Narula Institute of Technology
Department of Electronics & Communication Engineering
Curriculum of M Tech in ECE
(Total Credit: 90)

1st Semester

Code	Subject	Contacts periods per week				Credit
		L	T	P	Total	
MECE 101	Advanced Engineering mathematics	3	0	0	3	3
MECE 102	Advanced Digital communication	3	1	0	4	4
MECE 103	Digital filters design and its applications	3	1	0	4	4
MECE 104	Advanced RF & Microwave Engineering	3	1	0	4	4
MECE 105	Computational Intelligence	3	0	0	3	3
MECE 106	A. Satellite communication B. Communication networks C. Embedded System	3	0	0	3	3
MECE 192	Advanced communication lab	0	0	3	3	2
MECE 193	Digital signal processing lab	0	0	3	3	2
MECE 194	Advanced RF & Microwave Engineering Lab	0	0	3	3	2
						27

2nd Semester

Code	Subject	Contacts periods per week				Credit
		L	T	P	Total	
MECE 201	EMI/EMC	3	1	0	4	4
MECE 202	Wireless communication	3	1	0	4	4
MECE 203	Secure Communication& Coding	3	1	0	4	4
MECE 204	Remote sensing techniques & applications.	3	1	0	4	4
MECE 205	A. Image processing & Pattern recognition B. Computer Vision C. Detection and Estimation Theory	3	0	0	3	3
MECE 206	A. Optical fibre communication B. Ad-hoc networking C. Multimedia Communication	3	0	0	3	3
MECE 291	Coding & cryptography lab	0	0	3	3	2
MECE 292	Wireless communication lab	0	0	3	3	2
MECE 293	A. Image processing & Pattern Recognition Lab B. Advanced Simulation Lab	0	0	3	3	2
						28

3rd Semester

Code	Subject	Contacts periods per week				Credit
		L	T	P	Total	
MECE 301	Research Methodology	3	0	0	3	2
MECE 391	Technical Seminar	0	0	3	3	2
MECE 392	Computational Intelligence Lab	0	0	3	3	2
MECE 393	Thesis Part-I	0	0	3	3	10
		0	**0**	**9**	**9**	**16**

4th Semester

Code	Subject	Contacts periods per week				Credit
		L	T	P	Total	
MECE 491	Thesis Part-II	0	0	3	3	10
MECE 492	Comprehensive Viva Voce	0	0	0	0	9
	Total	**0**	**0**	**3**	**3**	**19**
	Total Credit (Sem: I+II+III+IV) =90					

Advanced Engineering Mathematics
Code: MECE 101
Contacts: 4-0-0
Credits: 4

Unit 1: 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. **6L**

Unit 2: 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. **5L**

Unit 3: 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. **5L**

Unit 4: Random Variables and their Probability Distributions
Random variables, Probability distribution function, Probability density function, Conditional Probability, Statistical Independence, Bayes formula.
Moments of random variables: Expected value and moments, Mean and variance of random variable, Coefficients of variation, Skewness and kurtosis, Moments, Covariance and Correlation coefficient, Mean and variance of sum and Product of two random variables. Conditional mean and variance, Application of conditional mean and variance.
5L

Unit 5: Discrete Random Variables and their Distributions
Moment Generation Function, Characteristics Function, Cumulants, Probability generating function, Binomial Distribution, Negative Binomial Distribution, Hypergeometric distribution, Multinomial, Poisson Distributions, Relationship between various Discrete-Type distributions **4L**

Unit 6: Continuous Random Variables and their Distributions
Normal, Log - Normal, Multivariate Normal, Gamma, Exponential, Chi-square, Weibull, Rayleigh distributions. Relationship between continuous distributions. **4L**

Unit 7: Transformation of Random Variables

Transformation of Single, Several Random Variables, Function of Random Variables, Sum, Differences, Product and Ratio of Two Random Variables, Transformation through characteristic Functions. **3L**

Unit 8: Stochastic Processes

Introduction- Classification of stochastic process, Stationary process (SSS and WSS) Stationary process, Ergodic Process, Independent increment Process, Markov Process, Counting Process, Narrow- Band Process, Normal Process, Wiener-Levy Process, Poisson, Bernoulli, Shot noise Process, Autocorrelation Function. **4L**

Unit 9: 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. **4L**

Text Book:

1. Michel K. Ochi, "Applied Probability and Stochastic Processes," John Wiley & Sons, ISSN – 0271-6356, 2008.
2. Kishor S. Trivedi, "Probability and Statistics with Reliability, Queuing and Computer Science Application," John Wiley, 2002.
3. Sen, M. K. and Malik, D. F.-Fundamental of Abstract Algebra, Mc. Graw Hill
4. Khanna, V. K. and Ghamdri, S. K.- Course of Abstract Algebra, Vikash Pub.
5. Scarborough, J. B.-Numerical Mathematical Analysis, Oxford University Press

Reference Books:

1. Paboulis, A, "Probability, Random variables and Stochastic Processes," Mc Graw Hill. New york 1984.
2. Cone, S. D.-Elementary Numerical Analysis, Mc. GrawHill.
3. Mukhopadhyay ,P.-Mathematical Statistics ,New Central Book Agency
4. Kapoor, V. K and Gupta, S.C.-Fundamental of Mathematical Statistics, Sultan Chand and Sons.
5. Uspensky, J. V.-Introduction to Mathematical Probability, Tata Mc. Graw Hill
6. Dreyfus, S. E.-The Art and Theory of Dynamic Programming –Theory and Applications, Academic Press.
7. Rao, S. S.-Optimisation Theory and Application, Wiley Eastern Ltd., New Delhi

Advanced Digital Communication
Code: MECE 102
Contacts: 4-0-0
Credits: 4

•Prerequisites

Fourier Expansion, Fourier transform, Normalized power spectrum, Power spectral density, Effect of transfer function on output power spectral density, Perceval's theorem. Autocorrelation & cross correlation between periodic signals, cross correlation power. Relation between power spectral density of a signal, its autocorrelation function and its spectrum. Distinction between a random variable and a random process. Probability, sample space, Venn diagram, joint probability, bay's theorem, cumulative probability distribution function, probability density function, joint cumulative probability distribution function, joint probability density function. 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. Gaussian probability density function – error function & Q function, Central limit theorem.

Module 1:
Deterministic& Random Signal Analysis

Bandpass&Lowpass Signals, Lowpass Equivalent of Bandpass Signals, Energy Considerations, Lowpass Equivalent of a Bandpass System. Vector Space Concepts, Signal Space Concepts, Orthogonal & orthonormal signals, Orthogonal Expansions of Signals, Gram-Schmidt Procedure. Bounds on Tail Probabilities, Limit Theorems for Sum of Random Variables. The concept of signal-space coordinate system, representing a signal vector by its orthonormal components, measure of distinguishability of signals. Complex Random Vectors. WSS Random Process, Cyclostationary Random Process, Proper and Circular Random Process, Markov Chains. Sampling Theorem for Band-limited Random Process, The Karhunen-Loeve Expansion. Banpass andLowpass Random Processes. **6L**

Module 2:
Characteristics of random variables and random processes:

Common probability density functions, - Gaussian, Rayleigh, Poisson, binomial, Rice, Laplacian, log-normal, etc. Probability of error in Gaussian Binary symmetric channel. Random processes – time average, ensemble average, covariance, autocorrelation, cross correlation, stationary process, ergodicprocess, wide sense stationary process. Power spectral density and autocorrelation, power spectral density of a random binary signal. Linear mean square estimation methods. **4L**

Module 3:
Optimum Receivers for AWGN Channels

Waveform and vector channel models. Detection of signals in Gaussian noise. Optimum detection and error probability for band limited signalling and power limited signalling– Non coherent detection – Comparison of digital signalling methods– Lattices and constellations based on lattices– Detection of signalling schemes with memory – Optimum receiver for CPM–

Performance analysis for wire line and radio communication systems. Introduction to partially coherent, double differentially coherent communication systems. **4L**

Module 4:

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.

Parametric coding/ hybrid coding/ sub band coding:

APC, LPC, Pitch predictive, ADPCM, voice excited vocoder, vocal synthesizer.

Line codes:

UPNRZ, PNRZ, UPRZ, PRZ, AMI, Manchester etc. Calculation of their power spectral densities. Bandwidths and probabilities of error Pefor different line codes. **5L**

Module 5:

Pulse Shaping and Equalization

Pulse shaping:Characterization of Band limited channels – ISI – Nyquist criterion – Controlled ISI – Channels with ISI and AWGN – Pulse shaping for optimum transmissions and reception.

Equalization:MLSE – Linear equalization – Decision feedback equalization – ML detectors – Iterative equalization – Turbo equalization. Adaptive linear equalizer – Adaptive decision feedbackequalization – Blind equalization. **3L**

Module 6:

Multichannel and Multicarrier Systems

Multichannel Digital Communications in AWGN Channels; Binary Signals, M-array Orthogonal Signals. Multicarrier Communications; Single Carrier verses Multicarrier Modulation, Capacity of a Nonideal Linear Filter Channel, OFDM, Modulation & Demodulation in an OFDM, An FFT Algorithm Implementation of an OFDM System. **3L**

Module 7:

Carrier and Symbol Synchronization

Signal Parameter Estimation; the Likelihood Function, Carrier Recovery and Symbol Synchronization in Signal Demodulation. CarrierPhase Estimation; Maximum Likelihood Carrier Phase Estimation, the Phase-Locked Loop, Effect of Additive Noise in the Phase Estimate. Symbol Timing Estimation; Maximum Likelihood Timing Estimation. **3L**

Module 8:

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. **4L**

Module 9:

Multiplexing & multiple access:

TDM/TDMA, FDM/FDMA, Space DMA, Polarization DMA, OFDM, ALOHA, Slotted ALOHA, Reservation ALOHA, CSMA-CD, CSMA-CA-basic techniques and comparative performances e.g. signal bandwidth, delay, probability of error etc. **3L**

Module 10: 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. **3L**

Module 11: Base band signal receiver and probabilities of bit error:
Peak signal to RMS noise output ration, probability of error. Optimum filter, its transfer function. Matched filter, its 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, and 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. **4L**

Text Books:
1. John G. Proakis and MasoudSalehi, "Digital Communications", Fifth edition, Mc Graw Hill International edition, 2008.
2. Ian A. Glover and Peter M. Grant, "Digital communications", Second edition, Pearson education, 2008.
3. Andrea Goldsmith, "Wireless Communications," Cambridge University Press, 2005
4. Principle of Communication Systems – Taub, Schilling, TMH
5. Principles of Digital Communication – Haykin
6. Principle of Digital communication - J. Das, S. K. Mallick, P. K Chakraborty, New Age Int.

Reference Books:
1. Marvin K. Simon, Sami M. Hinedi and William C. Lindsey, "Digital Communication Techniques: Signal Design and Detection" PHI publishers, 2009.
2. Bernard Sklar, "Digital Communications: Fundamentals and Applications", Second edition, Pearson Education Asia, 2002.
3. Digital Communication – Zeimer, Tranter.
4. Communication Systems, 4thed. – A. Bruce Carlson, Paul B. Crilly, Janet C. Rutledge, MGH International edition.
5. Digital Communications, 2nded. – Bernard Sklar, Pearson Education.
6. Electronic Communications, 4thed. – Dennis Roddy, John Coolen, PHI

Digital Filters Design and Its Applications
Code: MECE 103
Contacts: 4-0-0
Credits: 4

Prerequisites

Signals, Frequency-Domain Representation, Signal Processing, Analog Filters, Applications of Analog Filters, Fourier Series- Definition, Particular Forms, Theorems and Properties, Fourier Transform- Derivation, Particular Forms, Theorems and Properties, Z transform, Fourier transform, Laplace transform, Sampling & Quantization, LTI Systems, Digital signal transforms. Characterization of Discrete-Time Systems-Nonrecursive Systems, Recursive Systems, Discrete-Time System Networks- Network Analysis, Implementation of Discrete-Time Systems, Signal Flow-Graph Analysis, Introduction to Time-Domain Analysis, Convolution Summation-Graphical Interpretation, Alternative Classification, Stability-Constraint on Poles, Constraint on Eigenvalues, Stability Criteria, Test for Common Factors,Schur-Cohn Stability Criterion,Schur-Cohn-Fujiwara Stability Criterion, Jury-Marden Stability Criterion, Lyapunov Stability Criterion, State-Space Representation- Computability, Characterization, Time-Domain Analysis, Applications of State-Space Methods, Review of the DFT and FFT. Transfer Functions for Digital Filters: First-Order Transfer Functions, Second-Order Transfer Functions, Higher-Order Transfer Functions, Aliasing Effect

Module 1:

Realization of Digital Filters: Introduction, Realization-Direct Realization, Direct Canonic Realization, State-Space Realization, Lattice Realization, Cascade Realization, Parallel Realization, Transposition, Implementation- Design Considerations, Systolic Implementations. **3L**

Module 2:

Design of Nonrecursive (FIR) Filters: Introduction, Properties of Constant-Delay Nonrecursive Filters- Impulse Response Symmetries, Frequency Response, Location of Zeros, Design Using the Fourier series, Use of Window Functions-,Dolph-Chebyshev Window, Kaiser Windows, Prescribed Filter Specifications. **4L**

Module 3:

Design of Recursive (IIR) Filters: Introduction,Realizability Constraints, Invariant Impulse-Response Method, Modified Invariant Impulse-Response Method, Matched-z-Transformation Method, Bilinear-Transformation Method- Derivation, Mapping Properties of Bilinear Transformation, The Warping Effect, Digital-Filter Transformations- General Transformation,Lowpass-to-Lowpass Transformation,Lowpass-to-Bandstop Transformation, Application, Comparison between Recursive and Nonrecursive Designs. **5L**

Module 4:

Recursive (IIR) Filters Satisfying Prescribed Specifications: Introduction, Design Procedure, Design Formulas-Lowpass and Highpass Filters,Bandpass and Bandstop Filters, Butterworth Filters,Chebyshev Filters, Inverse-Chebyshev Filters, Elliptic Filters, Design Using the Formulas and Tables, Constant Group Delay- Delay Equalization, Zero-Phase Filters, Amplitude-Response Equalization. **4L**

Module 5:
Effects of Finite Word length in Digital Filters: Introduction, Number Representation- Binary System, Fixed-Point Arithmetic, Floating-Point Arithmetic, Number Quantization, Coefficient Quantization, Low-Sensitivity Structures, Product Quantization, Signal Scaling- Method A, Method B, Types of Scaling, Application of Scaling, Minimization of Output Roundoff Noise, Application of Error-Spectrum Shaping, Limit-Cycle Oscillations, Quantization Limit Cycles, Overflow Limit Cycles, Elimination of Quantization Limit Cycles, Elimination of Overflow Limit Cycles. **6L**

Module 6:
Design of Nonrecursive Filters Using Optimization Methods: Introduction, Problem Formulation, Lowpass and Highpass Filters, Bandpass and Bandstop Filters, Alternation Theorem, Remez Exchange Algorithm- Initialization of Extremals, Location of Maxima of the Error Function, Computation of $|E(\omega)|$and $Pc(\omega)$, Rejection of Superfluous Potential Extremals, Computation of Impulse Response, Improved Search Methods- Selective Step-by-Step Search, Cubic Interpolation, Quadratic Interpolation, Improved Formulation, Efficient Remez Exchange Algorithm, Gradient Information, Prescribed Specifications, Generalization- Antisymmetrical Impulse Response and Odd Filter Length, Even Filter Length, Digital Differentiators- Problem Formulation, First Derivative, Prescribed Specifications, Arbitrary Amplitude Responses, Multiband Filters. **7L**

Module 7:
Design of Recursive Filters Using Optimization Methods: Introduction, Problem Formulation, Newton's Method, Quasi-Newton Algorithms- Basic Quasi-Newton Algorithm, Updating Formulas forS_{k+1}, Inexact Line Searches, Practical Quasi-Newton Algorithm, Minimax Algorithms, Improved Minimax Algorithms, Design of Recursive Filters- Objective Function, Gradient Information, Stability, Minimum Filter Order, Use of Weighting, Design of Recursive Delay Equalizers. **4L**

Module 8:
Allpass Filters: Allpass transfer function and its properties–digital two-pair–design of allpass filters using digital two-pair–parallel allpass realization of certain IIR transfer functions. Miscellaneous Topics: Narrowband IIR digital filters with low roundoff noise–halfband digital filters–Hilbert transformers. **2L**

Module 9:
Digital Signal Processing Applications: Introduction, Sampling-Frequency Conversion-Decimators, Interpolators, Sampling Frequency Conversion by a Noninteger Factor, Design Considerations, Quadrature Mirror-Image Filter Banks-Operation, Elimination of Aliasing

Errors, Design Considerations, Perfect Reconstruction, Hilbert Transformers- Design of Hilbert Transformers, Single-Sideband Modulation, Sampling of Bandpassed Signals, Adaptive Digital Filters, Wiener Filters, Newton Algorithm, Steepest-Descent Algorithm, Least-Mean-Square Algorithm, Recursive Filters, Applications. Two-Dimensional Digital Filters- Two-Dimensional Convolution, Two-Dimensional z Transform, Two-Dimensional Transfer Function, Stability, Frequency-Domain Analysis, Types of 2-D Filters, Approximations, and Applications. **5L**

Text Books:

1. Digital Filters: Analysis, Design, and Applications by Andreas Antoniou, 2nd edition, 1993, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
2. Digital Filters and Signal Processing by Leland B. Jackson, 3rd edition, 1996, Kluwer Academic, Boston, MA
3. Digital Signal Processing by Andreas Antoniou, 2006, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

Reference Books:

1. Theory and Application of Digital Signal Processing by Lawrence R. Rabiner and Bernard Gold, 1975, Prentice-Hall of India Pvt. Ltd., New Delhi.
2. Digital Signal Processing by Sanjit K. Mitra, 3rd edition, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
3. Statistical Digital Signal Processing and Modeling by Monson H. Hayes, 2001, John Wiley & Sons, New York, NY.

Advanced RF & Microwave Engineering
Code: MECE 104
Contacts: 4-0-0
Credits: 4

Prerequisites
One semester course in electromagnetic engineering, microwave and antenna fundamentals.

Unit 1: Mathematical model of Microwave Transmission:
Concept of Model. Characteristics of TEM, TE and TM Modes. Losses associated with microwave transmission. Concept of Impedance in Microwave transmission. **2L**

Unit 2:Analysis of RF and Microwave Transmission Lines:
Coaxial Line. Rectangular Waveguide. Microstrip Line. Microwave Network Analysis: Equivalent Voltages and currents Model Network parameters for microwave Circuits. Scattering Parameters. **4L**

Unit 3:Passive and Active microwave Devices:
Microwave Passive components: Directional Coupler, Power Divider. Microwave Passive components: Magic Tee, attenuator, resonator. Microwave Filter Design. Microwave Active components: Diodes, Transistors. Microwave Active components: oscillators, mixers.
Microwave tubes: Klystron, Magnetron. Overview of microwave and millimeter wave vacuum tube devices, limitations of microwave vacuum tubes, gyratron vacuum tube devices. 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 Diode. **6L**

Unit 4: Microwave and mm wave circuits:
Review of scattering matrix concept in the light ofvector network analyzer, impedance matching network, couplers, power dividers, resonators and filters. Detectors, mixers, attenuators, phase shifters, amplifier and oscillator Ferrite based circuits. **4L**

Unit 5: Microwave Antenna:
Microwave Antenna Parameters. Antenna for ground systems. Antenna for airborne based systems. Antenna for satellite Microstrip antenna. Hertzian dipole, loop antenna, helical antenna, frequency independent antenna: Du0Hamel principle, logspiral and log periodic dipole antenna array. Babinet principle, waveguide slot antenna, horn antenna, parabolic reflector. Antenna arrays and phased array antenna. Antenna measurement. **6L**

Unit 6: Microwave Measurements:
Introduction to Radio Frequency & Microwave Measurements-Introduction Radio Frequency Band, microwave and millimetre wave. Power Measurement-High Power Measurement,

calorimeter technique, Low power Measurement, bolometer technique, Very Low Power Measurement. Frequency Measurement -Different Technique to measure frequency, Slotted Line Technique, maxima & minima, wavelength & frequency measurement. Impedance Measurement- Measurement of unknown load impedance of a transmission line, Slotted Line Technique to measure unknown impedance. Distortion & Frequency Translation Measurement- Different types of distortion occurred at microwave frequencies, Procedures for frequency translation. Detectors& Sensors: Definition of Detectors; Different type of microwave detectors functions and applications, Sensors Definition & working principle, applications. Vector **8L**

Unit 7: 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. **4L**

Unit 8: Microwave Systems:

Radar Fundamentals: Basic principles and fundamentals of Radar , block diagram of basic radar, classification, radar performance factors, radar range equation, factors influencing maximum range, effects of noise, Pulsed radar systems. Antennas and scanning, display methods, moving target indication, radar beacons, CW Doppler radar, FM CW phased array radars, applications of radar.

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

GPS. **6L**

Text Books:

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) Jordan & Balman, Electromagnetic waves & Radiating System
5) SKOLNIK : Introduction to radar systems , TMH
6) A.E. Bailey, Ed. Microwave Measurements- Peter Peregrinus Ltd

Reference Books:

1) R.S. Rao, "Microwave Engineering", PHI Publications
2) Annapurna Das, Sisir Das, "Microwave Engineering", McGraw Hill Publications
3) MONOJIT MITRA : Satellite communications , Prentice Hall of India
4) Albart Smith, Radio Engineering Principle and Applications
5) M. Dolukhanov, Propagation of Radio Waves (Mir Publication)
6) R.Garg,P.Bhartia,Indu Bhal,A.Ittipibom ; MicrostripAntenna Design hand book –Artech House
7) Girish Kumar & K.P.Roy—Broad band Microstrip Antenna-=Artech. House

8) Kin. Lu. Wong ; Compact and Broadband Microstrip Antenna—John Willey & Sons

Computational Intelligence
Code: MECE 105
Contacts: 3-0-0
Credits: 3

Prerequisites

- Knowledge of Basic Computing, Algorithms, Logical Reasoning & Automata

Unit 1: Foundation
Definition of AI, A brief overview of Artificial Intelligence, Pitfalls of the traditional AI, Computational Intelligence – A formal definition, Fundamental elements of soft computing, Computational learning theory, Synergism in soft computing **4L**

Unit 2: Artificial Neural Network:
Fundamental Concept, Evolution of Neural Network, Basic models of ANN and Terminologies, Perceptron Network, Adaptive Linear Neuron, Multiple Adaptive linear Neuron, Back-Propagation Network, Radial Basis Function Network, Associative Memory Network, Bidirectional Associative Memory, Hopfield Networks, Unsupervised Learning Network, KohonenSelf-Organizing Feature Map, Learning Vector Quantization, Adaptive Resonance Theory **14L**

Unit 3: Genetic Algorithm:
Introduction, Basic operators and Terminologies in GA, General Genetic Algorithm, Schema Theorem, Optimal Allocation of Trials, Stochastic Explanation of GA, The Markov model of Convergence Analysis, Application of GA in Optimization Problems, Application of GA in Machine Learning, GA as an alternative to Back Propagation Learning **10L**

Unit 4: Fuzzy Logic:
Introduction to Classical Sets and Fuzzy Sets, Classical Relation, Fuzzy Relation, Tolerance & Equivalence Relations, Noninteractive Fuzzy Sets, Membership Functions, Defuzzification, Fuzzy Arithmatic and Fuzzy Measures, Fuzzy Approximate Reasoning, Fuzzy Inference System, Scope of Parallelism in approximate reasoning, Realization of Fuzzy inference engine on VLSI Architecture, Fuzzy Abductive Reasoning, Fuzzy Logic Control Systems **12L**

Text Books:

1. S.N. Sivanandam, S.N. Deepa, “Principles of Soft Computing”, Prentice Hall of India.
2. Amit Konar, “Computational Intelligence-Principles, Techniques & Applications”, Springer
3. Imre J. Rudas, J´anos Fodor, Janusz Kacprzyk, “Computational Intelligence in Engineering”, Springer
4. S. Rajasekaran, G.A. Vijayalakshmi Pai, “NEURAL NETWORKS, FUZZY LOGIC, AND GENETIC ALGORITHMS”, PHI Learning

5. D. E. Goldberg, Genetic Algorithms in search, Optimization & Machine Learning, Pearson Education.

Satellite Communication
Code: MECE 106A
Contacts: 3-0-0
Credits: 3

Prerequisites

UNIT I: Introduction:
Origin of Satellite communication, Current state of satellite communication.
Orbital aspect of satellite communication: Orbital mechanism, equation of orbit, locating satellite in orbit, orbital elements, orbital perturbation, look angle, orbital period and velocity, azimuth and orbital inclination, coverage angle slant range, placement of satellite in geostationary orbit.
Space craft subsystem: Attitude and orbit control system, Telemetry tracking and command power system, and communication subsystem. **4L**

UNIT II: Satellite link design:
Basic link analysis, interference analysis, attenuation due to rain, link with and without frequency reuse. System noise temperature and T / T ratio, down link design, domestic satellite system, uplink design, design of satellite link for specified (C / N). **2L**

UNIT III: Satellite Subsystems:
Communication, telemetry, ranging & command, power, altitude control, tracking, antenna subsystems. **2L**

UNIT IV: Earth Station Technology:
Earth Station design; Earth station antenna, gain, pointing loss, G/T variation and it's measurement, antenna tracking, LNA, HPA, RF multiplexing, up converter, down converter, transponder hopping, polarization hopping, redundancy configuration, factors affecting orbit utilization, tracking, equipment for earth station. **4L**

UNIT V: Satellite transponder:
Transponder model, transponder channelization, frequency plans, processing transponders. **2L**

UNIT VI: 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. **6L**

UNIT VII: Propagation on satellite:
Earth's path – propagation effects, atmospheric absorption, Scintillation effects, Land and Sea multipath, Rain and ice effects, Rain drop distribution, calculation of attenuation. Rain effects on Antenna noise temperature. **2L**

UNIT VIII: Encoding and forward error correction:
Error detection and correction, channel capacity, error detecting codes, linear block codes, error correction with linear block codes, performance of block error correction codes, convolution codes, cyclic codes, BCH and codes, error detection on satellite links. **3L**

UNIT IX: 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. **3L**

UNIT X: Mobile satellite network:
Operating environment. MSAT network concept, CDMA MSAT relink. Worldwide timing by satellite relay. **2L**

Text Books:

1) MONOJIT MITRA : Satellite communications , Prentice Hall of India
2) Timothy Pratt, Charles Bostian, Teremy Allnutt, Satellite Communication, John Wiley & Sons.
3) " Satellite Communication", D. C. Agrawal, Khanna Publishers
4) "Satellite Communication", Dennis Roddy , 4th Edition, McGraw- Hill International edition, 2006

Reference Books:

1) "Satellite Communication", T. T. Hai., Mc.Graw Hill Publications
2) Satellite Communication Systems Engineering, W. L. Pitchand, H. L. Suyderhoud, R. A. Nelson, 2nd Ed., Pearson Education., 2007.
3) Satellite Communication, Mark R Chartrand, Cenage Learning
4) J. J. Spilker, Jr., Digital Communication by Satellite, Prentice Hall.
5) 4. Bruce R. Elbert, Satellite Communication Applications Hand Book, Artech House.

Communication Network
Code: MECE 106B
Contacts: 3-0-0
Credits: 3

Prerequisites

Unit 1: Introduction to Computer Networks
Uses of computer Network, Network Software-design Issues for layers, Service primitives and relationship of services to Protocols, Reference models-OSI &TCP/IP, network architectures introduction, Example of networks-X.25, Frame Relay & ATM, Protocols and Standards. **3L**

Unit 2: 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. **3L**

Unit 3: Physical Layer
Physical layer-Data rate limits, Transmission media-guided and Unguided, Switching systems- Circuit switching, Datagram Switching & Virtual circuit switching, Structure of circuit and packet switch, cable modem and DSL technologies, SONET basics, selection of IEEE std 802.11 ,a,b,c,g. bit communication between DTE and DCE, RS232, transmission media, modems. **4L**

Unit 4: Data link layer
Introduction to Data link layer in 802.11 LAN, Connecting devices like passive hubs, repeaters, Active hubs, Bridges, Two-layer Switches, Routers, three layer switches, Gateway etc., Backbone networks, Virtual LANs, Simple Router architecture, Sliding window protocol, 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. **5L**

Unit 5: Network layer
Basic design issues, network layer services, connection oriented and connection less services, Network layer issues like Delivery, forwarding, routing- intra-domain and Inter-domain routing, Routing algorithms like Shortest path routing, Flooding, Distance Vector Routing, Link State Routing, Path vector routing, static, dynamic, stochastic, flow based routing, optimal routing, etc., Quality of service, congestion control, Leaky Bucket Algorithm, IPv4 address, IPv6

address, Address mapping-ARP, RARP & DHCP, IPv4 datagram detail format, IPv6 datagram detail format, ICMP, IGMP. Addressing types-Physical, Logical & port address. **4L**

Unit 6: Transport Layer

Transport layer-Process to process delivery, Connection oriented & Connectionless Transport, UDP, TCP, congestion control and Quality of Service. Internetworking- motivation, goals and strategies, Routers and gateways, TCP / IP model, IP addressing, important features of IPv6. **3L**

Unit 7: Application Layer

Application layer protocols and applications like Ping, FTP, telnet, http (www), SMTP, SNMP, Trace route, TFTP, BOOTP, DNS, NFS, RPC, X-server, E-mail, Introduction to streaming Audio/Video,P2P file sharing, Introduction to socket programming. **3L**

Unit 8: Basics of Network Security and Network administration.

Network security: Introduction to Cryptography, Secret key algorithm, public key algorithm, Hash Functions, basic ITU-T Recommendation - X.805 Security Architecture, Basics of Security Requirements/Services/Dimensions, Basics of Security attacks, Basics of Security mechanisms / solutions. Cryptographic principle, DES, AES, RSA, Digital signature, Security in internet, VPN, Firewalls.

Network Administration: UTP Cabling for PC to PC communication, Network tester, network monitoring, Protocol Analyzer, Network Simulation, internet access through Dialup/DSL/Leased Line/Mobile handset.

Network management system - SNMP. Advance Protocol-RTP, SIP. **5L**

Text Books

1. Behrouz A. Forouzan," Data Communications and Networking", 4th Edition, Tata McGraw Hill
2. Andrew Tenenbaum, "Computer Networks", 4th Edition, Pearson Education.
3. Kurose & Ross, "Computer Networking- A top Down Approach featuring the Internet", 3rd edition, Pearson Education.
4. William Stallings, "computer Networks and Cryptography", 3rd edition, Pearson Education

Reference Books

1. Behrouz A. Forouzan, "TCP/IP protocol Suit", 3rd edition, Tata McGraw Hill Publications
2. Stevens,"TCP/IP illustrated Volume - I & II", Pearson education.
3. Feibel Werner, "Encyclopaedia of networking", Pearson education.
4. Frank J. Derfler, "Practical Networking", 2nd edition, QUE international Publishing.
5. Atul Kahate, "Cryptography and Network Security", 2nd edition, TATA McGraw Hill
6. Kenneth Mansfield, "Computer Networking from LANs to WANs: Hardware, software & Security", CENGAGE learning.
7. Nurul Sarkar, "Computer Networking & Hardware concepts", Information Science Publisher, USA

Embedded Systems Design
Code: MVLSI 106C
Contacts: 3-0-0
Credits: 3

Prerequisites

- Knowledge of Digital Electronics, Knowledge of Microprocessor / Microcontroller, Basic computing & Algorithm

UNIT I: Embedded System Introduction
Introduction to embedded system, embedded system architecture, classifications of embedded systems, challenges and design issues in embedded systems, fundamentals of embedded processor and microcontrollers, CISC vs. RISC, fundamentals of Von-Neumann /Harvard architectures, types of microcontrollers, selection of microcontrollers. **8L**

UNIT II: Embedded System Architecture
Embedded System Components, Memory architecture and interfacing, Memory organization, Virtual memory and memory management unit, Digital Signal Processor, ARM Processor, System on Chip (SoC). **10L**

UNIT III: Embedded System I/O
Interfacing bus types and arbitration methods, protocols – (RS232C, RS485, SPI, I2C, USB, IrDA, CAN), ISA bus, Timers, Interrupt, DMA, AD and DA converters **11L**

UNIT IV: Specification Technique
FSM Modelling, State Chart, SDL, Petri Net, UML **5L**

UNIT V: Real Time Operating System Concepts
Fundamentals of embedded operating systems, Architecture of the kernel, Task scheduler and scheduling policies, ISR, Semaphores, Mailbox, Message queues, Pipes, Events, Timers, Resource Management. **6L**

Text Books:
1) Raj Kamal, "Embedded Systems ", TMH Publications.
2) Frank Vahid, "Embedded System Design", Wiley Publications, New edition 2001.
3) Santanu Chattopadhyay, "Embedded System Design", PHI Learning
4) PiterMarwedel, "Embedded System Design", Springer

Reference Books:
1) Dr. K.V.Prasad , "Embedded / Real Time Systems", Dreamtech Publications
2) Iyer, Gupta , "Embedded Real systems programming", TMH Publications.
3) Steve Heath, "Embedded System Design", Neuwans Publications

Advanced communication Lab
Code: MECE 192
Contacts: 0-0-3
Credits: 2

1. Study of receiver and transmitter parameters of a typical radio communication system – selectivity, sensitivity, fidelity, image rejection, modulation sensitivity, transmission bandwidth etc.
2. Data communication through fiber optic link and measurement of Numerical Aperture, losses, power budget, stability etc.
3. Study of sampling, quantization and coding – sampling rate, quantization error, signal bandwidth etc.
4. Realization of different modulation schemes using I/Q modulator- QPSK, MPSK – signal bandwidth, effect of noise etc.

5. Simulation of different Modulation and Demodulation techniques –QAM, FSK using MATLAB and observe the scatter plot, signal bandwidth etc.

6. Study of Binary symmetric channel – noise & Pe etc. using MATLAB.
7. Multiple channel DSSS – spreading, dispreading, decoding etc.
8. Signal bandwidth and Pe vs. S/N in different modes of line coding. using MATLAB
9. Signal bandwidth and Pe vs. S/N in different modes of modulation. using MATLAB
10. Simulation of PSK system with M=4 using MATLAB
11. Cellular architecture, WiFi, WiMAX using QUALNET.
12. Genraton of OFDM signal using MATLAB

13. Different routing algorithms & protocols using QUALNET

14. Error rates in error control for different types of error control coding.
15. Innovative Experiment beyond the Curriculum.

Digital Signal Processing Lab
Code: MECE 192
Contacts: 0-0-3
Credits: 2

1. To study architecture of TMS320C54XX & Motorola DSP563XX
2. To generate basic signals using TMS320C54XX .
3. Write an ALP using instruction of TMS processors to add two numbers.
4. Write ALP to subtract two numbers.
5. Write an ALP to multiply two numbers of unsigned 32 bit data.
6. Write an ALP to divide 16 –bit data by an eight bit data.
7. Implementation of FFT using code Composer studio.
8. To implement Interpolation filter by Matlab.
9. To implement Decimation filter by Matlab.
10. To design FIR filter using MATLAB and find finite word length effect & cross verify using DSP processor.
11. To design IIR filter using MATLAB and find finite word length effect & cross verify using DSP Processor.
12. Digital filters – ripples in pass band & stop band,slope in transition band, poles & zeros etc.
13. Optimum filters for receiving base band random binary data – Pevs. S/N.
14. Innovative Experiment beyond the Curriculum.

Advanced RF & Microwave Engineering Lab
Code: MECE 194

Contacts: 0-0-3
Credits: 2

1. Important characteristics of different types of transmission lines.
2. Impedance measurement of microwave window applying Smith chart on HFSS.
3. Microwave phase shifter – calibration.
4. Measurement of dielectric constants – solids & liquids.
5. Characterization of micro strip antenna
6. To plot the radiation pattern of Horn Antenna,Dish Antenna and microstrip antenna and calculate its Antenna Gain,radiation pattern and Beam width.
7. Study of different types of Antenna (cassegain antenna /Parabolic Antenna)
8. Study of important parameters and practical considerations in microwave circuits.
9. Design and Simulation of simple monopole antenna.
10. Design microstrip antenna with different feed and find out there characteristics on HFSS.
11. Study of Co-planner structure using HFSS tools
12. Study of parametric simulation with patch antennas.
13. Design and Simulation of simple low pass filter using HFSS tools
14. Study of different type of Horn antennas on HFSS.
15. Verify results with any antennas related transactions papers using HFSS.
16. Innovative Experiment beyond the Curriculum.

EMI/EMC
Code: MECE 201
Contacts: 3-1-0
Credits: 4

Module I: **5**

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.

Module II: **4**

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.

Module III: **5**

Impedance Matching & Tuning - Purpose of Impedance matching, Factors important inthe 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.

Module IV: **4**

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

Module VI: **1**

Introduction To EMC - Concepts of EMC, EMC units.

Module VII: **2**

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

Module VIII: **5**

Different Mitigation Techniques for preventing EMI:
Grounding: Fundamental grounding concepts, Floating ground, Single-point & Multi-point ground, advantages & disadvantages of different grounding processes.
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.
Cross-talks & Coupling, Measurement set for measuring Cross-talk. Filtering & decoupling.

Module IX: **2**

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

Module X: **3**

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.

Module XI: **4**

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).

Module XII: **4**

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.

Module XIII: **2**

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

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. Applied Electromagnetic Compatibility-Dipak L Sengupta & Valdis V Liepa (John Wiley & SonsInc).
4. Electromagnetic waves & Radiating Systems-Jordan & Balmain (Prentice Hall Publication)
5. Elements Of Electromagnetic-Matthew N.O.Sadiku (Oxford University Press)
6. Microwave Engineering-David M.Pozar (John Wiley & Sons, INC).
7. Microwave Circuits & Passive Devices-M.L Sisodia & G S Raghuvanshi (New Age International Limited)

Wireless Communication
Code: MECE 202
Contacts: 3-1-0
Credits: 4

Module I: **2**
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.

Module II: **3**
Wireless Transmission: Frequencies, regulations, Signals, Antennas, Signal Propagation, path loss, Multi path and other effects.

Module III: **8**
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 IV: **8**
Different Wireless 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 cdma2000, IMT-2000. Access Control Mechanisms: SDMA, FDMA, TDMA, CDMA and their performance evaluation.

Module V: **3**

Modulation Techniques: ASK, FSK, PSK, Multi-carrier and Spread Spectrum: their use in Mobile and Wireless Communication Systems.

Module VI: **8**

Cellular Wireless Networks - Principles of cellular network, first, second and third Generation systems.
Cordless Systems and WLL: Cordless systems, Wireless Local Loop, IEEE 802.16 fixed broadband wireless access standard.
Mobile IP and wireless Access Protocol: Mobile IP, Wireless Application Protocol, Internet control message protocol, Message authentication, Service primitives and parameters.
Wireless Networks: Satellite networks, Wireless LAN, Wireless ATM. OSI, Mobile Network and transport layers, their protocols and implementation. Wireless Application Protocol.

Module VII: **8**

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.

Text Books:

1. Wireless Communications & Networks, by William Stallings, 2 Edition, 2009,nd Pearson Education, ISBN 81-7808-560-7
2. Wireless communications: principles and practice, by Theodore S. Rappaport, PHI / Pearson education.
3. Mobile communications, J. Schiller, Addison-Wesley.
4. Mobile cellular telecommunication – analog and digital systems, William C. Y. Lee, McGraw Hill, 2nd ed.

Reference Book:

1. Wireless communication and Networking by V.K. Garg, Morgan Kauffman Publisher, 2009, ISBN:9780123735805
2. Wireless Communication & Network, 3G & beyond, by Iti Saha Misra, McGrawHill, 2009, ISBN 10:0-07-015140-7
3. Wang, Wireless communication System, Pearson Education
4. Talukdar, Mobile computing, TMH
5. J.W.Mark, W. Zhuang, Wireless Communication and Networking, PHI
6. A. Santamaria et al, Wireless LAN systems, Artech House.
7. K. Feher, Wireless digital communications, Prentice Hall of India.
8. Roy Blake, Wireless communication technology, Thomson Delmer.

Secure Communication & Coding
Code: MECE 203
Contacts: 3-1-0

Credits: 4

Module I: **5**

Introduction: Attacks, Services and Mechanisms, Security attacks, Security services, A Model for Internetwork security.

Classical Techniques: Conventional Encryption model, Steganography, Classical Encryption Techniques.

Modern Techniques: Simplified DES, Block Cipher Principles, Data Encryption standard, Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles and Modes of operations.

Module II: **5**

Algorithms: Triple DES, International Data Encryption algorithm, Blowfish, RC5, CAST-128, RC2, Characteristics of Advanced Symmetric block ciphers. Conventional Encryption: Placement of Encryption function, Traffic confidentiality, Key distribution, Random Number Generation.

Public Key Cryptography: Principles, RSA Algorithm, Key Management, Diffie-Hellman Key Exchange, Elliptic Curve Cryptography.

Module III: **4**

Number Theory: Prime and Relatively prime numbers, Modular arithmetic, Fermat's and Euler's theorems, Testing for primarily, Euclid's Algorithm, the Chinese remainder theorem, Discrete logarithms.

Message authentication and Hash Functions: Authentication requirements and functions, Message Authentication, Hash functions, Security of Hash functions and MACs.

Module IV: **4**

Hash and Mac Algorithms: MD File, Message digest Algorithm, Secure Hash Algorithm, RIPEMD-160, and HMAC.

Digital signatures and Authentication Protocols: Digital signatures, Authentication Protocols, Digital signature standards.

Authentication Applications: Kerberos, X.509 directory Authentication service. Electronic Mail Security: Pretty Good Privacy, S/MIME.

Module V: **4**

IP Security: Overview, Architecture, Authentication, Encapsulating Security Payload, Combining Security Associations, Key Management.

Web Security: Web Security requirements, Secure sockets layer and Transport layer security, Secure Electronic Transaction.

Intruders, Viruses and Worms: Intruders, Viruses and Related threats.

Fire Walls: Fire wall Design Principles, Trusted systems.

Module VI: **5**

Coding for Reliable Digital Transmission and Storage: Mathematical model of Information, A Logarithmic Measure of Information, Average and Mutual Information and Entropy, Types of Errors, Error Control Strategies.

Linear Block Codes: Introduction to Linear Block Codes, Syndrome and Error Detection, Minimum Distance of a Block code, Error-Detecting and Error-correcting Capabilities of a Block code, Standard array and Syndrome Decoding, Probability of an undetected error for Linear Codes over a BSC, Hamming Codes. Applications of Block codes for Error control in data storage system

Module VII: **3**

Cyclic Codes: Description, Generator and Parity-check Matrices, Encoding, Syndrome Computation and Error Detection, Decoding ,Cyclic Hamming Codes, Shortened cyclic codes, Error-trapping decoding for cyclic codes, Majority logic decoding for cyclic codes.

Module VIII: **3**

Convolutional Codes: Encoding of Convolutional Codes, Structural and Distance Properties, maximum likelihood decoding, Sequential decoding, Majority- logic decoding of Convolution codes. Application of Viterbi Decoding and Sequential Decoding, Applications of Convolutional codes in ARQ system.

Module IX: **4**

Burst –Error-Correcting Codes: Decoding of Single-Burst error Correcting Cyclic codes, Single Burst-Error-Correcting Cyclic codes, Burst-Error-Correcting Convolutional Codes, Bounds on Burst Error-Correcting

Capability, Interleaved Cyclic and Convolutional Codes, Phased-Burst –Error Correcting Cyclic and Convolutional codes.

Module X: **3**

BCH –Codes: BCH code-Definition, Minimum distance and BCH Bounds, Decoding Procedure for BCH Codes-Syndrome Computation and Iterative Algorithms, Error Location Polynomials and Numbers for single and double error correction.

Text Books:

1. Error Control Coding-Fundamentals and Applications –Shu Lin, Daniel J.Costello,Jr, Prentice Hall, Inc.
2. Error Correcting Coding Theory-Man Young Rhee-1989, McGraw-Hill Publishing.
3. Cryptography and Network Security: Principles and Practice -William Stallings, 2000, PE

Reference Books:

1. Digital Communications-Fundamental and Application -Bernard Sklar, PE.
2. Digital Communications-John G. Proakis, 5th Ed., 2008, TMH.
3. Introduction to Error Control Codes-Salvatore Gravano-Oxford
4. Error Correction Coding – Mathematical Methods and Algorithms – Todd K.Moon, 2006, Wiley India.
5. Information Theory, Coding and Cryptography –Ranjan Bose, 2nd Edition, 2009, TMH.
6. Principles of Network and Systems Administration, Mark Burgess, John Wiely

Remote sensing techniques & applications.

Code: MECE 204
Contacts: 4-0-0
Credits: 4

Module I: **4**

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.

Module II: **6**

Variation of the earth's reflectivity with angle of incidence, wavelength and geographical location; 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.

Module III: **8**

Sensors and Cameras: Optical and infrared detectors and filters, Optical and infrared cameras; Microwave and Millimeter wave radiometers; Scanning systems, Mechanical and Electronic systems; Scatter meter; Altimeter.

Module IV: **8**

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.

Module V: **8**

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), Laboratory measurements of remote sensing parameters; Tropical rainfall measurements; Microwave sensing of sea surface.

Module VI: **6**

Interpretation of Sensing Data: Photo-interpretation, image and pattern recognition; Spectral interpretation of remote sensing imagery; Interpretation of thermal maps; Color coding and enhancement; Computer interpretation of images.

Text Books:

1. Fundamentals of Satellite Remote Sensing: An Environmental Approach, Emilio Chuvieco, Second Edition, Springer;
2. Remote Sensing: Principles and Application, by A N Patel, 2nd Edition, Scientific Publishers (India).

Reference Books:

1. Textbook of Remote Sensing and Geographical Information Systems by Kali Charan Sahu, Atlantic Publishers.
2. Image Processing and GIS for Remote Sensing: Techniques and Applications, Jian Guo Liu, Philippa J. Mason , 2nd Edition, Willey
3. Remote Sensing - Advanced Techniques and Platforms by Boris Escalante-Ramirez, Publisher: InTech

Image Processing & Pattern Recognition

Code: MECE 205A
Contacts: 3-0-0
Credits: 3

Prerequisite: Basic concept of vectors and matrices (relation between a column matrix and vector), inner product of two vectors, matrix multiplication, inversion, extracting Eigenvectors and Eigen values of a matrix, covariance matrix. Perception of dimensionality and hyper plane. Distance measures in Euclidean space between two points (e.g. Euclidean distance) and a point with a group of points (Mahalanobis distance). Knowledge about statistical distributions (e.g. Normal/ Gaussian), statistical independence, probability distribution function, condition probability, the law of total probability and Bayes rule.

Module I: **2**

Fundamentals of Image Processing and Image Transforms: Basic steps of Image Processing System Sampling and Quantization of an image, Basic relationship between pixels.
Image Segmentation: Segmentation concepts, Point, Line and Edge Detection, Thresholding, Region based segmentation.

Module II: **3**

Image Enhancement: Spatial domain methods: Histogram processing, Fundamentals of Spatial filtering, Smoothing spatial filters, sharpening spatial filters.
Frequency domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, Selective filtering.

Module III: **3**

Image Compression: Image compression fundamentals - Coding Redundancy, Spatial and Temporal redundancy, Compression models: Lossy & Lossless, Huffman coding, , Bit plane coding, Transform coding, Predictive coding, Wavelet coding, Lossy Predictive coding, JPEG Standards.

Module IV: **4**

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 concernedimage.

Module V: **4**

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.

Module VI: **2**

Image mining: Need, Image search and retrieval. Bottleneck of Text based image mining/ retrieval, Visual feature based image mining: Content-based image retrieval (CBIR).

Module VII: **1**

Image based face recognition: Basic technique for Eigen face generation & recognition.

Module VIII: **3**

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 nonconvex paradigm in this aspect.

Module IX: **3**

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 c-means. 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.

Module X: **3**

Classification and prediction: Definition of classification and prediction. Basic task of a classifier. Concept of training & testing data and over fitting. Bayes classification: Bayes' Theorem, Naïve Bayesian classification. Classification by Backpropagation: Multilayer Perceptron (MLP) neural network and Backpropagation algorithm.

Module IX: **4**

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.

Text Books:

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.

Reference Books:

1. S. Theodoridis and K. Koutroumbus, Pattern Recognition, Elsevier.
2. A. Ghosh, S. Dehuri, and S. Ghosh (editors). Multi-Objective Evolutionary
3. Algorithms for Knowledge Discovery from Databases. Springer, Berlin, 2008.
4. Anil K. Jain, Fundamentals of Digital Picture Processing, Prentice Hall.

5. D. E. Goldberg, Genetic Algorithms in search, Optimization & Machine Learning, Pearson Education.
6. Remote Sensing Digital Image Analysis: An Introduction by J.A Richards and X. Jia. Springer.
7. Data Clustering: A Reviewby Anil K. Jain, ACM Comput. Surv., Vol. 31, No. 3. (September 1999).

Computer Vision
Code: MECE 205B
Contacts: 3-0-0
Credits: 3

Module I: **4**
Digital Image Formation and low-level processing: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

Module II: **4**
Depth estimation and Multi-camera views: Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration.

Module III: **4**
Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

Module IV: **3**
Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

Module V: **4**
Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.

Module VI: **3**
Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

Module VII: **4**
Shape from X: Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges.

Module VIII: **4**
Miscellaneous Applications: CBIR, CBVR, Activity Recognition, computational photography, Biometrics, stitching and document processing; Modern trends - super-resolution; GPU, Augmented Reality; cognitive models, fusion and SR&CS.

Text Books :

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

Reference Books:

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.

2. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

Detection and Estimation Theory
Code: MECE 205C
Contacts: 3-0-0
Credits: 3

Module I: **3**
Random Processes: Discrete Linear Models, Markov Sequences and Processes, Point Processes, and Gaussian Processes.

Module II: **6**
Detection Theory: Basic Detection Problem, Maximum A posteriori Decision Rule, Minimum Probability of Error Classifier, Bayes Decision Rule, Multiple-Class Problem (Bayes)- minimum probability error with and without equal a priori probabilities, Neyman-Pearson Classifier, General Calculation of Probability of Error, General Gaussian Problem, Composite Hypotheses.

Module III: **7**
Linear Minimum Mean-Square Error Filtering: Linear Minimum Mean Squared Error Estimators, Nonlinear Minimum Mean Squared Error Estimators. Innovations, Digital Wiener Filters with Stored Data, Real-time Digital Wiener Filters, Kalman Filters.

Module IV: **8**
Statistics: Measurements, Nonparametric Estimators of Probability Distribution and Density Functions, Point Estimators of Parameters, Measures of the Quality of Estimators, Introduction to Interval Estimates, Distribution of Estimators, Tests of Hypotheses, Simple Linear Regression, Multiple Linear Regression.

Module V: **6**
Estimating the Parameters of Random Processes from Data: Tests for Stationarity and Ergodicity,
Model-free Estimation, Model-based Estimation of Autocorrelation Functions, and Power Special Density Functions.

TEXT BOOKS:
1. Random Signals: Detection, Estimation and Data Analysis -K. Sam Shanmugan & A.M. Breipohl, Wiley India Pvt. Ltd, 2011.
2. Random Processes: Filtering, Estimation andDetection -Lonnie C. Ludeman, Wiley India Pvt. Ltd., 2010.

REFERENCE BOOKS:
1. Fundamentals of Statistical Signal Processing: Volume I Estimation Theory– Steven.M.Kay,
Prentice Hall, USA, 1998.
2. Fundamentals of Statistical Signal Processing: Volume I Detection Theory–Steven.M.Kay, Prentice Hall, USA, 1998.
3. Introduction to Statistical Signal Processing with Applications -Srinath, Rajasekaran, Viswanathan, 2003, PHI.
4. Statistical Signal Processing: Detection, Estimation and Time Series Analysis – Louis L.Scharf,
1991, Addison Wesley.
5. Detection, Estimation and Modulation Theory: Part –I –Harry L. Van Trees, 2001, John Wiley & Sons, USA.
6. Signal Processing: Discrete Spectral Analysis – Detection & Estimation – Mischa Schwartz, Leonard Shaw, 1975, Mc Graw Hill.

Optical Fiber communication

Code: MECE 206A
Contacts: 3-0-0
Credits: 3

Module I: **2**
Introduction: Measurement of Information, Channel Capacity, Communication System Architecture, Basic Optical Communication System, Advantage of Optical Communication System.

Module II: **2**
Propagation in Dielectric Waveguides: Introduction, Step-index Fibers, Graded Index Fibers, Modes & Rays, Slab Wave Guide.

Module III: **2**
Attenuation in Optical Fibers: Introduction, Absorption, Scattering, Very Low Loss Materials, All Plastic & Polymer-Clad-Silica Fibers

Module IV: **4**
Wave Propagation: Wave Propagation in Step-Index & Graded Index Fiber, Overall Fiber Dispersion-Single Mode Fibers, Multimode Fibers, Dispersion-Shifted Fiber, Dispersion, Flattened Fiber, Polarization.

Module V: **4**
Source & Detectors: Design of LED's for Optical Communication, Semiconductor Lasers for Optical Fiber Communication System, Semiconductor Photodiode Detectors, and Avalanche Photodiode Detectors & Photo multiplier Tubes.

Module VI: **4**
Optical Fiber Communication System**:** Telecommunication, Local Distribution Series, Computer Networks Local Data Transmission & Telemetry, Digital Optical Fiber Communication System-First Generation, System, Second Generation System, Future System.

Module VII: **3**
Optical amplification: Doped Fiber Amplifiers, Semiconductor Optical Amplifiers, Raman Amplifiers, Optical amplification in WDM communication systems.

Module VIII: **4**
Data Communication Networks- Network Topologies, Mac Protocols, Analog System. Advanced Multiplexing Strategies- Optical TDM, Sub carrier Multiplexing, WDM Network Architecutres; SONET/SDH, Optical Transport Network, Optical Access Network, Optical Premise Network.

Module IX: **4**
Advanced modulation formats for optical communications: Advanced multiplexing (wavelength, time, polarization, code...), Single carrier advanced formats (QPSK, m-QAM, OFDM), Multi-carrier formats (O-OFDM, Nyquist-WDM), Systems analysis and evaluation

Module X: **1**
Applications-Military Applications, Civil, Consumer & Industrial Applications.

Text Books:

1. "Optical Fibre Communication Senior", PHI – 2nd Edition.
2. J. Gowar, "Optical Communication System" EEE – 2nd Edition.

Reference Books:
Keiser, "Optical Fibre Communication" Mc. Graw Hill – 2nd Edition

Ad-hoc Networking
Code: MECE 206B
Contacts: 3-0-0
Credits: 3

Module I: **5**
Wireless LANS and PANS: Introduction, Fundamentals of WLANS, IEEE 802.11 Standard, HIPERLAN Standard, Bluetooth, Home RF.
Wireless Internet: Wireless Internet, Mobile IP, TCP in Wireless Domain, WAP, Optimizing Web over Wireless.

Module II: **7**
AD HOC Wireless Networks: Introduction, Issues in Ad Hoc Wireless Networks, AD Hoc Wireless Internet. MAC Protocols for Ad Hoc Wireless Networks: Introduction, Issues in Designing a MAC protocol for Ad Hoc Wireless Networks, Design goals of a MAC Protocol for Ad Hoc Wireless Networks, Classifications of MAC Protocols, Contention -Based Protocols, Contention -Based Protocols with reservation Mechanisms, Contention – Based MAC Protocols with Scheduling Mechanisms, MAC Protocols that use Directional Antennas, Other MAC Protocols.

Module III: **8**
Routing Protocols: Introduction, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classification of Routing Protocols, Table –Driven Routing Protocols, On – Demand Routing Protocols, Hybrid Routing Protocols, Routing Protocols with Efficient Flooding Mechanisms, Hierarchical Routing Protocols, Power –Aware Routing Protocols.
Transport Layer and Security Protocols: Introduction, Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks, Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks, Classification of Transport Layer Solutions, TCP Over Ad Hoc Wireless Networks, Other Transport Layer Protocol for Ad Hoc Wireless Networks, Security in Ad Hoc Wireless Networks, Network Security Requirements, Issues and Challenges in Security Provisioning, Network Security, Attacks, Key Management, Secure Routing in Ad Hoc Wireless Networks.

Module IV: **6**
Quality of Service: Introduction, Issues and Challenges in Providing QoS in Ad Hoc Wireless Networks, Classification of QoS Solutions, MAC Layer Solutions, Network Layer Solutions, QoS Frameworks for Ad Hoc Wireless Networks.
Energy Management: Introduction, Need for Energy Management in Ad Hoc Wireless Networks, Classification of Ad Hoc Wireless Networks, Battery Management Schemes, Transmission Power Management Schemes, System Power Management Schemes.

Module V: **4**
Wireless Sensor Networks: Introduction, Sensor Network Architecture, Data Dissemination, Data Gathering, MAC Protocols for Sensor Networks, Location Discovery, Quality of a Sensor Network, Evolving Standards, Other Issues.

Text Books:
1. Ad Hoc Wireless Networks: Architectures and Protocols - C. Siva Ram Murthy and B.S.Manoj, 2004, PHI.
2. Wireless Ad-hoc and Sensor Networks: Protocols, Performance and Control -Jagannathan Sarangapani, CRC Press

Reference Books:
1. Ad-Hoc Mobile Wireless Networks: Protocols & Systems, C.K. Toh, 1 ed. Pearson Education.
2. Wireless Sensor Networks -C. S. Raghavendra, Krishna M. Sivalingam, 2004, Springer

Multimedia Communication
Code: MECE 206C
Contacts: 3-0-0
Credits: 3

Module I:
MULTIMEDIA COMMUNICATIONS: Introduction, multimedia information representation, multimedia networks, multimedia applications, media types, communication modes, network types, multipoint conferencing, network QoS application QoS.

Module II:
MULTIMEDIA INFORMATION REPRESENTATION: Introduction, digital principles, text, images, audio, video.

Module III:
TEXT AND IMAGE COMPRESSION: Introduction, compression principles, text compression, image compression.

Module IV:
AUDIO AND VIDEO COMPRESSION: Introduction, audio compression, DPCM, ADPCM, APC, LPC, video compression, video compression principles, H.261, H.263, MPEG, MPEG-1, MPEG-2, and MPEG-4.

Module V:
MULTIMEDIA INFORMATION NETWORKS: Introduction, LANs, Ethernet, Token ring, Bridges, FDDI High-speed LANs, LAN protocol.

Module VI:
THE INTERNET: Introduction, IP Datagrams, Fragmentation, IP Address, ARP and RARP, QoS Support, IPv8.

Module VII:
BROADBAND ATM NETWORKS: Introduction, Cell format, Switfh and Protocol Architecture ATM LANs.

Module VIII:
TRANSPORT PROTOCOL: Introduction, TCP/IP, TCP, UDP, RTP and RTCP.

Text Book:

1. Introduction to Multimedia Communications: Applications, Middleware, Networking, by K.R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, Wiley India Pub.
2. Multimedia Communications: Applications, Networks, Protocols and Standards, by Fred Halsall, Pearson

Reference Book:

1. Multimedia Communication Technology: Representation, Transmission and Identification of Multimedia Signals by Jens Ohm, Springer Science & Business Media
2. Multimedia Communications and Networking, by Mario Marques da Silva, CRC Press