Department: Electronics & Communication Engineering

Curriculum Structure (Effective from 2018-19 admission batch)

1st semester

Theory:							
Code	**Subject**	**Contacts periods per week**				**Full marks**	**Credit**
		L	**T**	**P**	**Total**		
MCE 101	Advanced Engg. Math.	3	1	0	4	100	4
MCE102	**Compulsory:** Advanced digital communication	4	0	0	4	100	4
MCE103	**Compulsory:** Advanced digital signal processing	4	0	0	4	100	4
MCE104	**Compulsory:** Advanced microwave communication engineering	4	0	0	4	100	4
MCE105	**Elect I:** A. Computer communication & networking B. Cognitive Radio C. Statistical Information Processing D. Wireless Sensor Networks E. Remote sensing techniques & applications.	4	0	0	4	100	4
	Total of theory				**20**	**500**	**20**
Practical							
MCE191	**Lab I:** Advanced communication Lab	0	0	3	3	100	2
MVE193	**Lab II:** Design and Simulation Lab	0	0	3	3	100	2
	Total of practical				**6**	**200**	**4**
Sessional							
MCE183	Seminar I	0	2	0	2	100	1
	Total credit of 1st semester:				**28**	**800**	**25**

Department: Electronics & Communication Engineering

Curriculum Structure (Effective from 2018-19 admission batch)

2nd semester

Theory:							
Code	**Subject**	**Contacts periods per week**				**Full marks**	**Credit**
		L	**T**	**P**	**Total**		
MCE 201	**Compulsory:** Photonics and Optical Communication	4	0	0	4	100	4
MCE 202	**Compulsory:** Error control coding	4	0	0	4	100	4
MCE 203	**Compulsory:** Mobile communication	4	0	0	4	100	4
MCE 204	**Elect II:** A. Cryptography & network security B. Artificial intelligence & soft computing C. Internet of Things D. Microwave measurement Techniques	4	0	0	4	100	4
MCE 205	**Elect III:** A. Satellite communication B. Image processing & pattern recognition C. MIMO System D. Advanced antenna and wave propagation	4	0	0	4	100	4
	Total of theory				**20**	**500**	**20**
Practical							
MCE 291	**Lab III:** Communication systems Lab	0	0	3	3	100	2
Sessional							
MCE 281	Term paper leading to thesis	0	2	0	2	100	1
	Total credit of 2nd semester:				**25**	**700**	**23**

Department: Electronics & Communication Engineering

Curriculum Structure (Effective from 2018-19 admission batch)

3rd semester

Theory:							
Code	**Subject**	**Contacts periods per week**				**Full marks**	**Credit**
		L	**T**	**P**	**Total**		
MCE 301	**Compulsory:** PROJECT DEVELOPMENT AND RESOURCE MANAGEMENT	4	0	0	4	100	4
MCE 302	**Elect IV:** A. High Performance Networks B. Ad-hoc networking C. Optical signal processing D. Pattern Recognition and Machine Learning	4	0	0	4	100	4
Sessional							
MCE 381	Dissertation (Part-I)				24	100	4
MCE 382	Defense of dissertation (Part-I)					100	8
	Total credit of 3rd semester:				**32**	**400**	**20**

Department: Electronics & Communication Engineering

Curriculum Structure (Effective from 2018-19 admission batch)

4TH semester

Sessional:							
Code	**Subject**	**Contacts periods per week**				**Full marks**	**Credit**
		L	**T**	**P**	**Total**		
Sessional							
MCE 481	Dissertation (Completion)				24	100	6
MCE 482	Post-submission defense of dissertation					100	18
MCE 483	Comprehensive Viva-Voce					100	4
	Total credit of 4th semester:				**24**	**300**	**28**
	Grand Total of credits:						**96**

Detail Syllabus
First Semester

Advanced Engineering Mathematics
Code: MCE 101

Contacts: 3-1-0

Credits: 4

COURSE OUTCOMES
On completion of the course students will be able to

CO1: Understand both linear & non-linear engineering problems whose solutions are not found in the closed form
CO2: Analyze stochastic engineering & industrial problems
CO3: Analyze the solution & examine optimization techniques
CO4: Optimize & solve the problems related to probability and statistics

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	2	1	2	1			2					2	2
CO2	2			3	3		2			1	1	1	2	1	1
CO3	2	3	2	3	2	2			1		3	2	3	2	2
CO4	2	3	2	2				1	1	1	2	3	2	2	2

Advanced digital communication Code: MCE 102

Contacts: 4-0-0

Credits: 4

COURSE OUTCOMES

On completion of the course students will be able to

CO1. Understand the knowledge of probability and statistical calculations on random signal analysis.
CO2. Analyse signal vector representation of various digitally modulated signals by creating signal constellation.
CO3. Demonstrate the concepts of sampling, Pulse Modulation techniques and their comparison.
CO4. Design Optimum (Matched) filter, demonstrate the effects of Inter Symbol Interference (ISI) and compare Eye pattern analysis.
CO5. Illustrate various types of coherent and non-coherent digital modulation techniques, analyse immunity parameters and calculate their error probabilities.

- *Perquisites*:
  - 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, its autocorrelation function and its spectrum.
  - 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.
  - 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.

- Spectral analysis of signals:
  - 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 its orthonormal components, measure of distinguishability of signals.

- 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, ergodic process, wide sense stationary process.
  - Power spectral density and autocorrelation, power spectral density of a random binary signal.
  - Linear mean square estimation methods.

- *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.

- 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 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.

- 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.

- 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.
- 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.

- Characteristics of different types of channels:
  - Gaussian, Poisson etc.

- 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.

- 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.

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

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3		1	1			2		3	3	3	2	3
CO2	3			3	3		2			1	3	3	2	3	3
CO3	3	3	3	3	2	2			1		3	3	3	2	2
CO4	3	3	3	2	3		2			2	2	3	3	3	3
CO5	3	3	3			2	2	3	1	2		3	2	2	1

Advanced digital signal processing Code: MCE 103

Contacts: 4-0-0

Credits: 4

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

Course Outcome:
After successful completion of course, students will be able to
CO1: Understand and process discrete time signals in different transform domain.
CO2: Design filters to suit specific requirements for specific applications.
CO3: Design multi rate signal processing of signals through systems.
CO4: Learn the different applications of digital signal processing on speech and image signal.

Frequency Domain Analysis of Discrete Time Domain Signals and Systems: 6L

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

Frequency Domain Characteristics of LTI Systems 6L

Response to complex exponential signals, steady state and transient response to sinusoidal signals, steady state response to periodic signals, response to aperiodic signals. Relation between system function H (z) and frequency response function h (w). Input-output correlation function and spectra, correlation functions and power spectra for random input signals. Invertibility of LTI systems, minimum/maximum/mixed phase systems, homomorphic systems and homomorphic deconvolution.

DFT & FFT 2L

Computation of DFT and it's properties, computation of DFT via FFT, chirp z-transform.

Design of Digital Filters 6L

Design of FIR filters, Effect of various windows, Effect of finite register length, frequency sampling, Optimization Algorithm. Adaptive Filters design, State-Space Kalman Filter, Extended Kalman Filter, Unscented Kalman Filter Sample-Adaptive Filters, Recursive Least Square (RLS) Adaptive Filters, The Steepest-Descent Method, LMS Filter.

Power Spectrum 6L

Estimation of Power Spectrum and Correlation, Non-parametric and Parametric methods, Minimum Variation Estimation methods, Eigen Analysis algorithm, Power Spectrum analysis using DFT, Maximum Entropy Spectral Estimation, Model-Based Power Spectral Estimation.

Multirate Signal Processing 6L

Sampling Rate Conversion; Decimation and Interpolation; Time and Frequency Domain Characterization; Filters in Sampling Rate Alteration Systems; Multi-rate Design of Decimator and Interpolator; Poly-phase Techniques; Poly-phase Down-sampler and Interpolator; Poly-phase Filter Design; Two-channel QMF Banks. Alias free FIR and IIR QMF Banks; Perfect Reconstruction Two-channel FIR Filter Banks; M-Channel Filter Banks Design; Cosine-Modulated M-channel Filter Banks Design;

Wavelet Transforms 6L

Fourier Transform and its limitations, Short Time Fourier Transform, Continuous Wavelet Transform, Discretization of the Continuous Wavelet Transform, Multiresolution Approximations; Wavelet and Scaling Function Coefficients, Orthonormality of Compactly Supported Wavelets, Bi- orthogonal Decomposition, Harr Wavelets, The Daubechies Wavelets Construction, Fast Wavelet Transform and Image Compression, Denoising using Wavelets, Perfect Reconstruction Filter bank design using Wavelets.

References:

1. Discrete – Time Signal Processing by A.V. Oppenheim and R. W. Schafer, with J. R. Buck (Prentice- Hall, 1998)
2. Digital Signal Processing Using MATLAB by V. K. Ingle and J. G. 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.
5. C.K.Chui, "Wavelets: A tutorial in Theory and Applications" (Academic Press).
6. R. E. Crochiere and L. R. Rabiner, *Multirate digital signal processing,* Prentice-Hall, 1983. A classic on multirate signal processing, although a bit outdated.
7. M. Vetterli and J. Kovacevic, *Wavelets and Subband Coding,* Prentice-Hall, 1995. Graduate level textbook with a unified view on wavelets and subband coding.
8. G. Strang and T. Nguyen, *Wavelets and Filter Banks,* Wellesley Cambridge Press, 1996. Nice exposition of wavelets and filter bank theory from a joint math-engineering perspective.
9. C. S. Burrus, R. A. Gopinath, and H. Guo, *Introduction to Wavelets and Wavelets Transforms,* Prentice Hall, 1997. An excellent graduate-level introduction to wavelets.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12	PSO1	PSO2	PSO3
CO1	2	3	1	2		2		2	2	3	1	2	2	2	1
CO2	1	2	2	1	2	2		2	2		2	3	3	2	2
CO3	3	2	1	3		3			1	1	1	2	3	3	2
CO4	2	2		2			1		1	2	2	1	3	3	2

Advanced microwave communication engineering Code: MCE 104

Contacts: 4-0-0

Credits: 4

Course Outcome:
After successful completion of course, students will be able to

CO1: Understand active & passive microwave devices & components used in Microwave communication systems
CO2: Explain the performance requirements of RF active circuits
CO3: Model and analyze performance RF devices and circuits.
CO4: Understand of working of microwave antennas & microwave systems
CO5: Analyze the working of microwave integrated circuits.

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

Microwave and millimeter wave devices:
- 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.

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

Antennas:
- Hertzian dipole, loop antenna, helical antenna, frequency independent antenna: Du0Hamel principle, log spiral and log periodic dipole antenna array.
- Babinet principle, waveguide slot antenna, microstrip antenna, horn antenna, parabolic reflector.
- Antenna arrays and phased array

antenna. Antenna measurement.

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.

Books

- P Bhartia & I J Bahl, *Millimeter wave engineering and Applications*, John Wiley & Sons
- David M Pozar, *Microwave Engineering*, John Wiley & Sons
- R E Collin, *Antenna & Radio wave Propagation*, McGraw Hill Book Co.

- Jordan & Balman, *Electromagnetic waves & Radiating System*
- R E Collin, *Microwave Engineering*, McGraw Hill CO.

CO-PO Mapping

CO	PO 1		PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2	1	3	1	2	3	3	3	2	3
CO2	1	2	1	2	3	1	1	1	2	1	3	2	3	3	3
CO3	2	1	3	2	1	1	3	2	3	2	3	3	3	2	2
CO4	2	2	1	2	2	2	3	2	3	1	3	1	3	2	2
CO5	1	1	1	1	1	2	3	2	3	1	3	1	3	2	2

Computer communication & networking
Code: MCE 105A

Contacts: 4-0-0

Credits: 4

Course Outcome:
After successful completion of this course, students should be able to:
CO1: Know about computer network organization and protocol implementation
CO2: Learn how securely data can be transmitted from one place to another using various protocols
CO3: Analyze some of the factors driving the need for network security, classify particular examples of attacks and physical points of vulnerability in simple networks.
CO4: Apply the benefits of latest technologies and know about modern internet services

Introduction - Motivation, goals, applications and classification of computer networks, common networks and standard organizations

Network Structure and Architecture- Network structure-concept of subnet, backbone and local access, Channel sharing techniques- FDM, TDM. Circuit and packet switching. Topological Design of a network.

Network architecture layering concept, OSI Reference Model, OSI Services and protocols Physical layer - bit communication between DTE and DCE, RS232, transmission media, modems.
Data link layer - error detection and correction, retransmission strategies, stop and wait protocol, sliding window protocols, pure Aloha protocols, slotted Aloha protocol, CSMA protocols, CSMA / CD and CSMA / CA protocol, HDLC.

LANs and their Interconnection - Basic concepts and IEEE standards, Architecture, protocol, management and performance of Ethernet, token ring and token bus LANs, WLAN, Bluetooth, LAN interconnection - repeaters and bridges, Transparent and source routing bridges and their relative advantages and disadvantages.

Network layer - basic design issues, network layer services, connection oriented and connection less services, routing – static, dynamic, stochastic, flow based routing, optimal routing, Quality of service, congestion control, Leaky Bucket Algorithm Transport layer- process to process delivery, TCP, UDP.

Internetworking- motivation, goals and strategies, Routers and gateways, TCP / IP model, IP addressing, important features of IPv6. Application layer – DNS, SMTP, FTP, HTTP, WWW
Network security -Cryptographic principle, DES, AES, RSA, Digital signature, Security in internet, VPN, Firewalls.
Network management system - SNMP.
Advance Protocol-RTP, SIP.

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

CO-PO Mapping

CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	3	2	1	2	3	1	2	3	3	3	2	3
CO2	2	3	1	2	3	1	2	1	2	1	3	3	3	3	3
CO3	2	3	3	2	2	1	3	2	3	2	3	3	3	2	2
CO4	2	2	1	2	2	2	3	2	3	1	3	1	3	2	2

Cognitive Radio
Code: MCE 105B

Contacts: 4-0-0

Credits: 4

Course Outcome:
After successful completion of this course, students should be able to:

Course Outcomes:
At the end of this course, students will be able to
CO 1: Understand the fundamental concepts of cognitive radio networks.
CO 2: Develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.
CO 3: Understand technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies.
CO 4: Analyze fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimisation techniques for better spectrum exploitation.

Syllabus Contents:
Unit 1:Introduction to Cognitive Radios: Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio.

Unit 2:Spectrum Sensing: Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models (spectrum of commons, real time secondary spectrum market).

Unit 3:Optimization Techniques of Dynamic Spectrum Allocation: Linear programming, convex programming, non-linear programming, integer programming, dynamic programming, stochastic programming.

Unit 4:Dynamic Spectrum Access and Management: Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.

Unit 5:Spectrum Trading: Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential).
Unit 6: Research Challenges in Cognitive Radio: Network layer and transport layer issues, crosslayer

design for cognitive radio networks.

References:

1. Ekram Hossain, Dusit Niyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press, 2009.
2. Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd., 2009.
3. Bruce Fette, "Cognitive radio technology", Elsevier, 2nd edition, 2009.
4. Huseyin Arslan, "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems", Springer, 2007.
5. Francisco Rodrigo Porto Cavalcanti, Soren Andersson, "Optimizing Wireless Communication Systems" Springer, 2009.
6. Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2	3	1	2	3	2	2	3	3	3	3	3
CO2	3	3	3	2	3	1	2	1	2	1	3	3	3	3	3
CO3	3	3	3	2	2	1	3	2	3	2	3	3	3	3	3
CO4	3	2	3	3	2	1	3	2	3	2	3	3	3	3	3

Statistical communication Code: MCE 105C

Contacts: 4-0-0

Credits: 4

Course Outcomes:
At the end of this course, students will be able to
CO 1: Characterize and apply probabilistic techniques in modern decision systems, such as information systems, receivers, filtering and statistical operations.
CO 2: Demonstrate mathematical modelling and problem solving using such models.
CO 3: Comparatively evolve key results developed in this course for applications to signal processing, communications systems.
CO 4: Develop frameworks based in probabilistic and stochastic themes for modelling and analysis of various systems involving functionalities in decision making, statistical inference, estimation and detection.

Syllabus Contents:
Unit 1: Review of random variables: Probability Concepts, distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Vector quantization, Tchebaychef inequality theorem, Central Limit theorem, Discrete &Continuous Random Variables. Random process: Expectations, Moments,Ergodicity, Discrete-Time Random Processes Stationary process, autocorrelation and auto covariance functions, Spectral representation of random signals, Properties of power spectral density, Gaussian Process and White noise process.

Unit 2: Random signal modelling: MA(q), AR(p), ARMA(p,q) models, Hidden Markov Model & its applications ,Linear System with random input , Forward and Backward Predictions, Levinson Durbin Algorithm.

Unit 3: Statistical Decision Theory: Bayes' Criterion, Binary Hypothesis Testing, M-ary
Hypothesis Testing, Minimax Criterion, Neyman-Pearson Criterion, Composite Hypothesis Testing. Parameter Estimation Theory: Maximum Likelihood Estimation, Generalized Likelihood Ratio Test ,Some Criteria for Good Estimators, Bayes' Estimation Minimum Mean-Square Error
Estimate, Minimum, Mean Absolute Value of Error Estimate Maximum A Posteriori Estimate , Multiple Parameter Estimation Best Linear Unbiased Estimator ,Least-Square Estimation Recursive Least-Square Estimator.

Unit 4: Spectral analysis: Estimated autocorrelation function, Periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Parametric method, AR(p) spectral estimation and detection of Harmonic signals.

Unit 5:Information Theory and Source Coding: Introduction, Uncertainty, Information and Entropy, Source coding theorem, Huffman, Shanon Fano , Arithmetic , Adaptive coding , RLE , LZW Data compaction, , LZ-77, LZ-78. Discrete Memory less channels, Mutual information,channel capacity, Channel coding theorem, Differential entropy and mutual information for continuous ensembles.

Unit 6:Application of Information Theory: Group, Ring & Field, Vector, GF addition, multiplication rules. Introduction to BCH codes, Primitive elements

,Minimal polynomials, Generator polynomials in terms of Minimal polynomials, Some examples of BCH codes,& Decoder, Reed- Solomon codes & Decoder, Implementation of Reed Solomon encoders and decoders.

References:

1. Papoulis and S.U. Pillai, "Probability, Random Variables and Stochastic Processes",4th Edition, McGraw-Hill, 2002.
2. D.G. Manolakis, V.K. Ingle and S.M. Kogon, "Statistical and Adaptive Signal Processing", McGraw Hill, 2000.
3. Mourad Barkat , "Signal Detection and Estimation", Artech House, 2nd Edition, 2005.
4. R G. Gallager, "Information theory and reliable communication", Wiley, 1st edition, 1968.
5. F. J. MacWilliams and N. J. A. Sloane, "The Theory of Error-Correcting Codes", New York, North-Holland, 1977.
6. Rosen K.H, "Elementary Number Theory", Addison-Wesley, 6th edition, 2010.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	2	2	3	2	2	1	3	2	2	2
CO2	3	2	3	2	3	2	2	1	2	1	3	3	2	3	2
CO3	3	3	2	2	2	1	3		2	2	3	1	2	3	2
CO4	3	3	3	2	2	2	3	2	2	2	3	3	2	2	3

Wireless Sensor Networks
Code: MCE 105D

Contacts: 4-0-0

Credits: 4

Course Outcomes:
At the end of this course, students will be able to

CO 1: Design wireless sensor network system for different applications under consideration.
CO 2: Understand the hardware details of different types of sensors and select right type of sensor for various applications.
CO 3: Understand radio standards and communication protocols to be used for wireless sensor network based systems and application.
CO 4: Use operating systems and programming languages for wireless sensor nodes, performance of wireless sensor networks systems and platforms.
CO 5: Handle special issues related to sensors like energy conservation and security challenges.

Syllabus Contents:
Unit 1:Introduction and overview of sensor network architecture and its applications, sensor network comparison with Ad Hoc Networks, Sensor node architecture with hardware and software details.
Unit 2:Hardware: Examples like mica2, micaZ, telosB, cricket, Imote2, tmote, btnode, and SunSPOT, Software (Operating Systems): tinyOS, MANTIS, Contiki, and RetOS.
Unit 3:Programming tools: C, nesC. Performance comparison of wireless sensor networks simulation and experimental platforms like open source (ns-2) and commercial (QualNet, Opnet)
Unit 4:Overview of sensor network protocols (details of atleast 2 important protocol per layer):Physical, MAC and routing/ Network layer protocols, node discovery protocols, multi-hop and cluster based protocols, Fundamentals of 802.15.4, Bluetooth, BLE (Bluetooth low energy), UWB.
Unit 5:Data dissemination and processing; differences compared with other database management systems, data storage; query processing.
Unit 6: Specialized features: Energy preservation and efficiency; security challenges; fault tolerance, Issues related to Localization, connectivity and topology, Sensor deployment mechanisms; coverage issues; sensor Web; sensor Grid, Open issues for future research, and Enabling technologies in wireless sensor network.

References:

H. Karl and A. Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, India, 2012.
C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors, "Wireless Sensor Networks", Springer Verlag, 1st Indian reprint, 2010.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	2	2	3	2	2		3	2	2	2
CO2	3	2	2	2	3	2	3	1	2	1	3	3	3	3	2
CO3	3	2	2	2	2	1	3		2	2	3		3	2	3
CO4	3	3	3	3	3	2	3	2	2	2	3	3	3	3	3
CO5	3	3	2	2	2	2	3	2	2	2	3	3	3	2	3

Remote sensing techniques & applications. Code: MCE 105E

Contacts: 4-0-0

Credits: 4

Course Outcome:
After successful completion of this course, students should be able to:

CO 1: Defining the mechanism of Remote sensing.
CO 2: Analyze working principle of various remote sensors.
CO 3: Design remote sensors for real life problems.
CO 4: Understand the interactions of radiation with the earth's water surface and atmosphere.

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

Variation of the earth's reflectivity with angle of incidence, wavelength and geographical location; Seasonal variation of reflectivity; Solar radiation reflected from the earth; Absorption of solar radiation by the earth; Thermal radiation from the earth; Thermal radiation from the atmospheric constituents; Thermal emission from cloud, rain, snow and fog; Radio noise and interference at satellite heights.

Sensors and Cameras: Optical and infrared detectors and filters, Optical and infrared cameras; Microwave and Millimetrewave radiometers; Scanning systems, Mechanical and Electronic systems; Scatterometer; Altimeter.

Remote Sensing Satellites: Orbits of remote sensing satellites; Remote sensing satellites – LANDSAT; Indian Remote Sensing (IRS) Satellites; INSAT, NOAA Series; NASA's Upper Atmosphere Research Satellites (UARS); TRMM satellite.

Remote Sensing of Atmosphere and Sea State: Passive and active remote sensing; Side Looking Airborne Radar (SLAR); Synthetic Aperture Radar (SAR); Along Track Scanning Radiometer
(ATSR), Laboratory measurements of remote sensing parameters; Tropical rainfall measurements; Microwave sensing of sea surface.

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

Computer interpretation of images.

Text & Reference Books:

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	2	2	3	2	2		3	2	2	3

CO2	2	2	1	1	3	2	2	1	2	1	3	3	3	3	3
CO3	3	2	2	2	2	1	3		2	2	3		3	3	2
CO4	2	3	2	2	2	2	3	2	2	2	3	3	2	3	2

Advanced communication Lab
Code: MCE 191

Contacts: 0-0-3

Credits: 2

Course Outcomes
On completion of the course students will be able to
CO 1: Understand the concept of advanced communication techniques and their applications.
CO 2 Demonstrate the practical methods of the use of generating communication signals.
CO 3 Evaluate practical methods of the use of demodulation communication signals.
CO 4 Develop insight into the relations between the input and output signals in various stages of a transmitter and a receiver.
CO 5: Clearly distinguish between contemporary advanced communication techniques.

Suggested topics are (not exclusive),

1. Detailed receiver and transmitter parameters of a typical radio communication system – SINAD, fidelity, image rejection, modulation sensitivity, transmission bandwidth etc.
2. Data communication through fiber optic link – losses, power budget, stability etc.
3. Sampling, quantization, coding – sampling rate, quantization error, signal bandwidth etc.
4. QPSK, MPSK – signal bandwidth, distinguishability, effect of noise etc.
5. Binary symmetric channel – noise & P_e etc.
6. PC2PC communication – protocol standards, frame/ packet/ UDP structure etc.
7. Multiple channel DSSS – spreading, dispreading, decoding etc.
8. Important characteristics of different types of transmission lines.
9. Impedance measurement of microwave window applying Smith chart.
10. Microwave phase shifter – calibration.
11. Measurement of dielectric constants – solids & liquids.
12. Horn, microstrip antenna – radiation pattern, gain etc.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	2	2	3	2	2		3	2	2	3
CO2	2	2	1	1	3	2	2	1	2	1	3	3	3	3	3
CO3	3	2	2	2	2	1	3		2	2	3		3	3	2
CO4	2	3	2	2	2	2	3	2	1	2	3	3	2	3	2
CO 5	3	2	1	2	2	2	3		2	1	3	3	2	3	2

Lab II: Design and Simulation Lab Code: MCE 192

Contacts: 0-0-3

Credits: 2

Course Outcomes
On completion of the course students will be able to

CO1:Demonstrate a sound technical knowledge of their selected project topic.
CO2: Undertake problem identification, formulation and solution.

CO3: Design engineering solutions to complex problems utilising a systems approach.
CO4: Conduct an engineering project.
CO5: Demonstrate the knowledge, skills and attitudes of a professional engineer.

Designing graphical user interfaced models of various communication systems/ subsystems with the help of suitable advanced software e.g. MATLAB/ LABVIEW/ NS/ PUFF/ IE3D/ ANSOFT/ HFSS/ CST/ QUALNET/ MICROWAVE OFFICE etc. for detail study of their operating principle and their performance vis-à-vis practical limitations like, channel bandwidth, noise, attenuation etc.
Suggested topics are (not exclusive),

1. ADPCM – granular noise & quantization noise.
2. MPSK – signal bandwidth, PSD, distinguishability, scatter plot etc.
3. Digital filters – ripples in pass band & stop band, slope in transition band, poles & zeros etc.
4. Optimum filters for receiving base band random binary data – P_e vs. S/N.
5. Signal bandwidth and P_e vs. S/N in different modes of line coding.
6. Signal bandwidth and P_e vs. S/N in different modes of modulation.
7. Error rates in error control for different types of error control coding.
8. Throughput vs. input density in different MAC protocols.
9. DSSS – error rate due to different types of chip code.
10. Fading channel/ multipath transmission and Rake receiver.
11. Cellular architecture, WiFi, WiMAX using QUALNET.
12. OFDM using QUALNET.
13. Different routing algorithms & protocols.
14. Characterization of micro strip antenna.
15. Characterization of transmission lines.
16. Study of important parameters and practical considerations in microwave circuits.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	2	2	3		2		3	3	3	3
CO2	3	3	2	1	3	2	2	1	2	1	1	3	3	3	3
CO3	3	2	2	3		1	3		2	2	1		3	3	3
CO4	3	3	2	2	2	2	3	2	1	2	1	3	3	3	3
CO 5	3	2	1	2	2	2	3		2	1	1	3	3	3	3

Lab II: Seminar I
Code: MCE183

Course Outcomes
On completion of the course students will be able to

CO1:Demonstrate a sound technical knowledge of their selected project topic.
CO2: Undertake problem identification, formulation and solution.
CO3: Design engineering solutions to complex problems utilising a systems approach.
CO4: Conduct an engineering project.
CO5: Demonstrate the knowledge, skills and attitudes of a professional engineer.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2	1	2	2	3		2		3	3	3	3

CO2	2	3	2	1	3	2	2	1	2	1	1	3	3	3	3
CO3	2	2	2	3		1	3		2	2	1		1	2	2
CO4	3	3	2	2	2	2	3	2	1	2	1	3	2	1	1
CO 5	3	2	1	2	2	2	3		2	1	1	2	3	2	2

Second Semester

Photonics and Optical Communication Code: MCE 201

Contacts: 4-0-0

Credits: 4

Course Outcomes

On completion of the course students will be able to

CO 1: Understand structure of Optical fiber, its types and propagation mechanism.
CO 2: Discuss the channel impairments like losses and dispersion.
CO 3: Classify and analyze the Optical sources and detectors along with their principle.
CO 4: Analyze characteristics of optical fiber, sources and detectors
CO 5: Study optical networks and their recent applications

Photonics:

- Introduction to Photonic materials and Photonic Devices.
- Optical waveguides.
- Optical fibers - application specific optical fibres, Photonic Bandgap Optical Fibers.
- Coupling of waves and modes
- Optical couplers;
- Fibre.Bragg gratings
- Electro-optic devices
- Semiconductor lasers and light-emitting diodes
- Photodetectors
- fibre lasers
- Optical Amplifiers,
- Fiber Raman Amplifiers,
- Semiconductor laser amplifiers,
- Doped–fiber amplifiers

Optical Communication:

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

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.

Optical Networks:

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

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	2	2	3	2	2		3	2	2	3
CO2	3	3	1	1	2	3	2	1	2	1	3	3	3	3	3
CO3	3	3	1	2	2	3	3		2	2	2		3	3	2
CO4	3	3	3	2	2	2	3	2	1	2	3	3	2	3	2
CO 5	3	2	3	2	2	3	3		2	1	2	3	2	3	2

Error control coding Code: MCE 202

Contacts: 4-0-0

Credits: 4

Course Outcomes

On completion of the course students will be able to

CO1: Understand role of random process in statistical signal processing
CO2: Understand signal modeling techniques
CO3: Comprehend the role of Binary Symmetric Channels
CO4: Understand the theory of hypothesis testing
CO5: Comprehend various digital filter design approaches

- **Introduction: Brief** description of a digital communication system, Cause of errors and need for error control coding, broad classes of error and classes of error correcting codes, general expression of the probability of error in a binary symmetric Gaussian channel, Principle of maximum likelihood decoding.

Linear 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). Irreducible polynomials, primitive polynomials.
- Vector space, sub space, dual space – their properties and interrelations.
- Numerical exercises with manual computation and by using MATLAB.

Linear block code:

- Definition of linear block code.
- Generator matrix, properties of generator matrix.
- Parity check matrix and its properties.
- 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.

Hamming code:

- Construction, error detection and correction capabilities.

Error detection/ correction performance of block codes

- Distance properties of block codes and their dual codes, concept of distance space and decoding sphere.
- Effect of code rate on random bit error probability.
- Probability of undetected word error, uncorrected word error and residual bit error.
- Simulation test of above for data transmission through Gaussian binary symmetric channel.

Cyclic code:

- Definition, generator polynomial, properties of cyclic code and generator polynomial.
- Generator matrix, parity check matrix, their properties and interrelations.
- Design and operation of encoder.
- Design and operation of syndrome circuit.
- Design & operation of Meggitt decoder.
- Simulation test of above for data transmission through Gaussian binary symmetric channel.
- Cyclic Hamming code.

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, encoding, parity check matrix, error trapping and decoding.

Reed-Solomon code:

- Brief qualitative discussion.

Convolutional code:

- Definition, encoder, generator sequences, generator matrix, principle of constructing code words, numerical 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.
- Simulation test of above for data transmission through Gaussian binary symmetric channel.
- Distance properties of convolutional codes.

- Multiple error/ Burst error correcting codes:
  - Shortened cyclic code, Hadamard code, Golay code, brief qualitative description of Kasami decoder.

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.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	2	1	2	2	3	2	2		3	2	2	2
CO2	3	3	3	1		3	2	1	2	1	3	3	2	2	2
CO3	3	3	3	2	2	3	2		2	2	2		2	2	2
CO4	3	3	3	1	2	2		2	1	2	3	3	2	2	2

CO 5	3	2	2	2	2	3	2		2	1	2	3	2	2	2

Mobile communication Code: MCE 203

Contacts: 4-0-0

Credits: 4

Course Outcomes
On completion of the course students will be able to

CO 1. Design appropriate mobile communication systems.
CO 2. Apply frequency-reuse concept in mobile communications, and to analyze its effects on interference, system capacity, handoff techniques
CO 3. Distinguish various multiple-access techniques for mobile communications e.g. FDMA, TDMA, CDMA, and their advantages and disadvantages.
CO 4. Analyze path loss and interference for wireless telephony and their influences on a mobile communication system's performance.
CO 5. Analyze and design CDMA system functioning with knowledge of forward and reverse channel details, advantages and disadvantages of using the technology
CO 6. Understanding upcoming technologies like 3G, 4G etc.

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, SCSD, 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.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	2	2	3	2	2		3	2	2	2

CO2	3	2	3	1		3	2	1	2	1		3	2	2	2
CO3	3	3	2	2	2	2	2		2	2	2		2	2	2
CO4	2	3		1	2	2		2		2	3	3	2	2	2
CO 5	3	3	2	2	2	3	2		2	1	2	3	2	2	2
CO 6	2	2	3	2	1	2	1		2	2	2	1	2	2	2

Cryptography & network security Code: MCE 204A

Contacts: 4-0-0

Credits: 4

Course Outcomes
On completion of the course students will be able to

CO1 Understand basic fundamentals of cryptography.
CO2 Realize functions and algorithms of cryptography.
CO3 Analyze and transmit data securely from one place to another using ciphers.
CO4 Understand and evaluate the advantages and challenges of network security applications.

Introduction: Principles of security, Overview of network security and cryptography, OSI Security architecture, model for network security, classification of attacks (Reply, Reflection, Man – in – the – middle), Virus, Worm, Trojan Horse, Spam etc.

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

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

Hash Algorithms: MD5 Message Digest Algorithm, Secure Hash Algorithm, Digital Signature Algorithm, Digital Signature Standard.

Network Security Applications: Authentication Applications (Kerberos), Electronic Mail Security (SMIME), IP Security (IPSec), Web Security (SSL and TLS), E – cash and Secure Electronic Transaction (SET), System security using Firewalls and VPNs.

Advance Applications of Network Security: Smart cards and security, Enterprise Application Security, Biometric Authentication, Database Access Control, Security and Privacy Issues in RFIDs.

Text and Reference Books:

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

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	2	1	2	2	3		2		3	2	3	2
CO2	3	3	3	1		3	3	1	2	2		3	2	2	3

CO3	3	3	2	2	2	2	2		2	2	2		3	2	2
CO4	2	3	2	2		2		2		2	3	3	2	3	3

Artificial intelligence & soft computing Code: MCE 204B

Contacts: 4-0-0

Credits: 4

Course Outcomes
On completion of the course students will be able to

CO 1: Demonstrate fundamental understanding of artificial intelligence (AI) and expert systems.
CO 2: Demonstrate and enrich knowledge to select and apply AI tools to synthesize information and develop models within constraints of application area
CO 3: Develop application on different soft computing techniques like Fuzzy, GA and Neural network
CO 4: Implement Neuro-Fuzzy and Neuro-Fuzz-GA expert system.

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.Elaine Rich, Kevin Knight, Artificial Intelligence, TMH.
3. Eugene Charnaik, Drew McDermott, Introduction to Artificial Intelligence, Pearson Education Asia.
4. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education.
5. A. Konar, Artificial Intelligence and Soft Computing.
6. Anil K. Jain and R.C.Dubes, Algorithms for Clustering Data, Prentice Hall
7. S. Theodoridis and K. Koutroumbus, Pattern Recognition, Elsevier
8. D. E. Goldberg, Genetic Algorithms in search, Optimization & Machine Learning, Pearson Education

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	2	2	1	1	2	1	3	3	3	3
CO2	2	3	2	2	2	3	3	1	2	2	1	3	3	3	3

CO3	3	3	3	2	2	2	1	1	2	2	1	1	3	3	3
CO4	3	3	3	2	1	2	2	1	1	2	3	3	3	3	3

Internet of Things
Code: MCE 204C

Contacts: 4-0-0

Credits: 4

Course Outcomes
On completion of the course students will be able to

At the end of this course, students will be able to:
CO 1: Understand what IOT technologies are used for today and what is required in certain scenarios.
CO 2: Understand the types of technologies that are available and in use today and can be utilized to implement IOT solutions.
CO 3: Apply these technologies to tackle scenarios in teams of using an experimental platform for implementing prototypes and testing them as running applications.

Unit 1
Smart cities and IOT revolution, Fractal cities, From IT to IOT, M2M and peer networking concepts, Ipv4 and IPV6.
Unit 2
Software Defined Networks SDN, From Cloud to Fog and MIST networking for IOT communications, Principles of Edge/P2P networking, Protocols to support IOT communications, modular design and abstraction, security and privacy in fog.
Unit 3
Wireless sensor networks: introduction, IOT networks (PAN, LAN and WAN), Edge resource pooling and caching, client side control and configuration.
Unit 4
Smart objects as building blocks for IOT, Open source hardware and Embedded systems platforms for IOT, Edge/gateway, IO drivers, C Programming, multithreading concepts.
Unit 5
Operating systems requirement of IOT environment, study of mbed, RIOT, and Contiki operating systems, introductory concepts of big data for IOT applications.
Unit 6
Applications of IOT, Connected cars IOT Transportation, Smart Grid and Healthcare sectors using IOT, Security and legal considerations, IT Act 2000 and scope for IOT legislation.

Learning Recourses:
1. A Bahaga, V. Madisetti, "Internet of Things- Hands on approach", VPT publisher, 2014.
2. A. McEwen, H. Cassimally, "Designing the Internet of Things", Wiley, 2013.
3. CunoPfister, "Getting started with Internet of Things", Maker Media, 1st edition, 2011.
4. Samuel Greenguard, "Internet of things", MIT Press, 2015.

Web Recourses:
1. http://www.datamation.com/open-source/35-open-source-tools-for-the-internet-ofthings1. html
2. https://developer.mbed.org/handbook/AnalogIn
3. http://www.libelium.com/50_sensor_applications/
4. M2MLabs Mainspring http://www.m2mlabs.com/framework
5. Node-RED http://nodered.org/

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	2	2	1	1	2	3	3	3	3	3
CO2	3	3	3	2	3	3	3	2	2	2	1	3	3	3	3
CO3	3	3	3	3	2	2	1	2	2	2	3	1	3	3	3

Microwave measurement Techniques Code: MCE 204D

Contacts: 4-0-0

Credits: 4

Course Outcomes
On completion of the course students will be able to

CO 1: Understand different types of microwave measurement system
CO 2: Analyze microwave networks and measure their measurements parameters.
CO 3: Explain the working of various microwave devices
CO 4: Identify the modern day applications of microwaves

a) **Introduction to Radio Frequency & Microwave Measurements-** Introduction Radio Frequency Band, microwave and millimeter wave.
b) **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.
c) **Impedance Measurement-** Measurement of unknown load impedance of a transmission line, Slotted Line Technique to measure unknown impedance.
d) **Distortion & Frequency Translation Measurement-** Different types of distortion occurred at microwave frequencies, Procedures for frequency translation.
e) **Detectors& Sensors:** Definition of Detectors; Different type of microwave detectors functions and applications, Sensors Definition & working principle, applications.
f) **Vector Network Analyzer (VNA):** Concept of vector network analyzer, measurement of Scattering parameters, Basic block diagram of vector network analyzer (VNA), Application of vector network analyzers.
g) **Scalar Network Analyzer (SNA):** Definition of network analyzer, Difference between SNA&VNA, Basic block diagram Scalar Network Analyzer.
h) **Spectrum Analyzer:** Basic block diagram of a spectrum analyzer, functions & applications of a spectrum analyzer.
i) **Time Domain Electrometer (TDR) & IC Technology:** Introduction to Electrometer, Measurement of reflection coefficient using electrometer technique, Basic block diagram of a time domain electrometer.

Recommended Books:

1. G.H.Bryant- Principles of Microwave Measurements- Peter Peregrinus Ltd.
2. D.Pozar- Microwave Engineering, 2nd Ed, John Wiley
3. T.S.Laverghetta- Hand book on Microwave Testing
4. S.F.Adam- Microwave Theory & Application- Prentice Hall, Inc
5. HP Application Notes
6. A.E. Bailey, Ed. Microwave Measurements- Peter Peregrinus Ltd
7. M. Engelson-Moder Spectrum Analyser: Theory & Applications Artech Hous

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	2	2	1	1	2	3	3	3	3	3

CO2	3	3	3	2	2	3	3	2	2	2	1	3	3	3	3
CO3	3	2	2	2	2	1	1	2	2	2	3	1	2	3	3
CO4	3	2	1	2	1	2	2	1	1	2	3	3	3	3	3

Satellite communication Code: MCE 205A

Contacts: 4-0-0

Credits: 4

Course Outcomes
On completion of the course students will be able to

CO 1: Learn the fundamental concepts for satellite communication.
CO 2: Design and study uplink and downlink communication system
CO 3: Analyze channels and study of propagation effects
CO 4: Study of mobile satellite networks and related parameters

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.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

CO1	3	3	3	2	1	2	2	1	1	2	3	3	3	3	3
CO2	2	3	2	2	2	2	3	2	2	2	1	2	2	3	3
CO3	2	2	3	2	2	2	1	3	2	2	3	1	3	2	3
CO4	3	2	1	3	2	2	2	1	1	2	3	3	3	3	3

Image processing & pattern recognition Code: MCE 205B

Contacts: 4-0-0

Credits: 4

Course Outcome:
After completion of the course students will be able to
CO1: Understand the basics of image processing and pattern recognition.
CO2: Able to apply different image processing methodologies.
CO3: Understand the importance of feature selection and generation.
CO4: Able to apply classification and clustering algorithms.

Objective: Students will have an idea about basic image processing in spatial domain/ image space, extraction of pixel-patterns from an image and construction of different feature spaces, application of pattern clustering and classification techniques to analyze/ recognize an image. Some hints on advance and more recent research topics like *change detection in remotely sensed imagery, Eigen face recognition, image miming, content based image retrieval* will also be provided.	
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.	
Part – A : Image Processing	6 L
Basics: Image definition, a simple image formation model, basic concepts of image sampling and quantization, representing a digital image, concept of pixel/ pel, spatial and gray level resolution, some basic relationships between pixels : Neighbors of a pixel, Adjacency, Connectivity, Path, Connected component, Connected component labeling. Distance measures: the three essential properties, Euclidean, City-Block and Chess-Board distance, concept of image operations on a pixel basis.	6 L
Popular image processing methodologies: Spatial domain technique : contrast stretching, basic point processing, thresholding function, concept of mask/ sub image, mask processing/ filtering, gray-level slicing, bit-plane slicing. Basics of spatial filtering : convolution mask/kernel, concept of sliding mask throughout the image-space, smoothing(averaging) filter/ low pass filter. Image segmentation by global and local gray level thresholding, region growing, region splitting and merging techniques. Morphological algorithms: thinning, thickening, skeletons.	8 L
Color image processing: Perception of color: color fundamentals. Two popular color models: RGB & HSI, concept of RGB & HSI space and their conceptual relationships, mathematical conversion from RGB to HSI space and vice versa.	2 L
Part – B : Pattern Recognition	
Basics of pattern recognition: Concept of a pattern: feature, feature vectors and classifiers. Importance of pattern recognition. Basic concept of fuzzy pattern recognition, linearly separable and inseparable classes, classes with some overlapping regions, convex and non-convex paradigm in this aspect.	2 L

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.	8 L
Classification and prediction: Definition of classification and prediction. Basic task of a classifier. Concept of training & testing data and overfitting. Bayes classification: Bayes' Theorem, Naïve Bayesian classification. Classification by Backpropagation: Multilayer Perceptron (MLP) neural network and Backpropagation algorithm.	6 L
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.	4 L
Part – C : Image analysis	
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	2 L
square-shaped local window (3x3 or 5x5 or like that) as the second feature, construction of high-dimensional feature space: e.g. treating all the pixel-gray-values of a local window as features (i.e. for 3x3 window 9-dimensional feature space will result). Application of partitional clusterings in the above mentioned feature-space to recognize the objects in the concerned image.	
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*.	2 L
Image mining: Need, Image search and retrieval. Bottleneck of Text based image mining/ retrieval, Visual feature based image mining: Content-based image retrieval (CBIR).	2 L
Image based face recognition: Basic technique for Eigen face generation & recognition.	
Intended outcomes: After completion of the course students will be able to analyze about the spatial image processing (in image space) and superiority of image pattern recognition. They will also get the idea about how to deal in an environment with high vagueness and/or ill-fashioned classes (or objects in some image) using fuzzy concept (fuzzy pattern recognition), function of basic and multilayer perceptron model to classify a data set. Some optimization processes (e.g. GA) to enhance the chance to reach a global optimum. Research and development kind of analyses should be realized by them concerning the recent trends in this aspect.	2 L

Text and Reference 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.
6. S. Theodoridis and K. Koutroumbus, *Pattern Recognition*, Elsevier.
7. A. Ghosh, S. Dehuri, and S. Ghosh (editors). *Multi-Objective Evolutionary*
8. *Algorithms for Knowledge Discovery from Databases*. Springer, Berlin, 9.
   2008.
10. Anil K. Jain, *Fundamentals of Digital Picture Processing*, Prentice Hall.
11. D. E. Goldberg, *Genetic Algorithms in search, Optimization & Machine Learning*, Pearson
12. Education.
13. 9. *Remote Sensing Digital Image Analysis : An Introduction* by J.A Richards and X. Jia. Springer.
14. *Data Clustering: A Review* by Anil K. Jain, ACM Comput. Surv., Vol. 31, No. 3. (September 1999), pp. 264-323.
15. Pattern Recognition: The Journal of the Pattern Recognition Society.
16. *IEEE* Transactions on (i) Pattern Analysis and Machine Intelligence (TPAMI), (ii) on *Neural* Networks, (iii) on *Fuzzy* Systems.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	2	1	2	2	1	1	2	3	3	3	3	2
CO2	3	3	2	2	2	1	3	2	2	2	1	3	3	1	3
CO3	2	2	1	2	2	2	1	2	2	2	3	1	3	3	2
CO4	3	2	2	3	2	2	2	1	1	2	3	1	3	2	2

MIMO System
Code: MCE 205C

Contacts: 4-0-0

Credits: 4

Course Outcomes:
At the end of this course, students will be able to:
CO 1. Understand channel modeling and propagation, MIMO Capacity, space-time coding, MIMO receivers, MIMO for multi-carrier systems (e.g. MIMO-OFDM), multi-user communications, multi-user MIMO.
CO 2. Understand cooperative and coordinated multi-cell MIMO, introduction to MIMO in 4G (LTE, LTE-Advanced, WiMAX).
CO 3 Perform Mathematical modeling and analysis of MIMO systems.

Course Outline:
Unit 1
Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multiantenna systems.
Unit 2
Diversity, Exploiting multipath diversity, Transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receive diversity, The rake receiver, Combining techniques, Spatial Multiplexing, Spectral efficiency and capacity, Transmitting independent streams in parallel, Mathematical notation.
Unit 3
The generic MIMO problem, Singular Value Decomposition, Eigenvalues and eigenvectors, Equalising MIMO systems, Disadvantages of equalising MIMO systems, Predistortion in MIMO systems, Disadvantages of pre-distortion in MIMO systems, Pre-coding and combining in MIMO systems, Advantages of pre-coding and combining, Disadvantages of precoding and combining, Channel state information.
Unit 4
Codebooks for MIMO, Beam forming, Beam forming principles, increased spectrum efficiency, Interference cancellation, Switched beam former, Adaptive beam former, Narrowband beam former, Wideband beam former.
Unit 5
Case study: MIMO in LTE, Code words to layers mapping, Pre-coding for spatial multiplexing, Pre-coding for transmit diversity, Beam forming in LTE, Cyclic delay diversity based pre-coding, Pre-coding codebooks, Propagation Channels, Time & frequency channel dispersion, AWGN and multipath propagation channels, Delay spread values and time variations, Fast and slow fading environments, Complex baseband multipath channels, Narrowband and wideband channels, MIMO channel models.

Unit 6
Channel Estimation, Channel estimation techniques, Estimation and tracking, Training based channel estimation, Blind channel estimation, Channel estimation architectures, Iterative channel estimation, MMSE channel estimation, Correlative channel sounding, Channel estimation in single carrier systems, Channel estimation for CDMA, Channel estimation for OFDM.

Learning Resources:
1. Claude Oestges, Bruno Clerckx, "MIMO Wireless Communications: From Real-world Propagation to Space-time Code Design",Academic Press, 1st edition, 2010.
2. Mohinder Janakiraman, “Space - Time Codes and MIMO Systems”, Artech House Publishers, 2004.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	2	2	1	1	2	3	2	3	3	1
CO2	2	3	3	2	2	3	3	2	2	1	1	3	2	3	3
CO3	2	2	1	2	2	2	1	2	2	2	3	1	3	1	2

Advanced antenna and wave propagation Code: MCE 205D

Contacts: 4-0-0

Credits: 4

Course Outcome:
After completion of the course students will be able to

CO1: Understand the transmission lines which play an important role in high- speed digital design and signal integrity of PCBs
CO2: Study the fundamentals of antenna theory and wave propagation mechanism.
CO3: Analyze different types of antennas and the radiation mechanism.
CO4: Analyzing and experimenting the atmospheric and terrestrial effects on radio wave propagation.

Antenna:

- Wire antennas, Aperture Antennas, Antenna gain, Antenna Temperature and other Antenna parameters.
- Relationships between antenna parameters. Reciprocity, Review of microwave antennas-Parabolic Reflector, Cassigrain feeds, Horn Antennas, Open-ended wave guides, lens antennas, Dielectric rod Antennas, Antennas for mobile communication. Applications of reaction concept and vocational principles in antennas and propagation, Frequency- independent antennas, Scattering and diffraction. Selected topics in microwave antennas, Internal-equation methods, current distribution: Self and mutual impedances: arrays: design and synthesis.
- Full wave analysis of Microstrip Antenna(MSA),Active Integrated MSA, Compact MSA with enhanced gain, Broadband Antenna(MSA), Dual frequency & Dual polarized MSA
- Application of broadcasting, microwave links, satellite communication and radio astronomy.
- Antenna Measurements
- Standardization and characterization of antennas, Anechoic Chamber, Open-air test range.

Propagation:

- Review of modes of propagation: Surface wave, Ground wave, Sky wave, Space wave, Troposphere propagation.
- Propagation over plane-Earth, Spherical Earth, Refraction, Anomalous Propagation, Diffraction, Modified refractive index- Its effects on wave propagation, Duct and other nonstandard propagation. Environmental noise, EMI - EMC, Radiation Hazards.
- Microwave & millimeter wave propagation, Effects on atmospheric precipitations: Rain, Fog, Snow, Ice, and other atmospheric gases.
- Low frequency propagation, Propagation through seawater, Sea clutter, Land clutter, Surface clutter, Radar equation,
- Microwave link considerations- multi-path Fading, its characteristics- Techniques for more link availability
- Earth space systems

Text & Reference Books:

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

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2	1	2	2	1	1	2	3	3	3	3	2
CO2	3	3	3	2	2	1	3	2	2	2	1	3	2	3	2
CO3	2	2	3	2	2	2	1	2	2	2	3	1	2	2	1
CO4	2	2	2	2	2	2	2	1	1	2	2	2	3	3	2

Communication systems Lab Code: MCE 291

Contacts: 0-0-3

Credits: 2

Course Outcome:
After completion of the course students will be able to
CO 1: Acquire an overall knowledge about the system architecture
CO 2: The important of system architecture in GOS parameters and its detail working principle.
CO 3: Provide skills for modeling and simulation of communication systems & networks on MatLab platform.
CO 4: To provide skills for writing MatLab programs and use communication and signal processing toolboxes.

Experiments on complete systems to acquire an overall knowledge about the Suggested topics are (not exclusive),

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

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	2	1	2	2	1	1	2	3	3	2	3	3
CO2	3	3	2	2	2	2	3	1	2	2	1	3	3	2	3
CO3	2	1	3	2	1	2	1	2	2	2	3	1	3	3	2
CO4	2	2	2	3	2	2	2	1	1	2	2	3	2	3	2

Third Semester

PROJECT DEVELOPMENT AND RESOURCE MANAGEMENT
Code: MCE 301
Contacts: 4-0-0
Credits: 4

Course Outcome:
After completion of the course students will be able to

CO 1: Describe a project life cycle, and can skillfully map each stage in the cycle.
CO 2: Identify the resources needed for each stage, including involved stakeholders, tools and supplementary materials
CO 3: Describe the time needed to successfully complete a project, considering factors such as task dependencies and task lengths
CO 4: Develop a project scope while considering factors such as customer requirements and internal/external goals

MODULE 1: **11L**

Research Methodology and Techniques:
Meaning of Research: Objective, Motivation and Types of research; Research Process: Its representation through flow chart; Sample Designing: Different types of sample designing; Testing of hypothesis; Chi-square test: A statistical measure of sampling analysis. 5L

Data collection and storing through Database Management Systems ; Concept of Data Warehouses and Data Marts; Concept of Multidimensional analysis of project data; Different types of statistical analysis through SQL. 6L

MODULE 2: **8L**

Agreement on Trade-Related aspects of Intellectual Property Rights (TRIPS): What is Intellectual Property, Importance of IPR, Patent, Types of Patents, Patentable inventions, Application and Registration of patents, Who can apply, rights and duties of patentee, infringement and remedies. 5L

R&D activities in educational institutes, IPR and patent issues. 3L

MODULE 3: **15L**

Management: Definition, Functions, Skills, Motivational Theories, Communication: Types, Nature, Importance, Channel richness, how to increase the effectiveness of organizational communication. 3L

Quality: Concept, Deciphering quality aspect of different products and services; Quality improvement; identification of potential areas. 3L

Basics of project management: Concept, Types, Productivity, Effectiveness& Competitiveness: Lifecycle of process, Feasibility, Viability, Cost- Benefit analysis, PERT and CPM, SWOT analysis, Resource smoothing and Resource Leveling through Critical Path Analysis (CPA), Simulation. 6L

Cost classification: Fixed cost, variable cost, semi-variable cost; Cost of Capital, Capital Budgeting, Budgeting; Master budget; Concept of Taxes: Direct Tax and Indirect Tax. 3L

MODULE 4: **6L**

Project Management – A case study.

Application and techniques described in Module 1.Implementation Phase, Human aspects, Time estimation,

Text Book:

1. Management of Technology, Tarek M.Khalil, McGraw Hill, 2000
2. Financial Management,Text,Problems and Cases, M Y Khan & P.K.Jain, McGraw Hill
3. Financial Management: Principles And Applications, 10/e, Keown,Pearson Education India

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	2	2	1	1	2	3	3	2	3	3
CO2	3	3	3	3	2	2	3	1	2	2	1	3	3	2	3
CO3	3	3	3	3	1	2	1	3	2	2	3	1	3	3	3
CO4	3	3	3	3	2	2	2	1	1	2	2	3	2	3	3

High Performance Networks

Code: MCE 302A

Contacts: 4-0-0

Credits: 4

Course Outcomes: At the end of this course, students will be able to
CO 1: Apply knowledge of mathematics, probability, and statistics to model and analyze some networking protocols.
CO 2: Design, implement, and analyze computer networks. Identify, formulate, and solve network engineering problems.
CO 3: Show knowledge of contemporary issues in high performance computer networks.Use techniques, skills, and modern networking tools necessary for engineering practice.

Syllabus Contents:
Unit 1: Types of Networks, Network design issues, Data in support of network design. Network design tools, protocols and architecture. Streaming stored Audio and Video, Best effort service, protocols for real time interactive applications, Beyond best effort, scheduling and policing mechanism, integrated services, and RSVP-differentiated services.

Unit 2: VoIP system architecture, protocol hierarchy, Structure of a voice endpoint, Protocols for the transport of voice media over IP networks. Providing IP quality of service for voice,signalingprotocols for VoIP, PSTN gateways, VoIP applications.

Unit 3: VPN-Remote-Access VPN, site-to-site VPN, Tunneling to PPP, Security in VPN. MPLS operation, Routing, Tunneling and use of FEC, Traffic Engineering, MPLS based VPN, overlay networks-P2P connections.

Unit 4:Traffic Modeling: Little's theorem, Need for modeling, Poisson modeling, Non-poisson models, Network performance evaluation.

Unit 5: Network Security and Management: Principles of cryptography, Authentication,integrity, key distribution and certification, Access control and fire walls, attacks and counter measures, security in many layers.

Unit 6: Infrastructure for network management, The internet standard management framework – SMI, MIB, SNMP, Security and administration, ASN.1.

References:

1. Kershenbaum A., "Telecommunications Network Design Algorithms", Tata McGraw Hill, 1993.
2. Larry Peterson & Bruce David, "Computer Networks: A System Approach", Morgan Kaufmann,2003.
3. Douskalis B., "IP Telephony: The Integration of Robust VoIP Services", Pearson Ed. Asia, 2000.
4. Warland J., Varaiya P., "High-Performance Communication Networks", Morgan Kaufmann, 1996.
5. Stallings W., "High-Speed Networks: TCP/IP and ATM Design Principles", Prentice Hall, 1998.
6. Leon Garcia, Widjaja, "Communication networks", TMH 7threprint 2002.
7. William Stalling, "Network security, essentials", Pearson education Asia publication, 4th Edition, 2011.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	2	2	1	1	2	3	3	2	3	3
CO2	2	3	3	3	2	3	3	1	2	2	1	3	3	3	3
CO3	3	3	3	1	3	2	2	3	1	2	3	1	3	3	3

Ad-hoc networking
Code: MCE 302B
Contacts: 4-0-0
Credits: 4

Course Outcome:
After completion of the course students will be able to
CO1: Understand the unique issues in ad-hoc/sensor networks.
CO2: Describe current technology trends for the implementation and deployment of wireless ad-hoc/sensor networks.
CO3: Discuss the challenges in designing MAC, routing and transport protocols for wireless ad-hoc/sensor networks.
CO4: Discuss the challenges in designing routing and transport protocols for wireless Ad-hoc/sensor networks.

- Ad hoc wireless Network: Introduction, Basic concept on ad hoc network, static and mobile ad hoc network, transmitter-receiver constraints, Applications.
- MAC protocol: Hidden terminal, Exposed terminal, IEEE802.11 in ad hoc mode.
- Routing protocols: Proactive, Reactive and hybrid routing protocol, Destination sequenced distance vector algorithm, Dynamic source routing, Ad hoc on-demand routing, Location aided routing, Link reversal routing.
- Analysis of TCP performance in wireless ad hoc network: TCP window management and problems, different solution schemes, QoS in wireless ad hoc network
- Achieving energy efficiency in wireless ad hoc network: Different schemes to increase the lifetime of the node in ad hoc network – MAC layer protocol, Routing protocol.
- Localization Management: Location acquisition technique, location sensing technique, location aware routing protocol.
- Security for wireless ad hoc network: Security goals, threats and challenges, Different schemes of security in ad hoc network, routing security.
- Case study: Sensor Network, Wi – Max.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	2	1	2	2	1	1	2	3	3	2	2	2
CO2	2	2	3	3	2	3	1	1	2	2	2	3	2	2	3
CO3	2	2	2	2	2	2	2	3	1	2	3	1	2	2	3
CO4	2	2	2	2	3	2	2	2	1	2	2	3	2	2	3

Optical signal processing Code: MCE302C
Contacts: 4-0-0
Credits: 4

Convergence in communication technology
Code: MCE 302D
Contacts: 4-0-0
Credits: 4

CO 1: Describe the various technologies used in telecommunications.
CO 2: Name the key telecommunications industry protocols
CO 3: Explain the application of technologies, architectures, and protocols used in the telecommunications industry.
CO 4: Identify the Telecommunications Policy and Regulations

Sl No	Module	No. of Lectures
1	**Emerged Technologies:** PSTN, Cellular (GSM/CDMA / EDGE, 3G), WLAN, ISDN, ATM, Frame Relay.	6
2	**Integrated Services and Convergence**: Reservation Protocols- RSVP, MPLS, All-IP Network, digital convergence, inter-networking.	6
3	**Voice over IP (VoIP):** VoIP architecture and network components, Gateways and gate keepers, VoIP functions, Signaling protocols, Routing calls over analog voice ports, Call signaling over digital voice ports, Direct inward dialing (DID), Dial peers.	8
4	**Gateway Control Protocols:** H.323 and MGCP gateways.	4
5	**Session Initiation Protocol:** SIP overview and architecture, SIP call flow, SIP addressing and configuration.	4
6	**IP Multimedia Service**	4
7	**IP Integration with Optical Networks** Optical Networks: IP/OTN (Optical Transport Networks).Optical switching: IP/ASON (Automatic Switched Optical Networks). IP based Optical metro networks**.**	4

8	**Telecommunications Policy and Regulations** Policy and technology perspectives of the telecommunications sectors. Impact of regulatory change on telecom operations; Universal service, the WTO, spectrum auction, regulatory environment of mobile multi-media services,; Telecommunication in the business innovation.	4

Books:

1. Olivier Hersent, David Gurle, Jean- Pierre Petit - *IP Telephony- Packet Based Multimedia System*- Pearson
2. Kelvin Wallace- *Authorized Self-Study Guide Cisco Voice over IP*, 3/e, Pearson Education, 2009
3. Houston H. Carr and Charles A. Snyder (2003) *The Management of Telecommunications*, McGraw-Hill Irwin: Boston
4. Steven Sheppard- *Telecommunications Convergence*, 2/e, McGraw-Hill Publishing

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	2	2	1	1	2	3	3	2	3	2
CO2	3	2	3	3	2	3	1	1	2	2	2	3	2	3	3
CO3	3	2	3	2	2	3	2	3	1	2	3	1	2	2	3
CO4	3	2	3	2	3	3	2	2	1	2	2	3	2	2	3

Pattern Recognition and Machine Learning
Code: MCE302D
Contacts: 4-0-0
Credits: 4

Course Outcomes: At the end of this course, students will be able to
CO 1: Study the parametric and linear models for classification
CO 2: Design neural network and SVM for classification
CO 3: Develop machine independent and unsupervised learning techniques.

Syllabus Contents:
Unit 1 Introduction to Pattern Recognition: Problems, applications, design cycle, learning and adaptation, examples, Probability Distributions, Parametric Learning - Maximum likelihood and Bayesian Decision Theory- Bayes rule, discriminant functions, loss functions and Bayesian error analysis

Unit 2 Linear models: Linear Models for Regression, linear regression, logistic regression Linear Models for Classification

Unit 3 Neural Network: perceptron, multi-layer perceptron, backpropagation algorithm, error surfaces, practical techniques for improving backpropagation, additional networks and training methods, Adaboost, Deep Learning

Unit 4 Linear discriminant functions - decision surfaces, two-category, multi-category, minimum squared error procedures, the Ho-Kashyap procedures, linear programming algorithms, Support vector machine

Unit 5 Algorithm independent machine learning – lack of inherent superiority of any classifier, bias and variance, re-sampling for classifier design, combining classifiers

Unit 6 Unsupervised learning and clustering – k-means clustering, fuzzy k-means clustering, hierarchical clustering

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	1	2	2	1	1	2	3	3	2	3	2
CO2	3	3	3	3	2	3	1	1	2	3	2	3	2	3	3
CO3	3	3	3	3	2	3	3	3	1	3	3	1	2	3	3