GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

School of Electrical, Electronics and Communication Engineering

Program: M. Tech. Communication Engineering

Scheme: 2017/2018/2019– 2021

Curriculum

Semester 1									
Sl. No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	MATH5001	Advanced Numerical & Statistical Methods	3	1	0	4	20	30	50
2	MCEN5002	Information Theory and Coding (PC)	3	0	0	3	20	30	50
3	****	Program Elective 1	3	0	0	3	20	30	50
4	****	Program Elective 2	3	0	0	3	20	30	50
5	MCEN5018	Advanced Digital Signal Processing (PC)	3	0	0	3	20	30	50
6	MCEN5005	Advanced Digital Signal Processing Lab (PC)	0	0	2	1	50	-	50
7	MCEN5006	Information Theory and Coding Lab (PC)	0	0	2	1	50	-	50
		Total	**15**	**1**	**4**	**18**			

Semester II									
Sl No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	CENG5001	Professional and Communication skills (UC)	0	0	4	2	20	30	50
2	MCEN5020	Optical Communication (PC)	3	0	0	3	20	30	50
3	****	Program Elective 3	3	0	0	3	20	30	50
4	****	Program Elective 4	3	0	0	3	20	30	50
5	MCEN5021	Mobile and Wireless Communication (PC)	3	0	0	3	20	30	50
6	MCEN5011	Digital Communication System Design (PC)	3	0	0	3	20	30	50
7	MCEN5012	Digital Communication System Design Lab (PC)	0	0	2	1	50	-	50
8	MCEN5013	Optical Communication Lab (PC)	0	0	2	1	50	-	50
		Total	**15**	**0**	**8**	**19**			

Semester III									
Sl No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	MCEN6009	Data Communication Networks (PC)	3	0	0	3	20	30	50
2	****	Program Elective 5	3	0	0	3	20	30	50
3	****	Program Elective 6	3	0	0	3	20	30	50
4	MCEN9997	Research Seminar (PC)	0	0	2	2	50	-	50

5	MCEN9998	Capstone Design-1 (PC)	0	0	10	5	50	-	50
		Total	**9**	**0**	**12**	**16**			

Semester IV

Sl No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	MCEN9999	Capstone Design-2 (PC)	0	0	30	15	50	-	50
		Total	**0**	**0**	**30**	**15**			

Programme Elective

Sl. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	MCEN5003	Advanced Radiation Systems	3	0	0	3
2	MCEN5008	Advanced Satellite Communication	3	0	0	3
3	MCEN5009	Mobile Ad Hoc Networks	3	0	0	3
4	MCEN6001	Advanced Digital Image Processing	3	0	0	3
5	MCEN5014	Network Security	3	0	0	3
6	MCEN5015	RF System Design	3	0	0	3
7	MCEN5016	Fiber Optic Communication Networks	3	0	0	3
8	MCEN5017	RF MEMS	3	0	0	3
9	MCEN6005	Communication ICs and Design	3	0	0	3
10	MCEN6006	Embedded System Design	3	0	0	3
11	MCEN6007	Spread Spectrum Techniques	3	0	0	3
12	MCEN5019	Wireless Sensor Networks	3	0	0	3
13	MCEN6011	Introduction to IoT and Architecture	3	0	0	3
14	MCEN6012	Error Control Coding	3	0	0	3

Detailed Syllabus

Name of The Course	Advanced Numerical & Statistical Methods			
Course Code	MATH5001			
Prerequisite	Matrices and Calculus			
	L	T	P	C
	3	1	0	4

Course Objectives: To introduce the applications and trade off of various advanced methods used to solve a wide variety of engineering problems dealing with algebraic and differential equation that are often encountered in engineering and cannot be solved by analytical methods along with the introduction of design of experiment.

Course Outcomes

CO1	Do numerical integration for various problems
CO2	Do interpolation using various interpolation techniques.
CO3	Understand the Ordinary & Partial Differential equations and their solutions.
CO4	Do numerical integration
CO5	Use wavelets and their applications

Text Book (s)

1. Numerical Method : E. Balagurusamy , Tata McGraw Hill Publication.
2. Applied Numerical Analysis : Curtis F. Gerald and Patrick O. Wheatley – Pearson Education Ltd.

Reference Book (s)

1. Numerical Methods for Scientific and Engineering computation: M.K Jain, S.R.K Iyengar and R.K Jain, New age International Publishers.
2. Statistical Methods : S.P. Gupta, Sultan Chand and Sons
3. Introduction to Mathematical Statistics: A.M. Mood, F. Graybil and D.C.Boes, Mc Graw Hill Publication.

Course content:

Unit-1	**System of Equations**	**8 hours**
Solution of system of linear equations- Direct Methods- Gauss elimination – Pivoting, Partial and Total Pivoting, Triangular factorization method using Crout LU decomposition, Cholesky method, Iterative Method- Gauss-Seidel and Jacobi method, ill conditioned matrix Solution of system of non linear equation- Newton Raphson and Modified Newton Raphson Method. Iterative methods.		
Unit-2	**Interpolation and Approximation**	**8 hours**
Lagrange, Spline and Hermite interpolation, Approximations, Error of approximation, Norms for discrete and continuous data, Least square approximation.		
Unit-3	**Numerical Integration**	**8 hours**
Newton Cotes closed Quadrature, Gauss Legendre Quadrature, Multiple Integration.		
Unit-4	**Numerical Solution of Differential Equations**	**8 hours**
Finite Difference Schemes, Numerical solution of Ordinary differential equation using Modified Euler's method, Runge-Kutta method of 2nd, 3rd and 4th orders, Predictor- Corrector method, Solution of Laplace's and Poisson's equations by Liebmann's method, Solution of one dimensional time dependent heat flow.		
Unit-5	**Probability and statistics**	**8 hours**
Review of concept of probability, Random Variables, Continuous and discrete distribution function, moments and moments generating functions, Binomial, Poisson, Negative Binomial, Geometric and		

Hyper-geometric Distributions, Uniform, Normal, Exponential, Gamma and Beta distributions. Point and Interval estimation, Testing of Hypothesis (t-test and chi square test), Analysis of variance and Introduction of Design of experiments.

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
20	30	50	100

Name of The Course	Information Theory and Coding			
Course Code	MCEN5002			
Prerequisite				
	L	T	P	C
	3	0	0	3

Course Objectives

1. To understand the fundamental concept of entropy and information as they are used in communications.
2. To enhance knowledge of probabilities, entropy, measures of information.
3. To identify the implications and consequences of fundamental theories and laws of information theory and coding with reference to the application in modern communication and computer systems.
4. To design different encoders using the different coding schemes like Huffman Coding, Shannaon Fano Coding, Cyclic codes, etc.,

Course Outcomes

CO1	Calculate the information content of a random variable from its probability distribution.
CO2	Relate the joint, conditional, and marginal entropies of variables in terms of their coupled probabilities.
CO3	Define channel capacities and properties using Shannon's Theorems.
CO4	Construct efficient codes for data on imperfect communication channels.
CO5	Generalize the discrete concepts to continuous signals on continuous channels.

Text Book (s):

1.Andrew J,Viterbi " *Principles of Digital Communication and Coding*", McGraw-Hill,1996.
2. Ranjan Bose, "Information Theory, Coding and Cryptography", TMH Publication, 2003.

Reference Book (s)

1. Andrea Goldsmith, " Wireless Communications", Cambridge University Press,2005.

2. Saro Glisic ,Advanced Wireless Communications 4G technologies, Wiley & Sons.

3. Stephen G.Wilson, " Digital Modulation & Coding", Prientice-Hall Inc.1996.

4. Daniel J.Costello ,"Error-Control Coding", Pearson Education Inc.2004.

5. John G.Proakis, "Digital Communication", 4th edition, McGraw Hill.

Course content:

Unit-1	Introduction to Information Theory	10 hours
Information theory and statistics. Method of types. Stein's lemma. AEP. Information capacity of networks. Slepian-Wolf theorem. Optimal investment and information theory. Universal portfolios and universal data compression. Maximum entropy and Burg's theorem		
Unit-2	**Introduction to Coding Theory**	**8 hours**

An overview – A frame work for Digital Communications-Concepts of Information theory for Discrete Alphabets-Information source and Entropy: Entropy for Discrete Random Variable, Shannon's noiseless coding theorem, Mutual information and Channel capacity, information measures for continuous random variables		
Unit-3	**Linear Block Codes and Convolution Codes**	**8 hours**
Binary Linear Block Codes, The generator matrix and the parity check matrix. Examples of linear block codes. Cyclic codes. Hard Decision Decoding-Probability of error for Hard Decision Decoding for AWGN, Soft Decision Decoding- Probability of error for Soft Decision Decoding for AWGN. Non-Linear Block codes-Reed Solomon code. Convolution, Encoder Basic structures-Code characterization: Trellis Diagrams-Maximum Likelihood Decoding-Viterbi algorithm-Distance properties of Convolutional codes for Binary-Input channels-Intersymbol Interference channels-Coding for Intersymbol Interference channels.		
Unit-4	**Space Time Codes**	**8 hours**
System model-Independent fade coefficients, Design criteria for Rayleigh Space-Time Codes-Code Construction-Reconfiguration efficiency of Space-Time coding. Space-Time codes for frequency selective channels-Coding gain properties-Diversity gain properties-Space-time trellis code design.		
Unit-5	**Cryptography**	**8 hours**
Security issues, private key encryption algorithms-stream ciphers, Shannon‟s theory, Introduction to number theory-modular arithmetic, public key encryption algorithms- Diffie-Hellman-public key distribution scheme, RSA public key distribution crypto system; Message authentication, hashing functions, Digital signatures.		

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
20	30	50	100

Name of The Course	Advanced Digital Signal Processing			
Course Code	MCEN5018			
Prerequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

This course examines the fundamentals of detection and estimation for signal processing. It will help the students to implement new algorithms for signal processing applications in frequency, time and mixed domains.

Course Outcomes

CO1	Learn Multirate signal processing.
CO2	Design digital filters.
CO3	Know signal processing application in frequency and time
CO4	Understand FFT and power estimation
CO5	Learn DSP Processors and its application

Text Book (s)

1. Steven W. Smith, " Digital Signal Processing: A Practical Guide for Engineers and Scientists", Elsevier, 2003.
2. John G. Proakis, "Digital Signal Processing Principles, Algorithms and Applications" , 4th edition , PHI 2007.

Reference Book (s)

1**.** Lawrence R. Rabiner, Bernard Gold, "Theory and Application of Digital Signal Processing", PHI 2001.

2. Roberto Cristi "Modern Digital Signal Processing", Thomson Brooks/Cole, 2004

Course content:

Unit-1	**Introduction to Modern Digital Signal Processing**	**8 hours**
Introduction to Modern Digital Signal Processing: Signals, systems and signal processing (continuous & discrete an overview), time domain and frequency domain analysis of signals. Sampling and reconstruction of signals, Concepts of Two dimensional, Multi-rate and adaptive signal processing.		
Unit-2	**Design of Filters**	**8 hours**
Design of digital filters, moving average filters, adaptive filters and Filter banks.		
Unit-3	**Fast Fourier Transform**	**8 hours**
Discrete and fast Fourier transform algorithms, Power spectrum estimation		
Unit-4	**Introduction to Digital signal Processors**	**8 hours**
Introduction to Digital signal Processors: Fixed and Floating Point Processors, Complex numbers – fixed and floating point representation. Applications: Applications of Digital Signal Processing to Speech & Audio coding and processing		
Unit-5	**Design and implementation example**	**8 hours**
An IIR and FIR audio filters - Modelling in MATLAB - Analog measurement on DSP Systems, Fixed and floating Point Realization impacts.		

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	PROFESSIONAL AND COMMUNICATION SKILL			
COURSE CODE	CENG5001			
Prerequisite	--			
	L	T	P	C
	0	0	4	2

Course Objectives:.

To develop the professional and communication skills of learners in a technical environment.
To enable the students to acquire functional and technical writing skills.
To acquire state-of-the-art presentation skills in order to present technical topics to both technical and non-technical audience.

Course Outcomes

CO1	The learners will be able to exhibit their language proficiency and skill in *Describing Technology.*
CO2	The learners will be able to exhibit their language proficiency and skill in *Investigating and designing using Technology.*
CO3	Exhibit their language proficiency and skill in Technical Writing and Syntax.
CO4	Exhibit their language proficiency and skill in Technical Resume and Company Profile Presentation.
CO5	Exhibit their language proficiency and skill in Pie chart, Bar chart, Line graphs: analysis and interpretation

Text Books and Softwares:

1. English Vocabulary in Use Advanced, McCarthy & Felicity, CUP, 2003
2. Sky Pronunciation CD-ROM
3. Cambridge Advanced Learner's Dictionary CD-ROM
4. English Master : Grammar

Reference Book (s)

1. Writing, Researching, Communicating, Keith et al, Tata McGraw-Hill, 1989
2. Advanced English Grammar, Martin, CUP, 2006

Unit-1	**Basics of Communication**	**8 hours**
Functional Language	Basic structures- Tense agreement, Prepositional phrases Techno-words : Basic Concepts 62, 63 Pronunciation : sounds of syllables: Past tense & plural endings	
Technical Expression	Organizational techniques in technical writing Guided writing: Paragraph Writing, Note Making	
Presentation Skills	Techniques of presentation (general topic: speech without visual aids) Listening to speeches and comprehending	
Graphical Skills	Flow chart: Process and Functional description	
Unit-2		**8 hours**
Functional Language	Basic structures- Voice, Conditionals Techno-words : Basic Concepts 64,65,67 Pronunciation : Word Stress: two syllable words	
Technical Expression	Mechanics of Technical Writing and Syntax Guided writing: Letter and email	

Presentation Skills	Interpersonal Communication Skills Writing techniques for Power point presentation, Group Discussion	
Graphical Skills	Technical Illustrations and Instructions	
Unit-3		**8 hours**
Functional Language	Basic structures- Modal Verbs and Phrasal verbs Techno-words : Basic Concepts 68,69,70,71 Pronunciation : Word Stress: compound words	
Technical Expression	Mechanics of Technical Writing and Syntax Guided writing: Technical Description	
Presentation Skills	Career advancement: Technical Resume and Company Profile Presentation and Group Discussion	
Graphical Skills	Pie chart, Bar chart, Line graphs: analysis and interpretation	
Unit-4		**8 hours**
Functional Language	Basic structures- Modal Verbs and Phrasal verbs Techno-words : Basic Concepts 72,73,74, Functional vocabulary 87 Pronunciation : Sentence Stress	
Technical Expression	Guided and Free writing: Abstract and Technical articles	
Presentation Skills	Nuances of Presentation to a Technical audience	
Graphical Skills	Oral Presentation of graphical representation	

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
20	30	50	100

Name of The Course	Optical Communication			
Course Code	MCEN5020			
Prerequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:.

To prepare the students understand the various process and subsystems involved in the optical communication.

To enable the students appreciate the different multiplexing technologies in the fiber optic communication.

To design optical communication systems to serve a defined purpose

Course Outcomes

CO1	understand the various process and subsystems involved in the optical communication.
CO2	Understand multiplexing techniques
CO3	To understand the different kind of losses, signal distortion, SM fibers.
CO4	Know the various optical sources, materials and fiber splicing
CO5	Know the fiber optical receivers and noise performance in photo detector.

Text Book (s)

1. R. Ramaswami & K.N. Sivarajan, Morgan Kaufmann," Optical Networks A practical Perspective", 2nd Edition, Pearson Education, 2000.

2. Govind P. Agrawal, "Fiber-Optic Communication Systems" , 3rd Ed., John Wiley & Sons 2003.

Reference Book (s)

1. Gerd Keiser, "Optical Fiber Communications" McGraw-Hill, 3rd Edition, 2000.
2. Thomas E. Stern and Krishna Bala, "Multiwavelength Optical Networks A Layered Approach", Addison Wesley, 1996

Course content:

Unit-1	**Introduction**	**8 hours**
Optical and Photonic Device Technology: Attenuation and dispersion, Chirp, Dispersion Management, Couplers, Isolators, Circulators, Multiplexers and Filters, EDFA, Raman Amplifier, SOA, SRA, Active and Passive Optical Switches, Optical Cross Connects, Wavelength Selective Cross Connects, Wavelength Converters, Optical Time Domain Reflectometry (OTDR),Optical Spectrum Analysers (OSA),WDM and Filters: dielectric, AWG and Fiber Bragg Grating (FBG) devices, Nonlinear optical fibers**.**		
Unit-2	**Optical Modulators**	**8 hours**
Phenomenological theory of nonlinearities. Optics of anisotropic media. Harmonic generation, mixing and parametric effects. Two-photon absorption, saturated absorption and nonlinear refraction. Rayleigh, Brillouin and Raman scattering. Self-focusing and self-phase-modulation. Self-induced transparency Solitons. Optical switching, Electro-Optic Effect and Acousto-Optic effects. EO and AO modulators		
Unit-3	**Detection and receiver design**	**8 hours**
Receiver Sensitivity – Bit-Error Rate, Eye Pattern, Minimum received power, Quantum limit of photo detection; Receiver Design – Front End, Linear channel, Decision circuit, Integrated		

Receivers; Noise in detection Circuit – Shot Noise, Thermal noise; Concept of Carrier to Noise Analysis		
Unit-4	**Network Architectures and Topologies**	**8 hours**
The End To End Transmission Path, Loss And Dispersion Budgets in Network Designing, Optical Signal Flow And Constraints, Design of STAR, BUS, MESH and RING Topologies, Static Multipoint Networks: The Broadcast Star, Multiplexing and Multiple Access Schemes: TWDM/MA, Sub carriers, CDMA, Capacity Allocation for Dedicated Connections, Demand Assigned Connections.		
Unit-5	**Optical Networks Architecture**	**8 hours**
Optical Networks Architecture, SONET/SDH Optical Network, WDM Optical Networks, Wavelength Routed Optical Network, Routing Algorithms, Network Monitoring and Management, Fault and Security Management, Routing Protocols, Intelligent Optical Network (ION), FDDI, FTTH, Business Drivers for Next Generation-Optical Networks, Coherent Optical Communication Systems and Design Requirements		

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
20	30	50	100

Name of The Course	Mobile and Wireless Communication			
Course Code	MCEN5021			
Prerequisite	Signals and Systems, Modulation Theory, Digital Communication			
	L	T	P	C
	3	0	0	3

Course Objectives:.

1. To understand the basic cellular system concepts.
2. To have an insight into the various propagation models and the speech coders used in mobile communication.
3. To understand the multiple access techniques and interference education techniques in mobile communication.

Course Outcomes

CO1	Understand 2G and 3G Wireless networks
CO2	Have a knowledge in Channel coding and Diversity
CO3	Understand various Modulation techniques for Mobile Radio.
CO4	Classify multiple access techniques in mobile communication.
CO5	Outline cellular mobile communication standards.

Text Book (s)

1. K.Feher, Wireless digital communications, PHI, New Delhi, 1999.
2. T.S.Rappaport, Wireless digital communications; Principles and practice, Prentice H NJ, 1996.

Reference Book (s)

1. W.C.Y.Lee, Mobile communications Engineering: Theory And Applications, Second Edition, McGraw Hill, New York.1998.
2. Schiller, Mobile Communications; Pearson Education Asia Ltd., 2000.

Course content:

Unit-1	**Introduction to Wireless Mobile Communications**	**8 hours**
History and evolution of mobile radio systems. Types of mobile wireless services/systems-Cellular, WLL, Paging, Satellite systems, Standards, Future trends in personal wireless systems.		
Unit-2	**Cellular Concept and System Design Fundamentals**	**8 hours**
Cellular concept and frequency reuse, Multiple Access Schemes, channel assignment and handoff, Interference and system capacity, Trunking and Erlang capacity calculations.		
Unit-3	**Mobile radio Propagation**	**8 hours**
Radio wave propagation issues in personal wireless systems, Propagation models, Multipath fading and Base band impulse respond models, parameters of mobile multipath channels, Antenna systems in mobile radio.		
Unit-4	**Modulation and Signal Processing**	**8 hours**
Overview analog and digital modulation techniques, Performance of various modulation techniques-Spectral efficiency, Error-rate, Power Amplification, Equalizing Rake receiver concepts, Diversity and space-time processing, Speech coding and channel coding.		
Unit-5	**System Examples and Design Issues**	**8 hours**
Multiple Access Techniques-FDMA, TDMA and CDMA systems, operational systems, Wireless networking, design issues in personal wireless systems		

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Digital Communication System Design			
Course Code	MCEN5011			
Prerequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

To understand the building blocks of digital communication system. To prepare mathematical background for communication signal analysis. To understand and analyse the signal flow in a digital communication system. To analyse error performance of a digital communication system in presence of noise and other interferences

Course Outcomes

CO1	Understand basics of digital communication systems.
CO2	Design various digital communication modulators demodulators.
CO3	interpret optimum receivers and matched filter receivers
CO4	summarize phase and carrier estimation methods.
CO5	Analyze Performance of spread spectrum communication system.

Text Book (s)

1. Simon Haykin, "Digital Communications", John Wiley & Sons, 2004.
2. John proakis, "Digital Communications",4th Edition, McGraw Hill,.

Reference Book (s)

1. Bernard Sklar, "Modern Digital Communication Techniques – Fundamental and applications", , Pearson Education, 2009.
2. Marvin K. Simon, Jim K. Omura, Robert A. Scholtz, Barry K. Levitt ,"Spread spectrum communications Handbook",McGraw-Hill,2002
3. Ha.H.Nguyen, Ed Shwedyk, "A First Course in Digital Communications", Cambridge University Press, 2009.
4. Dennis Silage, "Digital Communication Systems using MATLAB and Simulink", Bookstand Publishing, 2009.
5. Marvin K. Simon, Hinedi Sami, Lindsay William C. , "Digital Communication Techniques: Signal Design and Detection", PHI

Course content:

Unit-1	Introduction to Digital Communication Systems	8 hours
Building blocks of Digital Communication System- Source Coders, Channel Coders, Encryption concepts, Noise Sources and detection of known signals in noise, Probability of error, Channel decoders, Sources decoders, Correlation receiver, Concept of Matched filter, Overall system performance analysis.		
Unit-2	**Sampling, Quantization and Coding**	**8 hours**
Sampling in 1-D, 2-D and 3-D, Ideal sampling, Natural Sampling, Flat Sampling system design techniques. Various Sample and Hold designs, Quantizers- Quantization with error, Computation of quantization error for linear and non-linear quantizers like A-law and μ-law companders, Effect on Noise Spectrum, Error free quantizers like MAX quantizer.		
Unit-3	**Delta Modulation**	**8 hours**

Delta Modulator (DM), Adaptive Delta Modulators (ADM) Codecs, DPCM - Theoretical and Practical design of DPCM Codecs, effect of predictors, Computation of quantization error, Delta Modulator-Demodulators - Design concepts, Adaptive Delta Modulation and its design aspects.		
Unit-4	**Shift Keying Techniques**	**8 hours**
Concepts of ASK, PSK, FSK, Q-PSK, PSK, QAM, QAM Modems, M-ASK, M-PSK, M-FSK Modems, Techniques of coherent modulation and demodulation, Design of matched filters, System design aspects, Intersymbol Interference, Eye Pattern.		
Unit-5	**Spread Spectrum Concepts**	**8 hours**
Spread Spectrum Systems - Concepts of DS and FH systems, Spectral Pictures, Process Gain and Jamming Margin, Concepts of coders and decoders in each case, suppressed carrier modulation and coherent detection techniques**.**		

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
20	30	50	100

Name of The Course	Data Communication Networking			
Course Code	MCEN6009			
Prerequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

To impart the students a thorough exposure to the layered architecture of communication network and to analyse the protocols adopted for traffic management, routing and QOS provisioning.

Course Outcomes

CO1	Understand basic computer network technology, OSI and TCP/IP model
CO2	Analyze wireless transmission, multiplexing, switching, error detection and corrections
CO3	Differentiate among data link protocol, MAC protocols and their applications
CO4	Understands the design issues associated with Network layer, Routing algorithms and Congestion control algorithms
CO5	Analyze the design issues transport layer, connection management and network securities

Text Book (s)

1. J Frauzon "Computer Communication and Networks".
2. W. Stallings, "Data and computer communication", PHI.

Reference Book (s)

1. A.S. Tanenbaum, "Computer Networks", PHI.

Course content:

Unit-1	**Introduction**	**8 hours**
Introduction – Network Hardware – Software – Reference Models – OSI and TCP/IP models – Example networks: Internet, ATM, Ethernet and Wireless LANs - Physical layer – Theoretical basis for data communication - guided transmission media		
Unit-2	**Wireless Transmission**	**8 hours**
Wireless transmission - Communication Satellites – Telephones structure –local loop, trunks and multiplexing, switching. Data link layer: Design issues – error detection and correction.		
Unit-3	**Data Link**	**8 hours**
Elementary data link protocols - sliding window protocols – Data Link Layer in the Internet - Medium Access Layer – Channel Allocation Problem – Multiple Access Protocols.		
Unit-4	**Network Layer**	**8 hours**
Network layer - design issues - Routing algorithms - Congestion control algorithms – IP protocol – IP Address – Internet Control Protocol.		
Unit-5	**Transport Layer**	**8 hours**
Transport layer - design issues - Connection management - Addressing, Establishing & Releasing a connection – Simple Transport Protocol – Internet Transport Protocol (TCP) - Network Security: Cryptography.		

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Advanced Radiation Systems			
Course Code	MCEN5003			
Prerequisite	Microwave Engineering			
	L	T	P	C
	3	0	0	3

Course Objectives:.

To understand antenna radiation and its parameters. Design different types of antennas.

Course Outcomes

CO1	understand Antenna parameters and theory associated
CO2	Ability to design antenna for various applications
CO3	Knowledge of modern antenna design
CO4	Able to design microstrip antenna
CO5	Able to compare various microstrip antennas parameters

Text Book (s)

1. Balanis.A, "Antenna Theory Analysis and Design", 3rd edition, John Wiley and Sons, New York, 2010.
2. Kraus.J.D.,"Antennas for all applications" 3rd edition, TMH, 2010.

Reference Book (s)

1. Collin.R.E. and Zucker.F.,"Antenna Theory", Mc Graw Hill,New York,1996.
2. R.S.Elliot, “Antenna Theory and Design”, IEEE Press, John Wiley, 2005

Course content:

Unit-1	**Basic Concepts of Radiation**	**8 hours**
Radiation Mechanism – single wire, Double wire, dipole, Current distribution of thin wire antenna, Basic antenna parameters, Vector magnetic potential, Impedance concept-Balanced to Unbalanced transformer, Power radiated from Half wave dipole antenna.		
Unit-2	**Antenna Parameters**	**8 hours**
Types of linear arrays- Uniform spacing and amplitude, Uniform spacing and non-uniform amplitude, current distribution and directivity, Phased arrays, Continuous aperture sources, Antenna synthesis techniques.		
Unit-3	**Radiation from Apertures**	**8 hours**
Field equivalence principle, Rectangular and circular apertures, Uniform distribution on an infinite ground plane, Babinet’s principle, Geometrical theory of diffraction, Horn antenna -E-plane,H-plane and Pyramidal types, Parabolic Reflector antenna.		
Unit-4	**Micro Strip Antennas**	**8 hours**
Radiation mechanisms, Feeding methods, Rectangular patch, Circular patch, Input impedance of patch antenna, Circular polarization, Microstrip dipole, Microstrip arrays.		
Unit-5	**Antennas and Measurements**	**8 hours**
Modern Antennas: EBG antennas, UWB antennas, Smart Antennas, Terrahertz antennas. Antenna measurements: Antenna range, Radiation patterns, Gain, Directivity, Impedance and polarization measurements.		

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Advanced Satellite Communication			
Course Code	MCEN5008			
Prerequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:.

This course describes multiplexing and multiple access techniques used in Satellite communication. The satellite link design is also discussed. GPS and applications of satellite communication are covered in this course.

Course Outcomes

CO1	Discuss various multiplexing and multiple access techniques.
CO2	Design satellite uplink and downlink in various conditions.
CO3	Understand GPS concepts.
CO4	Compare competitive satellite services
CO5	Understand satellite access techniques

Text Book (s)

1. Wilbur L. Pritchard, H.G. Suyderhoud ,Robert A.Nelson, Satellite Communication Systems Engineering, Prentice Hall, New Jersey, 2006.
2. Timothy Pratt and Charles W.Bostain, Satellite Communications, John Wiley and Sons, 2003.

Reference Book (s)

1. D.Roddy, Satellite Communication, McGrawHill, 2006.
2. Tri T Ha, Digital Satellite Communication, McGrawHill,1990.
3. B.N.Agarwal, Design of Geosynchronous Spacecraft, Prentice Hall, 1993.

Course content:

Unit-1	**Introduction to Satellite Communication**	**8 hours**
Satellite Systems, Orbital description and Orbital mechanics of LEO, MEO and GSO, Placement of a Satellite in a GSO, Satellite – description of different Communication subsystems, Bandwidth allocation.		
Unit-2	**Multiplexing and Multiple Access Techniques**	**8 hours**
Different modulation and Multiplexing Schemes, Multiple Access Techniques – FDMA, TDMA, CDMA, and DAMA, Coding Schemes		
Unit-3	**Satellite Link Design**	**8 hours**
Basic link analysis, Interference analysis, Rain induced attenuation and interference, Ionospheric characteristics, Link Design with and without frequency reuse.		
Unit-4	**Global Positioning System**	**8 hours**
Radio and Satellite Navigation, GPS Position Location Principles, GPS Receivers and Codes, Satellite Signal Acquisition, GPS Receiver Operation and Differential GPS.		
Unit-5	**Applications**	**8 hours**
Satellite Packet Communications , Intelsat series – INSAT series –VSAT, mobile satellite services, IMMERSAT, Satellite and Cable Television, DBS (DTH), VSAT, Satellite Phones.		

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Mobile Ad Hoc Networks			
Course Code	MCEN5009			
Prerequisite				
	L	T	P	C
	3	0	0	3

Course Objectives: This course introduces literature on wireless and ad-hoc networks. It exposes fundamental issues in designing and analyzing Wireless and ad-hoc network.

Course Outcomes

CO1	Explain the characteristics features, wireless channels and mobility models of mobile Adhoc networks.
CO2	Summarize the protocols used at the MAC layer and scheduling mechanisms.
CO3	Compare and analyze types of routing protocols used for unicast and multicast routing.
CO4	Examine the network security solution and routing mechanism.
CO5	evaluate the energy management schemes and Quality of service solution in ad hoc networks

Text Book (s)

1.C.Siva ram murthy,B.S. Manoj, "Ad hoc wireless networks-Architectures and protocols" Pearson Education, 2005
2. Stefano Basagni, Marco Conti, "Mobile ad hoc networking", Wiely interscience 2004

Reference Book (s)

3. Charles E.Perkins ,"Ad hoc networking", Addison Wesley,2001

Course content:

Unit-1	**Ad Hoc Wireless Networks**	**8 hours**
Introduction to cellular and ad hoc wireless networks, applications of ad hoc networks, issues in ad hoc wireless networks – medium access scheme, routing, multicasting, transport layer protocols, pricing scheme, quality of service provisioning, self organization, security, address a security discovery, energy management, scalability, deployment considerations, ad hoc wireless Internet.		
Unit-2	**MAC Protocol**	**8 hours**
Issues in Designing a MAC Protocol for ad hoc wireless networks, design goals of a MAC Protocol for Ad Hoc Wireless Networks, Classification of MAC Protocols, Contention based Protocols, Contention based Protocols with Reservation mechanism, Contention Based MAC Protocols with Scheduling Mechanisms, Other MAC protocols.		
Unit-3	**Routing Protocol**	**8 hours**
Design issues and classification, Table-driven, On-demand and Hybrid routing protocols, Routing protocols with efficient flooding mechanisms, Hierarchical and power-aware routing protocols.		
Unit-4	**Multicasting Protocol**	**8 hours**
Design issues and operation, Architecture Reference Model, classification, Tree-based and Mesh-Bas Protocols, Energy-Efficient Multicasting, Multicasting with Quality of Service Guarantee, Applicatio Dependent Multicast Routing. Quality of Service: Issues and challenges in providing QoS, Classification of QoS solutions, MAC layer solutions, Network layer solutions, QoS frameworks, Network security issues.		
Unit-5	**Energy Management**	**8 hours**
Need, classification of battery management schemes, Transmission power management schemes, System power management schemes. Wireless Sensor Networks: Architecture, Data dissemination, Date gathering, MAC protocols, location discovery, Quality of a sensor network.		

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Advanced Digital Image Processing			
Course Code	MCEN6001			
Prerequisite				
	L	**T**	**P**	**C**
	3	0	0	3

Course Objectives: To introduce the fundamentals of visual information, representation of 2-D and 3-D information, enhancement of information, retrieval of information, and various colour models.

Course Outcomes

CO1	Students will be able to describe and Interpret basic elements of Digital Image Processing, Analyze the need and suitability of transforms in image processing applications
CO2	Design and implement filters for image enhancement in spatial domain and frequency domain for real time applications and apply image restoration algorithms
CO3	Segment and Extract features from images for analysis and recognition
CO4	Perform Wavelet analysis on images
CO5	Interpret Still and Video compression algorithms

Text Book (s)

1.Digital Image Processing/ Gonzalez and Woods/ Pearson Education 2008/Third Edition

2. Fundamentals of Digital Image Processing/ A.K. Jain/ PHI Indian Edition

3. Digital Image Processing using MATLAB/ Gonzalez, Woods, and Eddins/ Mc Graw Hill Second/ 2013

Reference Book (s)

1.Digital Image Processing/ K.R. Castleman/ Pearson 2014
2. Digital Image Processing Algorithms and Applications/I. Pitas/John Wiley 2002
3. Image Processing, Analysis, and Machine Vision/Milan Sonka, Vaclav Hlavac, Roger Boyale/ Cengage Learning 4th Edition

Course content:

Unit-1 Introduction **8 hours**
Need for DIP- Fundamental steps in DIP – Elements of visual perception -Image sensing and Acquisition – Image Sampling and Quantization – Imaging geometry, discrete image mathematical characterization, Two dimensional Fourier Transform- Properties – Fast Fourier Transform – Inverse FFT Discrete cosine transform and KL transform.-Discrete Short time Fourier Transform
Unit-2 **8 hours**
Image enhancement in spatial domain: Gray-level transformations, histogram equalization, spatial filters- averaging, order statistics; Edge detection: first and second derivative filters, Sobel, Canny, Laplacian and Laplacian-of Gaussion masks; Image filtering in frequency domain: Smoothing and sharpening filtering in frequency domain, ideal and Butterworth filters, homomorphic filtering; Image restoration: Degradation/ restoration process, noise models, restoration in presence of noise-only spatial filtering, linear position-invariant degradations, estimating the degradation function, inverse filtering, Wiener filtering, constrained least squares filtering
Unit-3 **8 hours**
Detection of discontinuities – Edge linking and Boundary detection- Thresholding- -Edge based segmentation-Region based Segmentation- matching-Advanced optimal border and surface detection- Use of motion in segmentation. Image Morphology – Boundary descriptors- Regional descriptors.
Unit-4 **8 hours**

Wavelets and Multi-resolution image processing- Uncertainty principles of FourierTransform, Time frequency localization, continuous wavelet transforms, wavelet bases and multi-resolution analysis, wavelets and Subband filter banks, wavelet packets.
Unit-5 **8 hours**
Image Compression-Redundancy–inter-pixel and psycho-visual; Losslesscompression – predictive, entropy; Lossy compression-predictive and transform coding; Discrete Cosine Transform; Still image compression standards–JPEG and JPEG-2000. Fundamentals of Video Coding-Inter-frame redundancy, motion estimationtechniques – full-search, fast search strategies, forward and backward motion prediction, frame classification – I, P and B; Video sequence hierarchy–Group of pictures, frames, slices, macro-blocks and blocks; Elements of a video encoder and decoder; Video coding standards – MPEG and H.26X.

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
20	30	50	100

Name of The Course	Network Security				
Course Code	MCEN5014				
Prerequisite					
		L	**T**	**P**	**C**
		3	0	0	3

Course Objectives: This course introduces various techniques used to provide security of networks. The data encryption and decryption methods are also discussed.

Course Outcomes

CO1	identify some of the factors driving the need for network security
CO2	identify and classify particular examples of attacks
CO3	define the terms vulnerability, threat and attack
CO4	identify physical points of vulnerability in simple networks
CO5	compare and contrast symmetric and asymmetric encryption systems and their vulnerability to attack, and explain the characteristics of hybrid systems.

Text Book (s)

1. William Stallings, Cryptography and Network Security: Principles and Standards, PrenticeHall India, 3rd Edition, 2003

Reference Book (s)

1. Charlie Kaufman, Radia Perlman and Mike Speciner, Network Security: Private Communication in a public world, Prentice Hall India, 2nd Edition, 2002
2. Man Young Rhee, "Internet Security", JohnWiley & Sons, 2003.
3. Pfleeger & Pfleeger, "Security in Computing", Pearson Education, 3rd Edition, 2003.

Course Content:

Unit-1	**Introduction**	**8 hours**
Attacks, Services– Mechanisms – Conventional Encryption – Classical and Modern Techniques – Encryption Algorithms – Confidentiality.		
Unit-2	**Public Key Encryption**	**8 hours**
RSA – Elliptic Curve cryptography – Number Theory Concepts.		
Unit-3	**Message Authentication**	**8 hours**
Hash Functions, Hash and Mac algorithms– Digest Functions – Digital Signatures – Authentication Protocols.		
Unit-4	**Network Security Practice**	**8 hours**
IP Security overview, architecture, authentication header, security payload and key management– Web Security: secure socket layer, transport layer security, secure electronic transaction, dual signature.		
Unit-5	**System Security**	**8 hours**
Intruders, viruses, worms**,** Fire Walls, Trusted systems: antivirus techniques and digital immune systems		

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
20	30	50	100

Name of The Course	RF System Design			
Course Code	MCEN5015			
Prerequisite				
	L	**T**	**P**	**C**
	3	0	0	3

Course Objectives: This Course introduces physics of CMOS. The impedance matching and design of amplifiers, oscillators are also discussed.

Course Outcomes

CO1	Understand basics of CMOS physics.
CO2	Perform impedance matching in RF circuits.
CO3	Design RF amplifiers, Oscillators and Mixers.
CO4	Describe analog and digital modulation techniques and modulation schemes
CO5	Understand and describe mathematically the relationship between baseband signals and bandpass signals

Text Book (s)

1. T.Lee, "Design of CMOS RF Integrated Circuits", Cambridge, 2004

2. B.Razavi, "RF Microelectronics", Pearson Education, 1997

Reference Book (s)

1. D.M.Pozar, "Microwave Engineering", John Wiley, 2005.

2. B.Razavi, "Design of Analog CMOS Integrated Circuits", McGraw Hill, 2001.

Course Content:

Unit-1	**CMOS Physics**	**8 hours**
CMOS: Introduction to MOSFET Physics – Noise: Thermal, shot, flicker, popcorn noise Transceiver Specifications: Two port Noise theory, Noise Figure, Sensitivity, SFDR, Phase noise - Specification distribution over a communication link. Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low IF Architectures – Transmitter: Direct upconversion, Two step upconversion		
Unit-2	**Impedance Matching and Amplifiers**	**8 hours**
S-parameters with Smith chart – Passive IC components - Impedance matching networks Amplifiers: Common Gate, Common Source Amplifiers – OC Time constants in bandwidth estimation and enhancement – High frequency amplifier design. Low Noise Amplifiers: Power match and Noise match – Single ended and Differential LNAs – Terminated with Resistors and Source Degeneration LNAs.		
Unit-3	**Feedback Systems and Power Amplifiers**	**8 hours**
Feedback Systems: Stability of feedback systems: Gain and phase margin, Root-locus techniques – Time and Frequency domain considerations – Compensation - Power Amplifiers: General model – Types – Linearisation Techniques – Efficiency boosting techniques		
Unit-4	**PLL and Frequency Synthesizers**	**8 hours**
PLL: Linearised Model – Noise properties – Phase detectors – Loop filters and Charge Pumps. Frequency Synthesizers: Integer-N frequency synthesizers – Direct Digital Frequency Synthesizers		
Unit-5	**Mixers and Oscillators**	**8 hours**
Mixer: characteristics – Non-linear based mixers: Quadratic mixers – Multiplier based mixers: Single balanced and double balanced mixers – subsampling mixers Oscillators: Describing Functions, Colpitts oscillators – Resonators – Tuned Oscillators –		

Negative resistance oscillators – Phase noise.

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
20	30	50	100

Name of The Course	Fiber Optic Communication Networks			
Course Code	MCEN5016			
Prerequisite				
	L	**T**	**P**	**C**
	3	0	0	3

Course Objectives: This course provides insight on light wave networks. It emphasizes on methodology for optical network design and analysis.

Course Outcomes

CO1	Distinguish Step Index, Graded index fibers and compute mode volume.
CO2	Explain the Transmission Characteristics of fiber and Manufacturing techniques of fiber/cable.
CO3	Classify the construction and characteristics of optical sources and detectors.
CO4	Discuss splicing techniques, passive optical components and explain noise in optical system.
CO5	Design short haul and long haul Analog/ Digital optical communication system and explain advanced optical transmission systems

Text Book (s)

1. R. Ramaswami & K.N. Sivarajan, Morgan Kaufmann," Optical Networks A practical Perspective", 2nd Edition, Pearson Education, 2000.
2. Govind P. Agrawal, "Fiber-Optic Communication Systems" , 3rd Ed., John Wiley & Sons 2003.

Reference Book (s)

1. Gerd Keiser, "Optical Fiber Communications" McGraw-Hill, 3rd Edition, 2000.
2. Thomas E. Stern and Krishna Bala, "Multiwavelength Optical Networks A Layered Approach", Addison Wesley, 1996.

Course Content:

Unit-1	**Network Elements**	**8 hours**
Optical and Photonic Device Technology: Attenuation and dispersion, Chirp, Dispersion Management, Couplers, Isolators, Circulators, Multiplexers and Filters, EDFA, Raman Amplifier, SOA, SRA, Active and Passive Optical Switches, Optical Cross Connects, Wavelength Selective Cross Connects, Wavelength Converters, Optical Time Domain Reflectometry (OTDR),Optical Spectrum Analysers (OSA),WDM and Filters: dielectric, AWG and Fiber Bragg Grating (FBG) devices, Nonlinear optical fibers.		
Unit-2	**Optical Modulators**	**8 hours**
Phenomenological theory of nonlinearities. Optics of anisotropic media. Harmonic generation, mixing and parametric effects. Two-photon absorption, saturated absorption and nonlinear refraction. Rayleigh, Brillouin and Raman scattering. Self-focusing and self-phase-modulation. Self-induced transparency Solitons. Optical switching, Electro-Optic Effect and Acousto-Optic effects. EO and AO modulators.		
Unit-3	**Detection and receiver design**	**8 hours**
Receiver Sensitivity – Bit-Error Rate, Eye Pattern, Minimum received power, Quantum limit of photo detection; Receiver Design – Front End, Linear channel, Decision circuit, Integrated Receivers; Noise in detection Circuit – Shot Noise, Thermal noise; Concept of Carrier to Noise Analysis.		
Unit-4	**Network Architectures and Topologies**	**8 hours**
The End To End Transmission Path, Loss And Dispersion Budgets in Network Designing, Optical Signal Flow And Constraints, Design of STAR, BUS, MESH and RING Topologies, Static Multipoint Networks: The Broadcast Star, Multiplexing and Multiple Access Schemes:		

TWDM/MA, Sub carriers, CDMA, Capacity Allocation for Dedicated Connections, Demand Assigned Connections.		
Unit-5	**Optical Networks Architecture**	**8 hours**
Optical Networks Architecture, SONET/SDH Optical Network, WDM Optical Networks, Wavelength Routed Optical Network, Routing Algorithms, Network Monitoring and Management, Fault and Security Management, Routing Protocols, Intelligent Optical Network (ION), FDDI, FTTH, Business Drivers for Next Generation-Optical Networks, Coherent Optical Communication Systems and Design Requirements		

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
20	30	50	100

Name of The Course	RF MEMS			
Course Code	MCEN5017			
Prerequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

This course introduces various sensors, actuators and RF MEMS and it's applications.

Course Outcomes

CO1	Know various sensors, actuators and RF MEMS.
CO2	Design MEMS based circuit.
CO3	able to analyze different MEMS technologies
CO4	familiar with the micro machnied designs for the design of reconfigurable antennas.
CO5	Design circuit using RF MEMS

Text Book (s)

1. Hector J. De Los Santos, "RF MEMS Circuit Design for Wireless Communications", Artech House, 2002.
2. Vijay K. Varadan, K.J. Vinoy, K.A. Jose, "RF MEMS and their Applications", John Wiley and Sons, Ltd., 2002.

Reference Book (s)

1. Gabriel M. Rebeiz, "RF MEMS Theory, Design & Technology", Wiley, 2002.

Course Content:

Unit-1	**Introduction to Sensors, Actuators and Mathematical Models**	**8 hours**
Micro machines, micro systems, benefits, Scaling laws, nano machines. Classification of transducers: electrostatic, piezoelectric, thermal sensing principles, SAW devices.		
Unit-2	**Surface Bulk Micro Machining**	**8 hours**
Overview of silicon processes techniques, micro machining techniques and special process for MEMS polymer MEMS, Recent advances in MEMS fabrication.		
Unit-3	**RF MEMS**	**8 hours**
Enabled circuit elements and models – RF/Microwave substrate properties, Micro machined – enhanced elements – capacitors, inductors, varactors, MEM switch – shunt MEM switch, low voltage hinged MEM switch approaches, push-pull series switch, folded – beam– springs suspension series switch, Resonators – transmission line planar resonators, cavity resonators, micromechanical resonators, film bulk acoustics wave resonators, MEMS modeling – mechanical modeling, electromagnetic modeling.		
Unit-4	**Novel RF MEMS**	**8 hours**
Enabled circuits – reconfigurable circuits – the resonant MEMS switch, capacitors, inductors, tunable CPW resonator, MEMS microswitch arrays, Reconfigurable circuits – double – stud tuner, Nth-stub tuner, filters, resonator tuning system, massively parallel switchable RF front ends, true delay digital phase shifters, reconfigurable antennas – tunable dipole antennas, tunable microstrip patch-array antenna.		
Unit-5	**RF MEMS Based Circuit Design**	**8 hours**
Phase shifters – fundamentals, X-Band RF MEMS phase shifter for phased array applications, Ka-Band RF MEMS phase shifter for radar systems applications, Film bulk acoustic wave filters – FBAR filter fundamentals, FBAR filter for PCS applications, RF MEMS filters – A Ka-Band millimeter-wave Micro machined tunable filter, A High-Q 8 MHz MEM Resonators filter, RF MEMS		

Oscillators – fundamentals, A 14GHz MEM Oscillator, A Ka-Band Micro machined cavity oscillator, A 2.4 GHz MEMS based voltage controlled oscillator.

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
20	30	50	100

Name of The Course	Communication ICs and Design				
Course Code	MCEN6005				
Prerequisite					
		L	**T**	**P**	**C**
		3	0	0	3

Course Objectives:

This course discusses on integrated circuit design techniques, transceiver architectures and telecommunication ICs.

Course Outcomes

CO1	Design low noise RF amplifiers and Oscillators.
CO2	Understand the concept of Nonlinear elements
CO3	Know communication ICs and their applications.
CO4	Design transceiver
CO5	Know various telecommunication IC

Text Book (s)

1. D.M. Pozar. Microwave Engineering. 3rd Ed., N.Y., John Wiley & Sons, Inc., 2005.
2. Leon W. Couch. Digital and Analog Communication Systems . 6th Ed, Prentice Hall PTR, New Jersey, 2001.

Reference Book (s)

1 B. Sklar. Digital Communications. Fundamentals and Applications. 2nd Ed., Prentice Hall PTR, New Jersey, 2001

Course Content:

Unit-1	**Introduction to RF IC design**	**8 hours**
Gain, decibels, impedance, levels. Nonlinearities and harmonic distortions. Intermodulation, dynamic range. Review of thermal noise. Noise models and circuit noise calculations. Introduction to low-noise amplifiers, Low-noise RF amplifiers structure. Relationship between power consumption, gain, linearity and noise figure.		
Unit-2	**Nonlinear Elements**	**8 hours**
Nonlinear elements, their characteristics and approximation methods. Harmonics analysis of the current in the nonlinear elements. Nonlinear resonant amplifiers and frequency multipliers. RF mixers: Up and down conversion mixers, single and double balanced mixers.		
Unit-3	**Oscillators**	**8 hours**
Types of oscillators. Feedback oscillator topologies. Resonant oscillators. Crystal oscillators. Small signal analysis of an oscillator. Short introduction to Voltage Controlled Oscillators (VCOs).		
Unit-4	**Transceivers**	**8 hours**
Transceivers architectures. Transceivers functions and characteristics. Direct conversion and super heterodyne receivers. Phase-locked loops: Phase-locked loops and frequency synthesis. Basic building blocks of the PLL. PLL synthesizers for radio applications.		
Unit-5	**Telecommunication ICs**	**8 hours**
PCM, CVSD codec, filters MODEMS, LAN chip sets, ISDN Codecs, Telephone subscriber circuits, line interface, switched capacitor, DSP chips. High speed decision circuits. MIC and MMIC. High speed DSP Chips. Fibre optic chips.		

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
20	30	50	100

Name of The Course	Embedded System Design				
Course Code	MCEN6006				
Prerequisite					
		L	**T**	**P**	**C**
		3	0	0	3

Course Objectives: This course introduces basic concepts of embedded systems, their programming, multiprocessors & synchronization.

Course Outcomes

CO1	Critically explain the components of Embedded Processing
CO2	Evaluate the architecture and functioning of embedded processors
CO3	Understand the various communication links in embedded system
CO4	Demonstrate Knowledge of RTOS and Its applications
CO5	Design and simulate the embedded system

Text Book (s)

1. Raj Kamal , Embedded Systems Architecture, Programming and Design, Tata McGraw-Hill, New Delhi, 2003.
2. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, Morgan Kaufman Publishers, 2001.

Reference Book (s)

1. Frank Vahid and Tony Givargi Embedded System Design: A Unified Hardware/Software Introduction, s, John Wiley & Sons, 2000.
3. John B Peatman, Design with PIC Microcontrollers, Prentice Hall of India, 2007

Course Content:

Unit I	**Introduction to Embedded System**	**8 hours**
An embedded system, processor, hardware unit, soft ware embedded into a system, Example of an embedded system, OS services, Embedded Design life cycle; Modeling embedded systems Processor and Memory Organization: Structural unit in as processor, processor selection for an embedded systems. Memory devices, memory selection for an embedded system, allocation of memory to program statements and blocks and memory map of a system. Direct memory accesses. .		
Unit II	**Devices and Buses for Device Networks**	**8 hours**
I/O devices, serial communication using FC, CAN devices, device drivers, parallel port device driver in a system, serial port device driver in a system, device driver for internal programmable timing devices, interrupt servicing mechanism, V context and periods for switching networked I/O devices using ISA, PCI deadline and interrupt latency and advanced buses.		
Unit III	**Programming Concepts and embedded programming in C**	**8 hours**
Languages, Firmware development environment, Start up code or Boot loader, Abstraction Layers, Application Layer, build download debug process of firmware.		
Unit IV	**Single and Multiprocessor Systems**	**8 hours**
Program Modeling Concepts in Single and Multiprocessor Systems: software development process, modeling process for software analysis before software implementation, programming model for the event controlled or response time constrained real time programs, modeling of multiprocessor system.		
Unit V	**Multiprocessing & Synchronization**	**8 hours**
Inter-Process Communication and Synchronization of Processors Tasks: and threads; multiple process in an application, problems of sharing data by multiple tasks and routines, inter process		

communications. RTOS task scheduling models interrupt literacy and response times, performance metric in scheduling models, standardization of RTOS, list of basic functions, synchronization

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
20	30	50	100

Name of The Course	Spread Spectrum Techniques			
Course Code	MCEN6007			
Prerequisite				
	L	T	P	C
	3	0	0	3

Course Objectives: This course introduces the architecture and elements of spread-spectrum systems. It also explains characteristics of spread-spectrum signal waveforms, methods for spread-spectrum and CDMA system performance analysis.

Course Outcomes

CO1	Know concept of spread spectrum system.
CO2	Learn jamming performance of coded & encoded spread spectrum system
CO3	Understand theory & concept of W-CDMA
CO4	Apply their knowledge of communications technology to CDMA and wireless systems
CO5	Understand the methods for spread-spectrum and CDMA system performance analysis

Text Book (s)

1. Jack K Holmes, "Spread Spectrum Systems for GNSS and wireless communication" Artech house, London.
2. Roger L Peterson, Rodger E. Ziemer, David E. Borth, "Introduction to Spread Spectrum Communications", prentice Hall.

Reference Book (s)

1. Kiji Tachikawa,"W-CDMA mobile communication systems", John Wiley & Sons.
2.. J.Prokais, "Digital Communications", McGraw Hill.

Course Content:

Unit I	**Introduction to spread spectrum systems**	8 hours
Introduction to Spread Spectrum Technique – Direct Sequence Spread Spectrum Systems, Frequency hopping Spread Spectrum Systems and Hybrid Spread Spectrum Systems-Time hopping Spread Spectrum Signals- Common Problems faced in Spread Spectrum Systems- Introduction to OFDM - Introduction to UWB communication		
Unit II	**Jamming performance of Uncoded Spread Spectrum Systems**	8 hours
Introduction-Jammer types-BER performance in Broadband noise jamming, Partial brand noise jamming and Pulsed jamming (DS/PSK, SFH/DPSK, SFH/PSK, JFH/MFSK, FFH/BFSK, Hybrid DS-SFS SS). BER performance in single tone and multi tone jamming.		
Unit III	**Jamming performance of Coded Spread Spectrum Systems**	8 hours
Interleaver structures for coded systems- Jamming Performance analysis using Linear Block codes, Convolutional codes, Iteratively decode codes.		
Unit IV	**Introduction to W-CDMA**	8 hours
Introduction to W-CDMA – Basic W-CDMA transmission technologies, Link capacity Expansion Technologies – WCDMA Characteristics and Specifications- W-CDMA system architecture- Radio		

Access Interface Standard – Design of W-CDMA Radio system – Quality of Service in W-CDMA systems.		
Unit V	**Rake Receiver, Capacity Analysis & Power Control**	8 hours
Multipath Effects (Delay Spread and Distortion) and Rake Receiver Approach; Capacity Analysis of Cellular CDMA Communication Systems; Power Control in CDMA Communication Systems, Interference Rejection for DS/SS		

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
20	30	50	100

Name of The Course	Wireless Sensor Networks				
Course Code	MCEN5019				
Prerequisite					
		L	**T**	**P**	**C**
		3	0	0	3

Course Objectives:

- Learn Ad hoc network and Sensor Network fundamentals
- Understand the different routing protocols
- Have an in-depth knowledge on sensor network architecture and design issues
- Understand the transport layer and security issues possible in Ad hoc and Sensor networks
- Have an exposure to mote programming platforms and tools Course Outcomes

Course Outcomes

CO1	Analyze the knowledge of wireless sensor networks in various application areas.
CO2	Comprehend and analyze localization and tracking issues associated with WSN network.
CO3	Evaluate the performance of energy saving approaches used in MAC Protocols.
CO4	Understand and analyze various routing metrics and routing algorithms in WSN network
CO5	Apply the techniques used for sensor data gathering, data storage and data retrievals in WSN.

Text Book (s)

1.Networking Wireless Sensors: Bhaskar Krismachari, Cambridge University Press

2. Wireless Sensor Networks: Edited by C.S Raghavendra, Krishna M, Sivalingam, TaiebZnati,

Reference Book (s)

1. Wireless Sensor Networks: An Information Processing Approach- by Feng Zhao, Leonidas Guibas , Morgan Kaufmann Series in Networking 2004.

2. Wireless Sensor Networks: Technology, Protocols, and Applications: KazemSohraby, Daniel Minoli, TaiebZnati, Wiley Inter Science.

Course Content:

Unit I	**Introduction**	8 Hours
Overview of sensor network protocols, architecture, and applications, simulation and experimental platforms, main features of WSNs, research issues and trends.		
Unit II	**Existing Technologies**	8 Hours
Fundamentals of 802.11 – Types, Concepts of 802.16, Basics of 802.15.4, Bluetooth, and UWB, Physical and MAC layers – Applications.		
Unit III	**Sensor Node Hardware and Software**	8 Hours
Hardware: mica2, micaZ, telosB, cricket, Imote2, tmote, btnode, and Sun SPOT, Software (OS): tinyOS, MANTIS, Contiki, and RetOS, Programming tools: C, nesC, Mate.		
Unit IV	**Network Connectivity and Routing**	8 Hours

Sensor deployment mechanisms, coverage issues, node discovery protocols, Data dissemination and processing, multi-hop and cluster based protocols, routing.	
Unit V	**Energy Management** 8 Hours
Data dissemination; data storage, query processing, sensorWeb, sensorGrid, Energy preservation and efficiency, security challenges, fault-tolerance.	

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
20	30	50	100

Name of The Course	Introduction to IoT and Architecture			
Course Code	MCEN6011			
Prerequisite	IoT			
Corequisite	IoT			
Antirequisite				
	L	**T**	**P**	**C**
	3	0	0	3

Course Objectives:

To understand the basic concept of IoT and study the applications of IoT.

Course Outcomes

CO1	Understand the concepts of Internet of Things
CO2	Analyze basic protocols in wireless sensor network
CO3	Design IoT applications in different domain and be able to analyze their performance
CO4	Implement basic IoT applications on embedded platform
CO5	Analyze and design of academic project

Text Book (s)

1.Rajkumar Buyya, Amir Vahid Dastjerdi, "Internet of Things Principles and Paradigms " Copyright © 2016 Elsevier Inc.

2.Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015. 2. Manoel Carlos Ramon, "Intel® Galileo and Intel® Galileo Gen

Reference Book (s)

1.API Features and Arduino Projects for Linux Programmers", Apress, 2014.

2.Marco Schwartz, "Internet of Things with the Arduino Yun", Packt Publishing, 2014.

Unit-1 Introduction **8 hours**
The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related, Standardization, Recommendations on Research Topics.
Unit-2 **8 hours**
Background/Related Work - OpenIoT Architecture for IoT/Cloud Convergence - Scheduling Process and IoT Services Lifecycle - Scheduling and Resource Management - Validating Applications and Use Cases - Future Research Directions
Unit-3 **8 hours**
Introduction - Background and Related Work - Device/Cloud Collaboration Framework - Powerful Smart Mobile Devices - Runtime Adaptation Engine - Privacy-Protection Solution - Applications of Device/Cloud Collaboration - Context - Aware Proactive Suggestion - Semantic QA Cache - Image and Speech Recognition.- Future Work
Unit-4 **8 hours**

Principles, Architectures, and Applications: Introduction - Motivating Scenario - Definitions and Characteristics. - Reference Architecture - Applications - Research Directions and Enablers.- Commercial Products - Case Study
Unit-5 **8 hours**
Introduction - Scenario -- Architecture Overview- Sensors - The Gateway - Summary - Data Transmission

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
20	30	50	100

Name of The Course	Error Control Coding			
Course Code	MCEN6012			
Prerequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Discuss the theory of Linear Block Codes their Encoding and Decoding Techniques as well their application in real World Scenarios.

Course Outcomes:

CO1	Be familiar with importance of error correction methods in data communication and storage.
CO2	Have gained experience of use of mathematical tools from groups and finite fields, in the design of codes and sequences.
CO3	Develop an ability to compare and contrast the strengths and weaknesses of various errors correcting code for a given application.
CO4	Develop and model different error correcting codes for appraise of reaching data rate to Shannon limit.
CO5	Demonstrate competence in analyzing and evaluating the practice of different error correcting coded in digital communication system

Text Book (s):

1. Gravano Salvatore,"Introduction to Error Control Codes", Oxford University Press, 1st Ed., 2007.

2. Bose Ranjan,"Information Theory, Coding and Cryptography", Tata McGraw-Hill, 1st Ed., 2007.

Reference Book (s)

1. Moon Tood K.,"Error Correction Coding - Mathematical Methods and Algorithms", Wiley-Interscience, 1st Ed., 2006.

2. Sklar Bernard,"Digital Communications - Fundamentals and Applications", Pearson Education-LPE, 2nd Ed., 2009.

3. Glover Lan and Grant Peter,&qout;Digital Communications", Pearson Education-LPE, 1st Ed., 2008.

Course Content:

Unit-1	**Channel Capacity And Coding**	**8 hours**
Introduction, Channel Models, Channel Capacity, Channel Coding, Information Capacity Theorem, The Shannon Limit, Random Selection Of Codes, Hamming Distance, Few Points Of Information Theory.		
Unit-2	**Block Codes**	**8 hours**
The Digital Communication Channel, Introduction To Block Codes, Single Parity Check Codes, Product Codes, Repetition Codes, Hamming Codes, Minimum Distance Of Block Codes, Soft - Decision Decoding, Automatic Repeat Request Schemes		
Unit-3	**Linear Codes**	**8 hours**
Definition of Linear Codes, Generator Matrices, The Standard Array, Parity - Check Matrices, Error Syndromes, Error Detection And Correction, Shortened And Extended Linear Codes.		
Unit-4	**Cyclic Codes**	**8 hours**
Definition Of Cyclic Codes, Polynomials, Generator Polynomials, Encoding Cyclic Codes, Decoding Cyclic Codes, Factors Of XN +1, Parity-Check Polynomials, Dual Cyclic Codes, Generator And Parity-Check Matrices Of Cyclic Codes.		

Unit-5	Convolution Codes	8 hours
Convolution, Encoding Convolutional Codes, Generator Matrices For Convolutional Codes, Generator Polynomials For Convolutional Codes, Graphical Representation Of Convolutional Codes, The Viterbi Decoder.		

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100