on Local Area Networks (LAN)
3. Studies on WLAN
4. Study of ISDN with protocol analyzer
5. Studies on GPS
6. Studies on GSM
7. Studies on Mobile Communication
8. Studies on Direct Sequence Spread Spectrum
9. Studies on Data Communication

Third Semester

Secured Communication

Code: MCE301A
Contacts: 3-1-0
Credits: 4

Introduction: Overview of network security and cryptography, model for network security.

Symmetric ciphers: Classical encryption techniques, block ciphers and Data Encryption Standard (DES), Advanced Encryption Standard (AES), Contemporary Symmetric Ciphers, and confidentiality using symmetric encryption.

Public Key Cryptography: 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, Hash functions, security of Hash functions and MACs.

Hash Algorithms: MD5 Message Digest Algorithm, Secure Hash Algorithm, Digital Signatures and Authentication protocols, Digital Signature Standard.

Network Security Applications: Authentication Applications (Kerberos), Electronic Mail Security (SMIME), IP Security (IPSec), Web Security (SSL).

Text and Reference Books:

1. William Stallings, Cryptography and Network Security—Principles and Applications, Pearson Education.
2. Ranjan Bose, Information Theory Coding and Cryptography, Tata McGraw Hill.
3. Atul Kahate, Cryptography and Network Security, Tata McGraw Hill.

Telecommunication Network Management

Code: MCE301B
Contacts: 3-1-0
Credits: 4

ASIC in Telecommunication

Code: MCE301C
Contacts: 3-1-0
Credits: 4

Introduction to ASICs
Types of ASICs- Full Custom ASICs, Standard-cell based ASICs, Gate Array Based ASICs, Channeled Gate Array, Channelless Gate Array, Design Flow.

CMOS Logic
Introduction to CMOS Logic, CMOS Transistors, the CMOS Process, CMOS Design Rules, Combinational Logic Cells, Sequential Logic Cells, Data Path Logic Cells- Data Path Elements, Adders, a simple example: an 8-bit Combinational–sum Adder, Multipliers, other Arithmetic Systems: Redundant Binary Encoding, Residue Number System, other Data Path Operators: Adder/Subtractor, Barrel Shifter, Leading-one Detector, Priority Encoder, Accumulator, Decrementer, all Zero Detector, all One Detector, I/O cells, Cell Compilers.

ASIC Library Design
Transistors as Resistors, Logical Effort, Library-cell Design, Gate Array Design, Standard-cell Design, Data Path-cell Design.

Programmable ASICs
The Antifuse, Static RAM, EPROM and EEPROM Technology.

Programmable ASIC Logic Cells
Actel ACT: ACT1 Logic Module, Shanon's Expansion Theorem, MUX Logic as Function Generators, ACT2 and ACT3 Logic Modules, Timing Model and Critical Path, Speed Grading, Worst Case Timing.
Xilinx LCA: XC3000 CLB, XC4000 Logic Block, XC5200 Logic Block, Xilinx CLB Analysis.
Altera FELX, Altera MAX: Logic Expanders, Timing Model, Power Dissipation in Complex PLDs.

VHDL
Basic Building Blocks of VHDL- Entity Declaration, Architecture Body, Identifiers, Data Objects, Data Types, Attributes, Some Combinational and Sequential circuit Design using VHDL.

Application in Telecommunication
Si-Ge Devices for RF Circuits, Interface for Optical Fibres, ASIC for Generation and Detection of PSK, FSK, QAM etc., Network Switching Circuits, Adaptive Circuits, Equalizer, PLL.

Text and Reference Books:

1. ASIC Design-Michael John Sebastian Smith
2. ASIC Handbook- Nigel Horspool, Peter Jorman
3. Surviving the ASIC Experience- John Schroeter
4. VHDL for Programmable Logic- Kevin Skahill

EMC Techniques & Management

Code: MCE301D
Contacts: 3-1-0
Credits: 4

Transmission Line Theory
Definitions, Different Types of Transmission line, Transmission Line Parameters, The Lumped element circuit model for a transmission line, Transmission Line Equation, Condition for lossless line, condition for distortion less line, Relation between Neeper & dB, The Terminated lossless transmission line: Input Impedance, Reflection Co-efficient, Return Loss, SWR, Special cases of lossless terminated lines, Power delivered to load, Transient on transmission line

Micro-strip Line: Pattern of EM field distribution in a Micro-strip Line, Derivation of Effective Dielectric Constant, Characteristic impedance & Attenuation, Different Micro-strip line design examples.

Impedance Matching & Tuning
Purpose of Impedance matching, Factors important in the selection of a particular matching network, Different types of Impedance matching, Single stub matching, double stub matching, The quarter-wave transformer, Quarter-wave transformer bandwidth calculation, The theory of small reflection, Single-section Transformer, Multi-section Transformer, Binomial Multi-section matching transformer, Binomial transformer design examples, Chebyshev Transformer, Chebyshev Polynomials, Chebyshev transformer design.

Introduction To EMI
Definitions, Different Sources of EMI(Electro-magnetic Interference), Electro-static discharge(ESD),Electro-magnetic pulse(EMP),Lightning, Mechanism of transferring Electro-magnetic Energy: Radiated emission, radiated susceptibility, conducted emission, conducted susceptibility, Differential & common mode currents.

Introduction To EMC
Concepts of EMC, EMC units.

EMC requirements for electronic systems
World regulatory bodies- FCC, CISPR etc. Class-A devices, class-B devices, Regulations of the bodies on EMC issues.

Different Mitigation Techniques For preventing EMI
1) Grounding: Fundamental grounding concepts, Floating ground, Single-point & Multi-point ground, advantages & disadvantages of different grounding processes.
2) Shielding: Basic concepts of shielding, Different types of shielding, Shielding effectiveness(S.E),S.E of a conducting barrier to a normal incident plane wave, multiple reflection within a shield, mechanism of attenuation provided by shield, shielding against magnetic field & Electric field, S.E for Electronic metal & Magnetic metal, Skin-depth,S.E for far-field sources, shield seams.
3) Cross-talks & Coupling, Measurement set for measuring Cross-talk.
4) Filtering & decoupling.

Non-ideal behavior of different electronic components:
Examples: Microwave oven, Personal Computers, Health Hazards-limits, EMC in healthcare environment.

Antennas
Characteristics of antennas, fields due to short electric dipole & small magnetic pole, near field & Far-field sources & their characteristics. Broadband antenna measurements,antenna factor.

EMI-EMC Measurements
EMC measurement set, Power losses in cable, calculation of signal source output for a mismatched load, Measuring & Test systems, Test facilities, measurements of radiated emission in open test range & in Anechoic chamber, Conducted emission testing by Line Impedance Stabilization network (LISN).

Time-domain & Frequency-domain Analysis Of Different Signals:
Fourier series & Fourier transform of different signals, identifying the frequency, phase & power spectrum of different signals. Time-domain Reflectrometry (TDR) basics for determining the properties of a transmission line.

System Design For EMC
Simple susceptibility models for wires & PCB, Simplified lumped model of the pick-up of incident field for a very short two-conductor line.

Recommended Books:

1. **Introduction to Electromagnetic compatibility-**Clayton R.Paul(John wiley & Sons)
2. **EMC Analysis Methods & Computational Models-**Frederick M Tesche, Michel V.Ianoz, Torbjorn Karlsson(John Willey & Sons, Inc)

Reference Books:

1. **EMI/EMC Computational modeling Hand Book**- by Archambelt.
2. **Electrostatic Discharge In Electronics-**Willian D.Greason(John Wiley & Sons, Inc).
3. **The ARIAL RFI Book-**Hare,WIRFI published by-The American Radio Relay League Newington.
4. **Applied Electromagnetic Compatibility-**Dipak L Sengupta & Valdis V Liepa(John Wiley & Sons Inc).
5. **Electromagnetic waves & Radiating Systems-**Jordan & Balmain (Prentice Hall Publication)

6. **Elements Of Electromagnetic-**Matthew N.O.Sadiku (Oxford University Press)
7. **Microwave Engineering-**David M.Pozar(John Wiley & Sons, INC).
8. **Microwave Circuits & Passive Devices-**M.L Sisodia & G S Raghuvanshi(New Age International Limited)