Rashtreeya Sikshana Samithi Trust

R. V. College of Engineering

(Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi)

Department of Electronics & Communication Engineering

Master of Technology (M.Tech)

COMMUNICATION SYSTEMS

Scheme and Syllabus of Autonomous System w.e.f 2016

R.V. College of Engineering, Bengaluru – 59

(Autonomous Institution affiliated to Visvesvaraya Technological University,, Belagavi)

Department of Electronics & Communication Engineering

Vision:

Imparting quality technical education through interdisciplinary research, innovation and teamwork for developing inclusive & sustainable technology in the area of Electronics and Communication Engineering.

Mission:

- To impart quality technical education to produce industry-ready engineers with a research outlook.
- To train the Electronics & Communication Engineering graduates to meet future global challenges by inculcating a quest for modern technologies in the emerging areas.
- To create centers of excellence in the field of Electronics & Communication Engineering with industrial and university collaborations.
- To develop entrepreneurial skills among the graduates to create new employment opportunities.

MASTER OF COMMUNICATION SYSTEMS – Program

Program Educational Objectives (PEO)

M. Tech. in Communication Systems Program, graduates will be able to:

PEO 1. Apply concepts of Statistics, Linear Algebra and Residue Calculus in Communication, Signal processing and Electromagnetics domain

PEO 2. Solve issues in real world communication sectors, and develop feasible and viable communication systems..

PEO 3. Inculcate effective communication skills , practice effective team work, professional ethics and pursue research.

Program Outcomes (PO)

M. Tech. Communication Systems graduates will be able to:

PO 1. Scholarship and Knowledge The courses expose students to a deep understanding of Channel Encoding and Decoding, Modulation and Demodulation, Radio Frequency Conversion, Channel Transmission, and performance extraction.

PO 2. Critical Thinking The course involves understanding of the physical issues in communications and its abstraction to mathematical models, followed by engineering approximation leading to a viable algorithm.

PO 3. Problem Solving The course involves mathematical modelling of communication events including noise, devices and systems that are different across various channels and hence is intensively problem oriented.

PO 4. Research Skills The approach in this course has been to provide a strong exposure to fundamentals with full mathematical rigor in Signal Processing, Communications and Electromagnetics followed by an exposure to specific courses in state of art in wireless, wireline and optical communications. This provides a strong background to engage in developments in these communication systems.

PO 5. Usage of Modern Tools The student is exposed to Numerical and Algorithmic procedures in the theoretical courses with a strong lab component using Matlab environment, Embedded Environment and Electromagnetic Flow solver tools like HFSS and FEKO.

PO 6. Multidisciplinary Work As a part of the mini project, major project or internship the student is exposed to interfacing for communications with real world sensors, transmission of speech and complex images from cameras all of which require multidisciplinary work.

PO 7. Project management and finance As a part mini and major project the student learns to draw up list of tasks and time lines for those tasks an essential ingredient in project management. Further in the projects the student learns the value of simulation and emulation, thereby understanding that a cost effective hardware realization is possible only through simulations.

PO 8. Communication Skills As a part of progress reports on mini and major projects the student is expected to develop his skills in written and oral presentation of the work that he has accomplished.

PO 9. Life Long Learning Exposure to prerequisite maths and a mathematically rigorous approach to communication theory will provide him with all the necessary background to pursue a career in any field of communications going forward in his career.

PO 10. Ethical Practice and Social Responsibility In the preparation of reports and in the process of accessing and understanding journal papers, the student gets to understand the importance of acknowledging the works of prior state of the art and peer reviews. This ethical practice is built at this stage.

PO 11. Independent and Reflective Learning In the individual lab assignments, miniproject and major project tasks the student is exposed to thought provoking issues in communication system practice that need association of theoretical learning with real issues in a communication environment.

Program Specific Criteria (PSC)

Lead Society: Institute of Electrical and Electronics Engineers

1. Curriculum:

The curriculum shall include Advanced mathematics applied to communication system design; Engineering topics, including programming, necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components; Communication theory and systems. The curriculum must prepare graduates for design and operation of communication networks for services such as voice, data, image, and video transport.

2. Faculty

The professional competence of the faculty must be in Applied Mathematics, Engineering, Communication System design and integration.

Program Specific Outcomes (PSO)

M. Tech. in Communication Systems graduates will be able to:

PSO 1. Use the knowledge of signal processing, communications, networks and Electromagnetics to simulate algorithms in virtual environments and implement them on embedded platforms.

PSO 2. Critically and systematically integrate knowledge to analyze, estimate solve complex problems and meet the challenges in the communication domain

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Department of Electronics & Communication Engineering

M. Tech. in Communication Systems

FIRST SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Experiential Learning S**	
1	16 MEM11R	Research Methodology	IM	3	1	0	0	4
2	16MCS12	Advanced Communications Systems -1 (Theory & Practice)	EC	4	0	1	0	5
3	16MCS13	Modern Digital Signal Processing	EC	4	0	0	1	5
4	16MCS14	Error Control and Coding	EC	4	0	0	0	4
5	16MAT15x	Elective -1	MA	4	0	0	0	4
6	16HSS16	Professional Skill Development	HSS	0	0	2	0	2
		Total		**19**	**1**	**4**	**0**	**24**

Elective-1			
16MAT151	Probability Theory and Linear Algebra	16MAT152	Probability Theory and Residue Calculus

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Department of Electronics & Communication Engineering

M. Tech. in Communication Systems

SECOND SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Experiential Learning S**	
1	16MEM21P	Project Management	IM	3	1	0	0	4
2	16MCS 22	Advanced Communication Systems – 2 (Theory & Practice)	EC	4	0	1	0	5
3	16MCS 23x	Elective-2	EC	4	0	0	0	4
4	16MCS 24x	Elective -3	EC	4	0	0	0	4
5	16MCS 25x	Elective -4	EC	4	0	0	0	4
6	16MCS 26	Minor Projects	EC	0	0	5	0	5
		Total		**19**	**1**	**6**	**0**	**26**

Elective-2			
16MCS231	Adaptive Signal Processing	16MCS232	VLSI Digital Signal Processing Systems
Elective-3			
16MCS241	Multimedia Communication	16MCS242	Digital Image Processing
Elective-4			
16MCS251	Real time Signal Processing & Communication Design	16MCS252	Communications Networks

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Department of Electronics & Communication Engineering

M. Tech. in Communication Systems

THIRD SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Experiential Learning S**	
1	16 MCS 31	Time-harmonic Electromagnetic Fields (Theory & Practice)	EC	4	0	1	0	5
2	16 MCS 32x	Elective-5	EC	4	0	0	0	4
3	16 MCS 33x	Elective-6	EC	4	0	0	0	4
4	16 MCS 34x	Elective-7	EC	4	0	0	0	4
5	16 MCS 35	Internship/Industrial Training	EC	0	0	3	0	3
6	16 MCS 36	Technical Seminar	EC	0	0	2	0	2
		Total		**16**	**0**	**6**	**0**	**22**

Elective-5			
16MCS321	Smart Antenna Signal Processing	16MCS322	Microwave Sources & Synthesizer
Elective-6			
16MCS331	Wireline Broadband Communications	16MCS332	Fiber Optic Communications
Elective-7			
16MCS341	Wireless Cellular and LTE 4G Broadband	16MCS342	Wireless Local Area Networks

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FOURTH SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Experiential Learning S**	
1	16 MCS 41	Major Project	EC	0	0	26	0	26
2	16 MCS 42	Seminar	EC	0	0	2	0	2
		Total		**0**	**0**	**28**	**0**	**28**

I SEMESTER

RESEARCH METHODOLOGY

Course Code	**:**	**16MEM11R**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P: S**	**3:2:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives:

This course will enable student to:

1. Understand of the underlying principles of quantitative and qualitative research
2. Perform the gap analysis and identify the overall process of designing a research study.
3. Choose the most appropriate research methodology to address a particular research problem
4. Explain a range of quantitative and qualitative approaches to analyze data and suggest possible solutions.

Unit – I **10 Hrs**

Overview of Research

Meaning of Research, Types of Research, Research and Scientific Method, Defining the Research Problem, Research Design, Different Research Designs.

Unit – II **09 Hrs**

Methods of Data Collection

Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Collection of Secondary Data, Selection of Appropriate Method for Data Collection.

Unit – III **10 Hrs**

Sampling Methods

Sampling process, Non-probability sampling, probability sampling: simple random sampling, stratified sampling, cluster sampling systematic random sampling, Determination of sample size, simple numerical problems.

Unit – IV **10 Hrs**

Processing and analysis of Data

Processing Operations, Types of Analysis, Statistics in Research, Measures of: Central Tendency, Dispersion, Asymmetry and Relationship, correlation and regression, Testing of Hypotheses for single sampling: Parametric (t, z and F) Chi Square, ANOVA, and non-parametric tests, numerical problems.

Unit-V **09 Hrs**

Essentials of Report writing and Ethical issues:

Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Precautions for Writing Research Reports.

Syllabus includes 12 hours of tutorials in which:

- Faculty is expected to discuss research methodology for specializations under consideration.
- Numerical problems on statistical analysis as required for the domains in which students are studying must be discussed.
- Statistical analysis using MINITAB/ MatLab and such other software can be introduced.

Course Outcomes:

After going through this course the student will be able to

CO1: Explain various principles and concepts of research methodology.

CO2: Apply appropriate method of data collection and analyze using statistical methods.

CO3: Analyze research outputs in a structured manner and prepare report as per the technical and ethical standards.

CO4: Formulate research methodology for a given engineering and management problem situation.

Reference Books:

1. Kothari C.R., "Research Methodology Methods and techniques", New Age International, 2004, ISBN: 9788122415223
2. Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., "Management Research Methodology", Pearson Education India, 2009 Edition, ISBN:9788177585636
3. Levin, R.I. and Rubin, D.S., "Statistics for Management", 7th Edition, Pearson Education: New Delhi, ISBN-13: 978-8177585841

Scheme of Continuous Internal Evaluation (CIE) for Theory

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M	---	---	M	----	----	---	H	---	H	-----
CO2	---	L	H	H	M	M	L	L	----	M	L
CO3	L	M	M	M	H	M	L	M	---	---	M
CO4	H	H	H	H	----	L	L	M	H	---	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1		
CO2		L
CO3		
CO4	L	

Advanced Communications Systems -1(Theory & Practice)						
Course Code	**:**	**16MCS12**		**CIE Marks**	**:**	**100+50**
Hrs/Week	**:**	**L:T:P:S**	**4:0:2:0**	**SEE Marks**	**:**	**100+50**
Credits	**:**	**5**		**SEE Duration**	**:**	**3 Hrs + 3Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Analyze the operation of different modulation & demodulation & equalization techniques spectrum communication system and analyze the error performance of digital modulation techniques in presence of AWGN noise.
2. Analyze and demonstrate the model of discrete time channel with ISI & the model of discrete time channel by equalizer.
3. Apply various types of equalizers used for channel modeling and adjusting the filter

coefficients

4. Develop the concept of characterization of fading multipath channels.

Unit – I	**10 Hrs**

Signal Representation – Low pass representation of bandpass signals, Low pass representation of bandpass random process. **Modulation:** Modulation Schemes without memory (Band Limited Schemes - PAM,BPSK,QPSK,MPSK,MQAM, Power Limited Schemes – FSK,MFSK, DPSK,DQPSK), modulation schemes with memory (Basics of CPFSK and CPM – Full Treatment of MSK), Transmit PSD for Modulation Schemes.

Unit – II	**10 Hrs**

Demodulation - Vector Channel, Vector Channel +AWGN, Performance parameters, Optimum Coherent Detection for power limited and Bandlimited schemes, Optimal Coherent detection for schemes with memory, Optimal Non – Coherent detection for schemes without and with memory (FSK, DPSK,DQPSK), Comparison of detection schemes.

Unit – III	**10 Hrs**

Equalization: Bandlimited channel characterization, signalling through band limited linear filter channels: Optimum receiver for channel with ISI and AWGN, Linear equalization, Decision - feedback equalization, Reduced complexity ML detectors.

Unit – IV	**10 Hrs**

Adaptive equalization: Adaptive linear equalizer, adaptive decision feedback equalizer, Adaptive equalization of Trellis - coded signals, Recursive least square algorithms for adaptive equalization, Blind Equalization.

Unit – V	**10 Hrs**

Spread spectrum signals for digital communication: Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, Frequency hopped spread spectrum signals, CDMA, Time hopping SS, Synchronization of SS systems.

Unit – VI (Lab Component)	**30 Hrs**

1. Simulation of DSSS and FH systems with Matlab
2. Generation of PN sequence and Gold sequence with Matlab
3. Performance Analysis of Rayleigh Fading Channel Models with Matlab
1. Build a hardware pseudo-random signal source and determine statistics of the generated signal source.
2. PAM Implementation on DSP processor
3. ASK Implementation on DSP processor
4. FSK implementation on DSP processor
5. BPSK implementation on DSP processor
6. QPSK implementation on DSP processor
7. MSK modulation and demodulation using MATLAB

Expected Course Outcomes:

After going through this course the student will be able to:

CO1: Explain the concept of low pass and Bandpass signals representations at the Transmitter, the process of Detection and Estimation at the receiver in the presence of AWGN only.

CO2: Evaluate the performance of Receivers for various types of symbol modulation through ideal and AWGN Non-bandlimited and bandlimited channels.

CO3: Design a set of communication blocks employing known symbol modulation schemes with detection methods along with defined channel models and appropriate equalizers, and compute parameters to meet desired rate and performance requirements.

CO4: Design and Evaluate Non band limited and Non power limited spread spectrum systems for communications in a Jamming environment, multiuser situation and low power intercept environment./

Reference Books:

1.	John G. Proakis, Masoud Salehi,"Digital Communications ",5e,Pearson Education(2014),ISBN:978-9332535893
2.	David Tse, Pramod Viswanath, "Fundamentals of Wireless Communication",1e,Cambridge University Press(2005), ISBN:0521845270
3.	Bernard Sklar,"Digital Communications: Fundamentals and Applications: Fundamentals &Applications",2e,Pearson Education(2009),ISBN:978-8131720929
4.	Simon Haykin ,"Digital Communications Systems",2e,Wiley(2013),ISBN:978-8126542314

Scheme of Continuous Internal Evaluation (CIE) for Theory

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Scheme of Continuous Internal Evaluation (CIE) for Practical

CIE for the practical courses will be based on the performance of the student in the laboratory, every week. The laboratory records will be evaluated for 40 marks. One test will be conducted for 10 marks. The total marks for CIE (Practical) will be for 50 marks.

Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Practical

SEE for the practical courses will be based on conducting the experiments and proper results for 40 marks and 10 marks for viva-voce. The total marks for SEE (Practical) will be 50 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	H	M	M	H	H	H	L	M	H	L	L
CO2	H	H	H	H	H	M	L	M	H		H
CO3	H	H	H	H	H	H			H		H
CO4	H	H	H	H	H	H			H	L	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	H
CO2	H	M
CO3	M	H
CO4	H	H

Modern Digital Signal Processing						
Course Code	**:**	**16MCS13**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:1**	**SEE Marks**	**:**	**100**
Credits	**:**	**5**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Review of various filter design concepts and understanding the need for Multirate filter banks.
2. Analyze & apply sampling-rate conversion Multirate digital signal processing.
3. Describe and demonstrate polyphaser structures for sapling rate conversion & demonstrate Multirate filter banks
4. Design and implement wavelet transforms (WT), applications of WT for filtering, compression and analysis of signals and images & various application of MDSP.

Unit – I	**10 Hrs**

Review of Digital Filters Introduction, Filter Design specifications, FIR Filter Design, IIR Filter Design, Allpass Filters, Special types of Filters, IIR Filters Based on two Allpass Filters, Concluding remarks.

Unit – II	**10 Hrs**

Fundamentals of Multirate Systems Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling Rate Conversion by a Rational Factor I/D. **Implementation of Sampling Rate Conversion:** Polyphase Filter Structures, Interchange of Filters and down samplers/Up samplers.

Unit – III	**10 Hrs**
Implementation of Sampling Rate Conversion Sampling Rate Conversion with Cascaded Integrator Comb Filters, Polyphase Structures for Decimation and Interpolation filters and Structures for Rational Sampling Rate Conversion.**Multistage** Implementation of Sampling Rate Conversion, Sampling Rate Conversion of Bandpass Signals, Sampling Rate Conversion by an Arbitrary Factor, Digital Filter Banks.	
Unit – IV	**10 Hrs**
Two Channel Quadrature Mirror Filter Bank Elimination of Aliasing, Condition for perfect Reconstruction, Polyphase form of the QMF Bank, IIR QMF Bank, Perfect Reconstruction Two-Channel FIR QMF Banks in Sub band Coding, M-channel QMF Bank	
Unit – V	**10 Hrs**
The Wavelet Transform and its relation to Multirate Filter Banks Introduction, Background and outline, The short-Time Fourier transform, The wavelet transform, Discrete-Time orthonormal wavelets, Continuous- Time orthonormal wavelet,Concluding remarks	
Expected Course Outcomes: After going through this course the student will be able to: CO1: Design & analyze the practical aspects of sampling and reconstruction and select a suitable sampling rate for a given signal processing problem. CO2: Design & development of tree-structured maximally decimated filter bank through the concept of discrete-time wavelets. CO3: Design and analyze multi-rate filters for a given specification. CO4: Implement Multirate QMF, PR orthogonal filter banks and wavelet filters for various applications.	
Reference Books:	
1.	Proakis, and Manolakis, "Digital signal processing", 3rd edition, Prentice Hall, 1996. ISBN 0131873741, 9780131873742
2.	Robert. O. Cristi, "Modern Digital signal processing", Cengage Publishers, India, 2003. ISBN:978-0534400958, 10534400957
3.	Vaidyanathan, P.P.,"Multirate Systems and Filter Banks", Pearson Publication 2006, ISBN: 81-7758-942-3S.
4.	K. Mitra, "Digital signal processing: A computer based approach", 3rd edition, TMH, India, 2007.ISBN 9780070667563

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Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M	M	H	H	L	M		M	M	M	H
CO2	M	M	H	H	L	M		M	M	M	H
CO3	M	M	H	H	L	M		M	M	M	H
CO4	M	M	H	H	L	M		M	M	M	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	L
CO2		L
CO3	M	L
CO4	H	L

Error Control and Coding						
Course Code	**:**	**16MCS14**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**5**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Explain the Entropy, information rate and capacity for the Discrete memoryless channel.
2. Apply modern algebra and probability theory for the coding & Analyze and implement convolutional encoders and decoders.
3. Compare Block codes such as Linear Block Codes, Cyclic codes etc and Convolutional codes.
4. Detect and correct errors for different data communication and storage systems.
5. Implement different Block code encoders and decoders.

Unit – I	**10 Hrs**

Information theory: Information and its measure, Entropy and information rate, coding for a discrete memoryless channel, Mutual Information, Discrete Channel Capacity, coding for the binary symmetric channel.**Introduction to algebra**: Groups, Fields, binary field arithmetic, Construction of Galois FiECS GF (2^m) and its properties, Computation using Galois filed GF (2^m) arithmetic, Vector spaces and Matrices.

Unit – II	**10 Hrs**

Linear block codes: Generator and parity check matrices, Encoding circuits, Syndrome and error detection, Minimum distance considerations, Error detecting and error correcting capabilities, Standard array and syndrome decoding, Single Parity Check Codes(SPC),Repetition codes, Self dual codes, Hamming codes, Reed-Muller codes. and interleaved codes.

Unit – III	**10 Hrs**

Cyclic codes: Introduction, Generator and parity check polynomials, Encoding of cyclic codes, Syndrome computing and error detection, Decoding of cyclic codes, Error trapping Decoding, Cyclic hamming codes, Shortened cyclic codes.	
Unit – IV	**10 Hrs**
BCH codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field arithmetic, Implementation of error correction. **Non-binary BCH codes:** q-ary linear block codes, Primitive BCH codes over GF(q), Reed -Solomon codes, decoding of non-binary BCH and RScodes: The Berlekamp - Massey Algorithm. Interleavers, RS+Interleaving	
Unit – V	**10 Hrs**
Majority Logic decodable codes: One -step majority logic decoding, One-step majority logic decodable codes, Two-step majority logic, decoding, Multiple-step majority logic decoding. **Convolution codes:** Encoding of convolutional codes, Structural properties, Distance properties, Viterbi decoding algorithm	
Expected Course Outcomes: After going through this course the student will be able to: CO1: Demonstrate an understanding of the theoretical and practical skills in the design of error control encoders and decoders. CO2: Develop the various error control coding techniques and their applications in telecommunication and data storage systems. CO3: Design and evaluate error control coding schemes using probability theory. CO4: Identify bottlenecks and optimize the performance of data transmission systems using principles and techniques developed tin this course.	
Reference Books:	
1.	A.Bruce Carlson,Paul B.Crilly,Janet C.Rutledge , "Communication Systems",Mcgraw-Hill,4th edition,2002**,**ISBN 0071121757, 9780071121750
2.	Shu Lin and Daniel J. Costello. Jr, "Error control coding", Pearson, Prentice Hall, 2nd edition, 2004. ISBN 0130426725, 9780130426727
3.	Blahut. R. E, "Theory and practice of error control codes", Addison Wesley, 1984. ISBN 0201101025 , 9780201101027
4.	Salvatore Gravano, "Introduction to Error control coding", Oxford university press,2007. ISBN 0-19-856231-4

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Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**

CO1	M	M	M	M		M		M	M	M	
CO2	M	H	H	M		M		M	H	M	
CO3	H	H	H	M		M		M	H	M	
CO4	H	H	H	M		M		M	H	M	

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	M	L
CO2		L
CO3	M	L
CO4	H	L

Probability Theory and Linear Algebra						
Course Code	**:**	**16MAT151**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Use various methods to compute the probabilities of events
2. Analyze and interpret statistical data using appropriate probability distributions, e.g. binomial and normal & Apply central limit theorem to describe inferences,
3. Perform a regression analysis, and compute and interpret the coefficient of correlation& Compute inner products and determine orthogonality on vector spaces, including Gram-Schmidt orthogonalization
4. Compute with the characteristic polynomial, eigenvectors, eigenvalues and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result,

Unit – I	**10 Hrs**

Fundamentals of Probability Theory Definitions, scope and history; Axioms of Probability, Assigning Probabilities; Joint and Conditional Probabilities, Independence; Bayes's Theorem and applications. **Random Variables, Distributions and Density Functions** Definition of random variables, continuous and discrete random variables; cumulative distribution function for discrete and continuous random variables; probability mass function, probability density functions and properties; Some special distributions: Uniform, Exponential, Laplace, Gaussian and Rayleigh distributions; Binomial, and Poisson distribution. Engineering Application: An Optical Communication System.

Unit – II	**10 Hrs**

Operations on random variables Expectation, moments and central moments of a random variable; Characteristic Functions, Probability generating and Moment generating functions; Evaluating Tail probabilities. Joint PDF, Joint CDF, Joint PMF; conditional expectation, Joint moments; covariance and correlation; independent, uncorrelated and orthogonal random variables; Jointly Gaussian random variables; Transformations of pairs of Random variables, Linear Mean Square Estimation. **Multiple Random variables** Joint and Conditional PMF's, CDF's and PDF's;

Central limit theorem; Gaussian random variables in multiple dimensions; mean vector, covariance matrix and properties.

Unit – III	**10 Hrs**

Random Processes From Random Variable to Random Process, Classification of Random Processes, Stationary and ergodic random processes, Properties of the Auto correlation function, Gaussian random processes. **Spectral Analysis** Power Spectral Density, The Wiener-Khintchine-Einstein Theorem**,** Multiple Random Processes, Transmission of Random Processes through Linear Systems. Engineering Application : PSD's of digital modulation formats and Matched filter.

Unit – IV	**10 Hrs**

Matrices and Gaussian elimination Geometry of Linear Equations, Matrix multiplication, Inverses and Transposes, Rank of a Matrix, Special matrices and applications. **Determinants, Eigenvalues and Eigen vectors** Introduction, Properties of the Determinants and Applications, Diagonalization of a Matrix, Computation of eigen values and Eigen vector.

Unit – V	**10 Hrs**

Vector Spaces Vector Spaces and Subspaces, Linear Independence, Basis and dimension, Four fundamental Subspaces, Linear Transformations. **Orthogonality** Orthogonal Vectors and Subspaces, Projections and Least squares, Orthogonal Bases and Gram- Shmidt orthogonalization, Rank-Nullity theorem.

Expected Course Outcomes:

After going through this course the student will be able to:

CO1: Demonstrate the understanding of fundamentals of probability theory, random process, matrix theory

CO2: Analyze and solve problems on probability distributions, multiple random variables, matrix analysis

CO3: Apply acquired knowledge to find moments, properties of auto correlation function, rank and diagonalization of matrix, verify rank nullity theorem

CO4: Estimate cumulative distribution function, probability generating function, orthogonality of vector spaces. Also be able to recognize problems which involve these concepts in communication systems.

Reference Books:

1.	Scott. L. Miller and Donald. G. Childers, "Probability and Random Processes: With Applications to Signal Processing and Communications", Elsevier Academic Press, 2nd Edition, 2012, ISBN 9780121726515
2.	Gilbert Strang, "Linear Algebra and its Applications", Cengage Learning, 4th Edition, 2006, ISBN 97809802327
3.	A Papoullis and S U Pillai , "Probability, random variables and Stochastic process",Mcgraw Hill 2002, ISBN 9780071226615

Scheme of Continuous Internal Evaluation (CIE) for Theory

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	M	M	M								
CO2	M	M	M	H		M			M	M	M
CO3	M	M	M						M	M	M
CO4	M	H	M	H	H	M	M		M	M	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	M	M
CO2	M	M
CO3	L	L
CO4	H	H

Probability Theory and Residue Calculus						
Course Code	**:**	**16MAT152**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Use various methods to compute the probabilities of events & Identify probability distributions encountered in real life situations and use the concepts of random variables to solve simple problems.
2. Apply central limit theorem to describe inferences. & Analyze sequences and series of analytic functions and types of convergence,
3. Evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula, and
4. Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.

Unit – I	**10 Hrs**

Fundamentals of Probability Theory Definitions, scope and history; Axioms of Probability, Assigning Probabilities; Joint and Conditional Probabilities, Independence; Bayes's Theorem and applications. **Random Variables, Distributions and Density Functions**

Definition of random variables, continuous and discrete random variables; cumulative distribution function for discrete and continuous random variables; probability mass function, probability density functions and properties; Some special distributions: Uniform, Exponential, Laplace, Gaussian and Rayleigh distributions; Binomial, and Poisson distribution. Engineering Application: An Optical Communication System.

Unit – II	**10 Hrs**

Operations on random variables Expectation, moments and central moments of a random variable; Characteristic Functions, Probability generating and Moment generating functions; Evaluating Tail probabilities. Joint PDF, Joint CDF, Joint PMF; conditional expectation, Joint moments; covariance and correlation; independent, uncorrelated and orthogonal random variables; Jointly Gaussian random variables; Transformations of pairs of Random variables, Linear Mean Square Estimation.**Multiple Random variables** Joint and Conditional PMF's, CDF's and PDF's; Central limit theorem; Gaussian random variables in multiple dimensions; mean vector, covariance matrix and properties.

Unit – III	**10 Hrs**

Random Processes From Random Variable to Random Process, Classification of Random Processes, Stationary and ergodic random processes, Properties of the Auto correlation function, Gaussian random processes. **Spectral Analysis** Power Spectral Density, The Wiener-Khintchine-Einstein Theorem**,** Multiple Random Processes, Transmission of Random Processes through Linear Systems. Engineering Application : PSD's of digital modulation formats and Matched filter.

Unit – IV	**10 Hrs**

Integrals Definite Integrals, Contours, Line Integrals. Cauchy Goursat Theorem with proof. Simply and Multiply connected Domains, Indefinite Integrals, The Cauchy Integral Formula, Derivatives of Analytic Functions, Morera's Theorem, Maximum Moduli of Functions, The

Fundamental Theorem of Algebra. **Series** Convergence of Sequence and Series. Taylor Series. Laurent Series. Further Properties of Series. Uniform Convergence. Integration and Differentiation of Power Series.

Unit – V	**10 Hrs**

Residues and Poles

The Residues. The Residue Theorem. The principal part of a Function. Poles. Quotients of Analytic Functions. Evaluation of Improper Real Integrals. Improper Integrals Involving Trigonometric Functions. Integration around a Branch point.

Expected Course Outcomes:

After going through this course the student will be able to:

CO1: Demonstrate the understanding of fundamentals of probability theory, random process, properties of complex functions

CO2: Analyze and solve problems on probability distributions, multiple random variables, Cauchy's integral formula and analytic functions

CO3: Apply acquired knowledge to find moments, properties of auto correlation function find Laurent's series and discuss its convergence

CO4: Estimate cumulative distribution function, probability generating function, singularities and residues of complex functions and evaluate complex integral using the residue theorem. Also be able to recognize problems which involve these concepts in communication systems.

Reference Books:

1.	Scott. L. Miller and Donald. G. Childers, "Probability and Random Processes: With Applications to Signal Processing and Communications", Elsevier Academic Press, 2nd Edition, 2012. ISBN-9381269521, 978-9381269527.
2.	Wilfred Kaplan, "Advanced Calculus", Addison Wesley Higher Mathematics, 5th Edition.ISBN :0201799375, 978-0201799378.
3.	A Papoullis and S U Pillai , "Probability, random variables and Stochastic process",Mcgraw Hill 2002, ISBN 9780071226615

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Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M	M	M								
CO2	M	M	M	H		M			M	M	M
CO3	M	M	M	H					M	M	M
CO4	M	M	M	H	M				M	M	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	M
CO2	M	M
CO3	L	L
CO4	L	L

PROFESSIONAL SKILL DEVELOPMENT						
Course Code	**:**	**16HSS16**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L:T:P:S**	**0:0:4:0**	**Credits**	**:**	**02**

Course Learning Objectives (CLO):

This course will enable student to:

1. Understand the importance of verbal and written communication
2. Improve qualitative and quantitative problem solving skills
3. Apply critical and logical think process to specific problems
4. Manage stress by applying stress management skills

Unit –I	**5Hrs**

Communication Skills: Basics of Communication, Personal Skills & Presentation Skills, Attitudinal Development, Self Confidence, SWOC analysis.
Resume Writing: Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts.

Unit – II	**6 Hrs**

Quantitative Aptitude and Data Analysis*:* Number Systems, Math Vocabulary, fraction decimals, digit places etc. Reasoning and Logical Aptitude, - Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions. Verbal Analogies – introduction to different question types – analogies, sentence completions, sentence corrections, antonyms/synonyms, vocabulary building etc. Reading Comprehension, Problem Solving

Unit – III	**4 Hrs**

Interview Skills: Questions asked & how to handle them, Body language in interview, Etiquette, Dress code in interview, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on Stress Interviews, Technical Interviews, General HR interviews

Unit – IV	**5Hrs**

Interpersonal and Managerial Skills: Optimal co-existence, cultural sensitivity, gender sensitivity; capability and maturity model, decision making ability and analysis for brain storming; Group discussion and presentation skills;

Unit – V	**4Hrs**

Motivation and Stress Management: Self motivation, group motivation, leadership abilities Stress clauses and stress busters to handle stress and de-stress; professional ethics, values to be practiced, standards and codes to be adopted as professional engineers in the society for various projects**.**

Note: The respective departments should discuss case studies, standards and aptitude tests pertaining to their domain.

Expected Course Outcomes:
After going through this course the student will be able to:
CO1: Develop professional skill to suit the industry requirement
CO2: Analyze problems using quantitative and reasoning skills
CO3: Develop leadership and interpersonal working skills
CO4: Demonstrate verbal communication skills with appropriate body language.

References

1. Stephen R Covey, "The 7 Habits of Highly Effective People", Free Press, 2004 Edition, ISBN: 0743272455
2. Dale Carnegie, "How to win friends and influence people", General Press, 1st Edition, 2016, ISBN: 9789380914787
3. Kerry Patterson, Joseph Grenny, Ron Mcmillan, "Crucial Conversation: Tools for Talking When Stakes are High", McGraw-Hill Publication, 2012 Edition, ISBN: 9780071772204

4. Ethnus, "Aptimithra: Best Aptitude Book", Tata McGraw Hill, 2014 Edition, ISBN: 9781259058738

Scheme of Continuous Internal Examination (CIE)

Evaluation will be carried out in TWO Phases.

Phase	Activity	Weightage
I	After 7 weeks - Unit 1, 2 & Part of Unit 3	50%
II	After 12 weeks – Unit 3, 4, 5	50%

CIE Evaluation shall be done with weightage as follows:

Writing skills	10%
Logical Thinking	25%
Verbal Communication & Body Language	35%
Leadership and Interpersonal Skills	30%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	---	L	---	----	H	----	H	H	H	M
CO2	H	M	H	---	---	---	----	---	M	H	M
CO3	---	---	L	---	---	H	---	H	H	H	H
CO4	---	---	H	---	----	H	L	H	H	H	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1		
CO2		
CO3	H	H
CO4		

SECOND SEMESTER

PROJECT MANAGEMENT						
Course Code	**:**	**16MEM21P**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P: S**	**3:2:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives:

This course will enable student to:

1. Understand the principles and components of project management.
2. Appreciate the integrated approach to managing projects.
3. Elaborate the processes of managing project cost and project procurements.
4. Apply the project management tools and techniques.

Unit – I	**10 Hrs**

Introduction: Project, Project management, relationships among portfolio management, program management, project management, and organizational project management, relationship between project management, operations management and organizational strategy, business value, role of the project manager, project management body of knowledge.

Unit – II	**10Hrs**
Generation and Screening of Project Ideas: Generation of ideas, monitoring the environment, corporate appraisal, scouting for project ideas, preliminary screening, project rating index, sources of positive net present value. **Project Scope Management:** Project scope management, collect requirements define scope, create WBS, validate scope, control scope. **Organizational influences & Project life cycle:** Organizational influences on project management, project state holders & governance, project team, project life cycle.	
Unit – III	**10 Hrs**
Project Integration Management: Develop project charter, develop project management plan, direct & manage project work, monitor & control project work, perform integrated change control, close project or phase. **Project Quality management:** Plan quality management, perform quality assurance, and control quality.	
Unit – IV	**8Hrs**
Project Risk Management: Plan risk management, identify risks, perform qualitative risk analysis, perform quantitative risk analysis, plan risk resources, control risk. **Project Scheduling:** Project implementation scheduling, Effective time management, Different scheduling techniques, Resources allocation method, PLM concepts. Project life cycle costing.	
Unit-V	**10 Hrs**
Tools & Techniques of Project Management: Bar (GANTT) chart, bar chart for combined activities, logic diagrams and networks, Project evaluation and review Techniques (PERT) Planning, Computerized project management	
Syllabus includes tutorials for one hour per week: • Case discussions on project management • Numerical problems on PERT & CPM • Computerized project management exercises using M S Project Software	
Course Outcomes: After going through this course the student will be able to: CO1: Explain the process of project management and its application in delivering successful projects. CO2: Illustrate project management process groups for various project / functional applications. CO3: Appraise various knowledge areas in the project management framework. CO4: Develop project plans and apply techniques to monitor, review and evaluate progress for different types of projects.	
Reference Books:	
1.	Project Management Institute Inc ,"A Guide to the Project Management Body of Knowledge (PMBOK Guide)", 5th Edition, 2013, ISBN: 978-1-935589-67-9
2.	Harold Kerzner, "Project Management A System approach to Planning Scheduling & Controlling", John Wiley & Sons Inc., 11th Edition, 2013, ISBN 978-1-118-02227-6.
3	Prasanna Chandra, "Project Planning Analysis Selection Financing Implementation & Review", Tata McGraw Hill Publication, 7th Edition, 2010, ISBN 0-07-007793-2.
4.	Rory Burke, "Project Management – Planning and Controlling Techniques", John Wiley & Sons, 4th Edition, 2004, ISBN: 9812-53-121-1

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Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	M	M	----	M	H	H	H	----	H	----
CO2	----	M	----	-----	M	H	H	H	L	H	----
CO3	---	M	H	---	M	H	H	H	H	H	M
CO4	M	H	M	L	H	H	H	H	----	H	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1		
CO2	L	
CO3		M
CO4		M

Advanced Communications Systems -2 (Theory & Practice)						
Course Code	**:**	**16MCS22**		**CIE Marks**	**:**	**100+50**
Hrs/Week	**:**	**L:T:P:S**	**4:0:2:0**	**SEE Marks**	**:**	**100+50**
Credits	**:**	**5**		**SEE Duration**	**:**	**3 Hrs + 3Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Describe and demonstrate the model of discrete time channel with ISI, model of discrete time channel by equalizer & various types of equalizers used for channel modeling and adjusting the filter coefficients
2. Demonstrate the concept of spread spectrum communication system and analyze the error performance.
3. Analyze the operation of different modulation techniques and analyze the error performance of digital modulation techniques in presence of AWGN noise
4. Design the characterization of fading multipath channels.

Unit – I	**10 Hrs**

Multichannel and Multicarrier Signalling: Multichannel Communications in an AWGN channel, Multicarrier Communications in AWGN channel. Synchronization – Signal Parameter estimation, Carrier Phase Estimation, Symbol Timing Recovery, Joint estimation of Carrier phase and symbol timing.

Unit – II	**10 Hrs**

Channel Models: Physical Models for wireless Channels, baseband equivalent model for channel, time and frequency coherence, statistical channel models.**Point-to-Point Communication**, Detection diversity and channel uncertainty: Detection in Rayleigh fading channels, Time diversity, Antenna diversity, Frequency diversity, Impact of the channel uncertainty.

Unit – III	**10 Hrs**

Capacity of wireless channel: AWGN channel capacity, Resources of AWGN channel, Linear time invariant Gaussian channel, Capacity of fading channels.

Unit – IV	**10 Hrs**

MIMO spatial multiplexing and channel modeling: Multiplexing capability of deterministic MIMO channels,Physical modeling of MIMO channels, Modeling of MIMO fading channels**.**

Unit – V	**10 Hrs**

MIMO capacity and multiplexing architectures: The V-BLAST architecture, Fast fading MIMO channel, Capacity with CSI at receiver, Performance gains, Full CSI, Performance gains in a MIMO channel, Receiver architectures – (Linear decorrelator, Successive cancellation, Linear MMSE receiver), Information theoretic optimality, Connections with CDMA multiuser detection and ISI equalization, Slow fading MIMO channel, D-BLAST: an outage-optimal architecture, Suboptimality of V-BLAST, Coding across transmit antennas: D-BLAST

Unit – VI (Lab Component)	

1. Radiation characteristics of Microstrip Patch and Printed Dipole Antenna
2. Measurement of S-parameters of a power divider, printed directional coupler and resonant antennas (Patch and Dipole antennas) using network analyser.
4. Design and Simulation of Waveguide Magic-Tee and Horn antenna.
5. Design and Simulation of a Printed Hybrid Ring and Power divider
6. Characterization of Microwave Waveguide Tee's, Directional Coupler, Circulator and Isolator
7. Analog and Digital communication link using optical fiber
   Study of Propagation loss, Bending loss and Measurement of Numerical Aperture in OFC
8. Matched filter & Linear equalizer simulation in Matlab
9. Students will be provided open ended problem to access their capabilities

Expected Course Outcomes:

After going through this course the student will be able to:

CO1: Explain the concepts of multi-channel signaling scheme including synchronization for carrier and symbol timing recovery at receiver as well as models for a multipath channel environment.

CO2: Evaluate the degradation in performance of various symbol signaling schemes in a multipath environment.

CO3: Develop & analyze schemes to improve performance in a multipath environment including diversity, maximal ratio combining and RAKE receivers and evaluate their performance improvements.

CO4: Develop and evaluate the performance of a MIMO scheme to meet specified rate in a given multipath environment.

Reference Books:

1.	John G. Proakis, Masoud Salehi,"Digital Communications ",5e,Pearson Education(2014),ISBN:978-9332535893
2.	David Tse, Pramod Viswanath, "Fundamentals of Wireless Communication",1e,Cambridge University Press(2005), ISBN:0521845270
3.	Bernard Sklar,"Digital Communications: Fundamentals and Applications: Fundamentals &Applications",2e,Pearson Education(2009),ISBN:978-8131720929
4	Simon Haykin ,"Digital Communications Systems",2e,Wiley(2013),ISBN:978-8126542314

Scheme of Continuous Internal Evaluation (CIE) for Theory

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Continuous Internal Evaluation (CIE) for Practical

CIE for the practical courses will be based on the performance of the student in the laboratory, every week. The laboratory records will be evaluated for 40 marks. One test will be conducted for 10 marks. The total marks for CIE (Practical) will be for 50 marks.

Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Practical

SEE for the practical courses will be based on conducting the experiments and proper results for 40 marks and 10 marks for viva-voce. The total marks for SEE (Practical) will be 50 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	H	H	H	H	H	M	L	L	H	L	H
CO2	H	H	H	H	H	M	L	M	H	M	H
CO3	H	H	H	H	H	H	L	H	H	L	H
CO4	H	H	H	H	H	H	M	M	H	M	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	M	M
CO2	H	H
CO3	M	H
CO4	H	H

Adaptive Signal Processing						
Course Code	**:**	**16MCS231**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Explain the concepts of forward, backward linear models and autoregressive models. Apply the concepts to predictive modeling of speech & steepest descent search algorithms and performance measure & also process , models and power spectral estimation
2. Employ the concepts of adaptive filters and adaptive systems with examples
3. Analyze the concepts of Wiener filer and apply to sidelobe canceller.
4. Design the concepts of least mean square algorithm and its applications.

Unit – I	**10 Hrs**

Introduction to Adaptive Filters

Adaptive filter structures, issues and examples. Applications of adaptive filters. Channel equalization, active noise control. Echo cancellation, beam forming.

Stochastic processes and models: Partial characterization of a discrete time stochastic process, correlation matrix, Asymptotic stationarity of an autoregressive process, Yule-walker equations, power spectral density, properties of power spectral density, power spectrum estimation

Unit – II	**10 Hrs**

Wiener filters

Linear optimum filtering, principle of orthogonality, minimum mean square error, Wiener-Hopf equation, Error performance surface, Multiple linear regression model, Linearity constrained minimum variance filter, Generalized sidelobe cancellers.

Unit – III	**10 Hrs**

Linear Prediction
Forward linear prediction, Backward linear prediction, Levinson-Durbin Algorithm, Properties of prediction error filter, Schur-Cohn Test, Autoregressive modeling of a stationary stochastic process, Cholesky Factorization, Lattice predictors, All pole All pass lattice filters, Joint process estimation, predictive modeling of speech.

Unit – IV	**10 Hrs**

Method of Steepest Descent
Basic idea of Steepest Descent Algorithm, The Steepest Descent Algorithm applied to the Wiener filter, stability of Steepest Descent Algorithm, the Steepest Descent algorithm as a deterministic search method, Virtue and limitation of the Steepest Descent Algorithm.

Unit – V	**10 Hrs**

Least –Mean-Square Adaptive Filters: Least –Mean-Square Adaptive Algorithm, Statistical LMS theory, Comparison of LMS Algorithm with the steepest-Descent Algorithm, Directionality of convergence of the LMS algorithm for nonwhite input, Robustness of the LMS filter, Upper bound on the step size parameter for different scenarios.

Expected Course Outcomes:

After going through this course the student will be able to:

CO1: Develop a strong grounding in the fundamentals of Adaptive signal processing & Use appropriate mathematical skills to describe, analyze, and solve problems in Adaptive signal processing.
CO2: Evaluate and test the modern Adaptive signal processing systems using simulation tool.
CO3: Design suitable algorithm for specific applications.
CO4: Apply the concept of modern linear algebra for Adaptive signal processing.

Reference Books:

1.	S. Haykin, "Adaptive Filter Theory", Prentice Hall, Englewood Cliffs, NJ, 1991 (end Ed.). ISBN 013322760X, 978-0133227604
2.	B. Farhang-Boroujeny, "Adaptive Filters : Theory and Applications", by, John Wiley and Sons, 1999. ISBN: 1119979544
3.	Jacob Benesty, Yiteng Huang, "Adaptive Signal Processing: Applications to Real-World Problems",Springer, 2003, ISBN:3450000518
4.	Victor Solo ,Xuan Kong, "Adaptive Signal Processing Algorithms: Stability and Performance" ,Prentice Hall, 1e, 1994,ISBN: 978-0135012635

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Scheme of Semester End Examination (SEE) for Theory
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	H	M	M	L	H	M	L	L	M	L	L

CO2	H	M	H	M	H	M	L	L	M	L	L
CO3	H	H	H	H	H	M	M	M	M	M	M
CO4	H	H	H	H	H	M	M	M	H	H	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	M	H
CO2	H	L
CO3	M	L
CO4	H	L

VLSI Digital Signal Processing Systems						
Course Code	**:**	**16MCS232**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Describe VLSI algorithm transforms including retiming, pipelining and parallel processing, folding/unfolding, algebraic transforms, relaxed look-ahead transforms, and dynamic algorithm transforms.
2. Design and optimize VLSI architectures for basic DSP algorithms.
3. Analyze circuit design tradeoffs to jointly optimize for power, performance, and area.
4. Design VLSI design methodology for signal processing systems.

Unit – I	**10Hrs**

Introduction to digital Signal Processing systems

Introduction, Typical DSP algorithms, DSP Application demands and scaled CMOS technologies, Representations of DSP algorithms.

Unit – II	**10Hrs**

Pipelining and parallel processing

Introduction, Pipelining of FIR Digital filters, parallel processing, pipelining and parallel processing for low power.

Unit – III	**10Hrs**

Algorithmic strength reduction in filters and transforms
Introduction, parallel FIR filters, Discrete Cosine transform and inverse DCT, Parallel architectures for Rank-Order Filters.

Unit – IV	**10Hrs**

Pipelined and parallel Recursive and Adaptive Filters

Introduction, Pipeline interleaving in digital Filters, pipelining in 1st order IIR digital filters, Pipelining in higher order IIR Digital filters, parallel processing for IIR filters, combined pipelining and parallel processing for IIR filters, low power IIR digital Filter Design using Pipelining and parallel processing, Pipelined Adaptive Digital Filters.

Unit – V	**10Hrs**

Programmable digital Signal Processor
Introduction, evolution of programmable Digital Signal processors, Important feature of DSP processors, DSP Processors for Mobile and wirelesses communication, Processor for multimedia signal Processing.

Expected Course Outcomes:

After going through this course the student will be able to:

CO1: Develop a strong grounding in the fundamentals of VLSI digital signal processing ,
CO2: Understand DSP architectures and CMOS technologies to describe, analyze, and solve problems in VLSI digital signal processing.
CO3: Evaluate and test the modern VLSI digital signal processing systems using simulation tool.
CO4: Design suitable algorithm for specific applications & Develop applications using general purpose digital signal processors

Reference Books:

1	Keshab K. Parthi , "VLSI Digital Signal processing systems :Design and implementation" Wiley 1999,ISBN: 81-265-1098-6.
2	Rulph chasseing, "Digital Signal Processing and applications " with C6713 and C6416 DSK, Wiley 2005.
3.	Nasser Kehtarnavaz, " digital Signal Processing System Design: Lab view based hybrid programming,Academic press 2008.

Scheme of Continuous Internal Evaluation (CIE) for Theory
CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Theory
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	H	M	M	L	H	M	L	L	M	L	L

CO2	H	M	H	M	H	M	L	L	M	L	L
CO3	H	H	H	H	H	M	M	M	M	M	M
CO4	H	H	H	H	H	M	M	M	H	H	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	H	H
CO2	H	M
CO3	M	M
CO4	L	L

Multimedia Communication						
Course Code	**:**	**16MCS241**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Understand the basics of analog and digital video: video representation and transmission
2. analyze analog and digital video signals and systems
3. Analyze the fundamental video processing techniques & acquire the basic skill of designing video compression
4. Design video transmission systems: error control and rate control

Unit – I	**10 Hrs**
Multimedia Communications: multimedia information representation, multimedia networks, multimedia applications, network QoS and application QoS	
Unit – II	**10 Hrs**
Information Representation: text, images, audio and video, Text and image compression, compression principles, text compression, image compression. Audio and video compression, audio compression, video compression, video compression principles, video compression standards: H.261, H.263, P1.323, MPEG 1, MPEG 2, Other coding formats for text, speech, image and video.	
Unit – III	**10 Hrs**
Detailed Study of MPEG 4: coding of audiovisual objects, MPEG 4 systems, MPEG 4 audio and video, profiles and levels. MPEG 7 standardization process of multimedia content description, MPEG 21 multimedia framework, Significant features of JPEG 2000, MPEG 4 transport across the Internet.	
Unit – IV	**10 Hrs**
Synchronization: Notion of synchronization, presentation requirements, reference model for synchronization, Synchronization specification. Multimedia operating systems, Resource management, process management techniques.	
Unit – V	**10 Hrs**

Multimedia Communication Across Networks: Layered video coding, error resilient video coding techniques, multimedia transport across IP networks and relevant protocols such as RSVP, RTP, RTCP, DVMRP, multimedia in mobile networks, multimedia in broadcast networks
Expected Course Outcomes: After going through this course the student will be able to: CO1: Describe and describe various multimedia data. CO2: Analyze the representation of multimedia data. CO3: Describe the concept involved in MPEG4 standards. CO4: Develop algorithms for protocols like RSVP, RTP for multimedia communication .over mobile networks.

Reference Books:

1.	Fred Halsall, "Multimedia Communications", Pearson education, 2001. ISBN: 8131709949, 978-8131709948
2.	K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, "Multimedia Communication Systems", Pearson education, 2004.ISBN: 013031398X978-0130313980
3.	Raif steinmetz, Klara Nahrstedt, "Multimedia: Computing, Communications and Applications", Pearson education, 2002,ISBN: 3540408673, 978-3540408673
4.	John Billamil, Louis Molina, "Multimedia : An Introduction", PHI, 2002, ISBN: 1575765578, 978-1575765570

Scheme of Continuous Internal Evaluation (CIE) for Theory

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	H	L	L	M	H	M		L	L		L
CO2	M	M	L	M	H	H	L	L	M		L
CO3	M	M	M	M	H	L			L	L	L
CO4	M	H	H	H	H	H	M	L	M		L

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	M	H
CO2	L	H
CO3	M	M
CO4	H	L

Digital Image Processing						
Course Code	**:**	**16MCS242**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Insight on of image processing along with its application areas.
2. Knowledge about different techniques for image processing
3. Knowledge of MATLAB image processing tool box
4. Expose students to current technologies and issues that are specific to image processing systems
5. Develop hands-on experience in using computers to process images
6. Familiarize with MATLAB Image Processing Toolbox

Unit – I	**10 Hrs**
Introduction, Digital Image definitions- Common values, Characteristics of Image Operations, Video Parameters, Tools- 2D Convolution, properties of 2D convolution, 2D Fourier Transforms, properties of 2D Fourier Transforms, Statistical Description of Images, Perception-Brightness Sensitivity, Spatial frequency sensitivity, Psychophysics of color vision ,Optical illusions.	
Unit – II	**10 Hrs**
Image Sampling-2D sampling theory, Extensions of sampling theory. Image Quantization-The optimum Mean square Lloyd-Max quantizer, optimum mean square uniform quantizer for non-uniform densities, Analytical models for practical quartiers, Visual quantization, vector quantization.	
Unit – III	**10 Hrs**
Image Transforms-Two dimensional orthogonal and unitary transforms, Discrete linear othrogonal transforms[DFT,WHT,KLT,DCT and SVD], quantization of transform coefficients, transform coding of color images	
Unit – IV	**10 Hrs**
Image Enhancement- Contrast and dynamic range modification, smoothing operations, edge detection-derivative based operation, image interpolation and motion estimation, Pseudo coloring.	
Unit – V	**10 Hrs**
Image Restoration-Degradation estimation, reduction of additive noise, reduction of image blurring, simultaneous reduction of noise and blurring, reduction of signal dependent noise. Temporal filtering of image restoration, extrapolation of band limited signals.	

Expected Course Outcomes:

After going through this course the student will be able to:

CO1: Describe fundamentals of digital image processing: hardware and software, digitization, enhancement and restoration, encoding, segmentation, feature detection.

CO2: Explore the algorithms and techniques involved in Digital Image Processing using computational tools.

CO3: Design & analyze the various processing techniques on an image in both spatial and frequency (Fourier) domains

CO4: Implement the different processing techniques on different types of images using MATLAB.

Reference Books:

1.	Rafael C. Gonzalez & Richard E. Woods, "Digital Image Processing", 3rd edition, Pearson Education , 2016, ISBN-10: 9332570329,978-9332570320
2.	A.K. Jain, "Fundamental of Digital Image Processing", PHI publications, 2015. **ISBN:** 978-933255191
3.	Jähne, Bernd," Digital Image Processing", Springer , 2005, ISBN: 9783540275633
4.	Chris Solomon, Toby Breckon, "Fundamentals of Digital Image Processing: A Practical Approach with Examples in Matlab", Wiley, 2011, ISBN: 978-0-470-84472-4

Scheme of Continuous Internal Evaluation (CIE) for Theory

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	H	M	H	M	L	L			L		M
CO2	H	H	M	M	M	M			H		M
CO3	H	H	H	H	H	H			H		H
CO4	H	H	H	H	H	H			H		H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	M	H
CO2	L	H
CO3	M	M

CO4	H	M

Real time Signal Processing & Communication Design						
Course Code	**:**	**16MCS251**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Describe the key theoretical principles underpinning DSP in a design procedure through design examples and case studies
2. Describe the architecture of a digital signal processor and some programming issues in fixed-point digital signal processor in real-time implementation.
3. Design the digital filters & other signal processing & communication algorithm
4. Implement & optimize digital filters & other signal processing & communication algorithm

Unit – I	**10 Hrs**

Introduction to Real-Time Digital Signal Processing, Design and Implementation of FIR Filters & Introduction , Design of FIR Filters , Implementation Considerations, Applications: Interpolation and Decimation Filters , Practical Applications Program Examples Design and Implementation of IIR Filters , Introduction , Design of IIR Filters , Realization of IIR Filters , Implementation Considerations, Practical Applications Program Examples

Unit – II	**10 Hrs**

Frequency Analysis and the Discrete Fourier Transform Fourier Series and Fourier Transform ,Discrete Fourier Transform, Fast Fourier Transforms , Implementation Considerations, Practical Applications Program Examples **Adaptive Filtering** Introduction to Random Processes, Adaptive Filters, Performance Analysis, Implementation Considerations, Practical Applications Program Examples

Unit – III	**10 Hrs**

Digital Signal Generation and Detection Sine Wave Generators, Noise Generators , DTMF Generation and Detection, Experiments and Program Examples**, Adaptive Echo Cancellation**, Introduction to Line Echoes Adaptive Line Echo Canceller Practical Considerations Double-Talk Effects and Solutions ,Nonlinear Processor Adaptive Acoustic Echo Cancellation Experiments and Program Examples

Unit – IV	**10 Hrs**

Speech Signal Processing Speech Coding Techniques , Speech Enhancement, VoIP Applications Experiments and Program Examples ,**Audio Signal Processing** ,Audio Coding Audio Equalizers Audio Effects Experiments and Program Examples

Unit – V	**10 Hrs**

Frequency modulation: Theory, Single tone FM, Narrow band FM, FM bandwidth, FM demodulation, Discrimination and PLL methods**, Digital Modulation scheme**: PRBS, and data scramblers: Generation of PRBS, Self synchronizing data scramblers, Implementation of PRBS and data scramblers. **PAM** theory, baseband pulse shaping and ISI, Implementation of transmit filter and interpolation filter bank. Simulation and theoretical exercises for PAM, Hardware exercises for PAM

Expected Course Outcomes:

After going through this course the student will be able to:

CO1: Explain the signal processing methods & communication system algorithms
CO2: Design & develop program for signal processing & communication system algorithm
CO3: Design the digital & adaptive filters , speech & audio signal processing & also Communication systems with given specification
CO4: Implement & optimize for digital & adaptive filters algorithms, speech ,audio signal processing & communication system programming in fixed point processor

Reference Books:

1.	Sen M. Kuo, Bob H. Lee, Wenshun Tian, "Real-Time Digital Signal Processing: Fundamentals, Implementations and Applications", 3e,Wiley(2013), ISBN: 978-1118414323
2.	V. Udayashankara "Real Time Digital Signal Processing: Fundamentals, Algorithms and Implementation Using Tms Processor", PHI India, 2010, ISBN: 978-8120340497
3.	B. Venkataramani and M Bhaskar,"Digital Signal Processors ",2e,TMH(2010), ISBN: 9780070702561
4.	John G Proakis ,et.al,"Contemporary Communication Systems Using MATLAB", 3e, Wadsworth Publishing(2011),ISBN: 978-0495082514

Scheme of Continuous Internal Evaluation (CIE) for Theory

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Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M	H	H	M	H		L		H		
CO2	M	H	H	M	L		H		M		
CO3	M	M	L	M	M	L	L		H		
CO4	H	H	H	H	H	L	M		H	L	

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	H	L
CO2	L	M
CO3	H	H
CO4	H	M

Communication Networks						
Course Code	**:**	**16MCS252**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1 Describe basic networking principles & various aspects involved in multiple access and multiplexing.
2 Analyze the LAN architectures and the various data switching techniques.
3 Demonstrate protocols operating at different layers of computer networks.
4 Design various aspects involved in network control and traffic management.

Unit – I	**10 Hrs**

Introduction to networks: Computer network, Telephone networks, Networking principles. (Text book 1), Protocol layering Multiplexing- TDM, FDM, SM, WDM **Multiple Access:** Introduction, Choices and constraints, base technologies, centralized and distributed access schemes.

Unit – II	**10 Hrs**

Local Area Networks: Ethernet - Physical layer, MAC, LLC, LAN interconnection, Token ring- Physical layer, MAC, LLC, FDDI. **Switching**- introduction, circuit switching, packet switching, multicasting.Scheduling: Introduction, requirements, choices, performance bounds, best- effort techniques. Naming and addressing .

Unit – III	**10 Hrs**

SONET, SDH ,ATM Networks- features, signaling and routing, header and adaptation layers ,virtual circuits, SSCOP, Internet- addressing, routing, end point control Internet protocols- IP, TCP, UDP, ICMP, HTTP.

Unit – IV	**10 Hrs**

Traffic Management: Introduction, framework for traffic management, traffic models, traffic classes, traffic scheduling **.Control of Networks**: Objectives and methods of control, routing optimization in circuit and datagram networks, Markov chains, Queuing models in circuit and datagram networks .

Unit – V	**10 Hrs**

Congestion and flow control: window congestion control, rate congestion control, control in ATM Networks, flow control model, open loop flow control, closed loop flow control .

Expected Course Outcomes:

After going through this course the student will be able to:

CO1: Explain the performance of various multiple access protocols.
CO2: Design the network protocol for given specifications of applications.
CO3: Design & develop the scheduling algorithms for various performance metrics.
CO4: Develop various network traffic management and control techniques for given specification

Reference Books:

1.	J. Walrand and P. Varaya, "High performance communication networks", Harcourt Asia (Morgan Kaufmann), 2000, ISBN: 1-55860-574-6
2.	S. Keshav, "An Engineering approach to Computer Networking", Pearson Education, 1997., ISBN-10: 0201634422

3.	Leon-Garcia, and I. Widjaja, "Communication network: Fundamental concepts and key architectures", TMH, 2000., ISBN-13: 9780070228399
4.	J. F. Kurose, and K. W. Ross, "Computer networking: A top down approach featuring the Internet", Pearson Education, 2001, ISBN-13: 9780132856201

Scheme of Continuous Internal Evaluation (CIE) for Theory

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M	H	H	M	H		L		H		
CO2	M	H	H	M	L		H		M		
CO3	M	M	L	M	M	L	L		H		
CO4	H	H	H	H	H	L	M		H	L	

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	H
CO2	H	H
CO3	M	L
CO4	H	M

MINOR PROJECT						
Course Code	**:**	**16MCS26**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**0:0:10:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**05**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Understand the method of applying engineering knowledge to solve specific problems.
2. Apply engineering and management principles while executing the project
3. Demonstrate the skills for good presentation and technical report writing skills.

4. Identify and solve complex engineering problems using professionally prescribed standards.

GUIDELINES

1. Each project group will consist of maximum of two students.
2. Each student / group has to select a contemporary topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Allocation of the guides preferably in accordance with the expertise of the faculty.
4. The number of projects that a faculty can guide would be limited to four.
5. The minor project would be performed in-house.
6. The implementation of the project must be preferably carried out using the resources available in the department/college.

Course Outcomes:

After completion of the course the student would be able to**:**

CO1: Conceptualize, design and implement solutions for specific problems.
CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply resource managements skills for projects
CO4: Synthesize self-learning, team work and ethics.

Scheme of Continuous Internal Examination (CIE)

Evaluation will be carried out in THREE Phases. The evaluation committee will comprise of FOUR members : guide, two senior faculty members and Head of the Department.

Phase	Activity	Weightage
I	Synopsis submission, Preliminary seminar for the approval of selected topic and Objectives formulation	20%
II	Mid-term seminar to review the progress of the work and documentation	40%
III	Oral presentation, demonstration and submission of project report	40%

****Phasewise rubrics to be prepared by the respective departments**

CIE Evaluation shall be done with weightage / distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/experimental setup 25%
- Conducting experiments / implementation / testing 25%
- Demonstration & Presentation 15%
- Report writing 25%

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

1. Brief writeup about the project 5%

2. Presentation / Demonstration of the project 20%
3. Methodology and Experimental Results & Discussion 25%
4. Report 20%
5. Viva Voce 30%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M	M	H	H	H	---	---	M	---	H	H
CO2	----	---	----	---	H	----	---	H	H	H	----
CO3	H	H	M	---	M	M	H	H	---	M	H
CO4	---	H	----	---	----	H	M	M	M	H	---

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	H
CO2		L
CO3	L	
CO4		L

THIRD SEMESTER

Time-harmonic Electromagnetic Fields (Theory & Practice)						
Course Code	:	**16 MCS 31**		**CIE Marks**	**:**	**100+50**
Hrs/Week	**:**	**L:T:P:S**	**4:0:1:0**	**SEE Marks**	**:**	**100+50**
Credits	**:**	**5**		**SEE Duration**	**:**	**3 Hrs + 3Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Apply the basic theorems and concepts of electromagnetics to dielectrics and conductors and EM wave behavior in different materials.
2. Understand the uniform plane wave propagation in unbounded lossless and lossy medium.

3. Understand and analyze the wave propagation in rectangular and circular waveguides.
4. Analyze the radiation and scattering equations and study the scattering effect from a strip, a flat rectangular plate and a circular cylinder.
5. Develop an understanding of numerical techniques in electromagnetics like, Method of Moments, Geometrical optics and geometrical theory of diffraction.

Unit – I	**10 Hrs**

Theorems and Concepts

Electrical properties of matter: Dielectrics, polarization, permittivity, magnetic, magnetization, permeability, current, conductors and conductivity.

The Source Concept, Duality, Uniqueness, Image Theory, The Equivalence Principle, Fields in Half-space, The Induction Theorem, Reciprocity, Reaction Theorem, Green's Functions, Integral Equations, Radiation Field.

Wave Equations and its Solution

Maxwell's equations, The Wave Equation, Waves in Perfect Dielectrics, Intrinsic Wave Constants, Waves in Lossy Matter, Reflection of Waves, Boundary conditions, Time harmonic electromagnetic fields and Numericals. Time varying electromagnetic fields, solution to the wave equation in rectangular coordinate system, cylindrical coordinate system and spherical coordinate system and Numericals.

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Unit – II	**10 Hrs**

Wave Propagation and Polarization

Transverse electromagnetic modes, Uniform plane waves in unbounded lossless medium (Principal axis, Oblique angle), Uniform plane waves in unbounded lossy medium (Principal axis and Oblique angle), Polarization (Linear, Circular and Elliptical).

Reflection and transmission: Normal incidence and oblique incidence (Lossless media)

Unit – III	**10 Hrs**

Wave propagation in bounded media

Wave propagation in Rectangular waveguide, TE and TM mode, power density and power, attenuation, stripline and microstrip lines.

Wave propagation in circular waveguide, TE and TM modes, and attenuation. (Numericals wherever applicable).

Unit – IV	**09 Hrs**

Wave propagation in unbounded media

Radiation: Solutions to the inhomogeneous vector potential wave equation, Far field radiation, Radiation and scattering equations in rectangular coordinates (Far field).

Scattering: Infinite line source cylindrical wave radiation (Electrical line source and magnetic line source), plane wave scattering from a strip, plane wave scattering from a flat rectangular plate and scattering by a circular cylinder (TE or TM polarization).

Unit – V	**10 Hrs**

Wave propagation in unbounded media- continued

Integral equation and Moment Method: Electrostatic charge distribution (finite wire and bent wire), Pocklington integral equation and Hallen's integral equation.

Geometrical optics: Amplitude relation, phase and polarization relation, reflection from a curved

surface, reflection from a conducting sphere and reflection from a line source above a finite width strip.

Geometrical theory of diffraction: Amplitude, phase and polarization relation, diffraction by a curved edge, diffraction by a wedge with a straight edge, diffraction by a pyramidal horn antenna and diffraction by a paraboloid reflector.

Lab Component	**30 Hrs**

3. Study of Reflex klystron source.
4. Radiation characteristics of Microstrip Patch and Printed Dipole Antenna
5. Radiation characteristics of Pyramidal Horn Antenna.
6. Measurement of S-parameters of a power divider, printed directional coupler and resonant antennas (Patch and Dipole antennas) using network analyser.
7. Design and Simulation of Waveguide Magic-Tee and Horn antenna.
8. Design and Simulation of a Printed Hybrid Ring and Power divider.
9. Design and simulation of Microstrip patch and printed dipole antenna.
10. Characterization of Microwave Waveguide Tee's, Directional Coupler, Circulator and Isolator.
11. Geometrical optics Ray tracing through a dielectric lens.
12. Geometrical theory of diffraction through a metallic sphere.

Expected Course Outcomes:

After going through this course the student will be able to:

CO1: Understand electromagnetics propagation in media using modal wave harmonics and Geometric Ray optics with Diffraction at boundaries.

CO2: Demonstrate analytical skills in applying electromagnetics concepts of modal wave harmonics to propagation in bounded media like wave guides.

CO3: Demonstrate analytical skills in applying electromagnetics concepts of modal wave harmonics and Geometrical Ray optics with Diffraction to Radiation from antennas in unbounded media.

CO4: Evaluate and design scattering in guided and radiative structures like strip, plate, cylinder and sphere using numerical EM solver that employ the concepts studied.

Reference Books:

5.	Constantine A Balanis, "Advanced engineering electromagnetics", John Wiley & Sons, 1st edition, 1989, ISBN: 0-471-62194-3.
6.	Roger F Harrington, "Time harmonic electromagnetic fields", John Wiley & Sons, IEEE press classic reissue, 2001, ISBN: 0-471-20806-X.

Scheme of Continuous Internal Evaluation (CIE) for Theory

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Continuous Internal Evaluation (CIE) for Practical

CIE for the practical courses will be based on the performance of the student in the laboratory, every week. The laboratory records will be evaluated for 40 marks. One test will be conducted for 10 marks. The total marks for CIE (Practical) will be for 50 marks.

Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Practical

SEE for the practical courses will be based on conducting the experiments and proper results for 40 marks and 10 marks for viva-voce. The total marks for SEE (Practical) will be 50 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	H	L	L	L	L	H	L	M	M	L	L
CO2	H	M	H	M	M	M	L	M	M	L	M
CO3	H	M	H	M	M	M	L	M	M	L	M
CO4	M	H	H	H	H	H	L	M	H	L	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	M	H
CO2	H	M
CO3	M	H
CO4	H	H

Smart Antenna Array Signal Processing						
Course Code	:	**16MCS321**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be

5. Introduced to the basic definitions and relationships that analyzes and synthesizes arrays.
6. Introduced to various weighting techniques for arrays to obtain desirable frequency wavenumber response and beam pattern with desirable properties.
7. Introduced to various techniques for characterization of space time random process and their interaction with arrays and apertures.
8. Various beamforming algorithm are introduced are that require less computations are introduced for arrays
9. Various parametric estimation algorithms are introduced to determine direction of arrival for incoming signal on array.

Unit – I	**10 Hrs**

Spectral Analysis of Deterministic Signals

Principles of Estimation Theory - Properties of Estimators, Estimation of Mean , Estimation of Variance, Spectral Analysis of Deterministic Signals, Effect of Signal Sampling, Windowing, Periodic Extension, Effect of Spectrum Sampling, Estimation of the Autocorrelation of Stationary Random Signals, Estimation of the Power Spectrum of Stationary Random Signals, Power Spectrum Estimation Using the Periodogram, Power Spectrum Estimation by Smoothing a Single Periodogram, The Blackman-Tukey Method of Power Spectrum Estimation by Averaging Multiple Periodograms—The Welch Bartlett Method.

Unit – II	**10 Hrs**

Joint Signal Analysis

Estimation of Cross-Power Spectrum, Estimation of Frequency Response Functions, Multi-taper Power Spectrum Estimation, Estimation of Auto Power Spectrum, Estimation of Cross Power Spectrum. Signal Modelling and Parametric Spectral Estimation - The Modelling Process: Theory

and Practice Minimum-Variance Spectrum Estimation ; Harmonic Models and Frequency Estimation Techniques - Harmonic Model, Pisarenko Harmonic Decomposition ,MUSIC Algorithm , Minimum-Norm Method , ESPRIT Algorithm.

Unit – III	**10 Hrs**

Arrays

Introduction, Two-Element Array, N-Element Linear Array: Uniform Amplitude and Spacing, N-Element Linear Array: Directivity Design Procedure, N-Element Linear Array: Three-Dimensional Characteristics, Rectangular-to-Polar Graphical Solution, N-Element Linear Array: Uniform Spacing, Planar Array.

Narrowband Processing

Signal Model, Steering Vector Representation Eigenvalue Decomposition Conventional Beamformer Source in Look Direction Directional Interference Random Noise Environment Signal-to-Noise Ratio

Unit – IV	**10 Hrs**

Beam Forming

Conventional Spatial Beamforming - Spatial Matched Filter, Tapered Beamforming. Optimum Beamforming – Eigenanalysis of the Optimum Beamformer, Interference Cancelation Performance , Tapered Optimum Beamforming, The Generalized Sidelobe Canceler, Performance Considerations for Optimum Beamformer (In brief Effect of Signal Mismatch, Effect of Bandwidth)

Adaptive Beamforming - Sample Matrix Inversion , Diagonal Loading with the SMI Beamformer, Implementation of the SMI Beamformer, Sample-by- Sample Adaptive Methods – RLS and Steepest Descent methods.

Other Adaptive Array Processing Methods - Linearly Constrained Minimum-Variance Beamformer.

Unit – V	**10 Hrs**

Direction-of-Arrival Estimation Methods

Spectral Estimation Methods**,** Bartlett Method**,** Minimum Variance Distortionless Response Estimator**,** Linear Prediction Method**,** Maximum Entropy Method**,** Maximum Likelihood Method**,** Eigenstructure Methods**,** MUSIC Algorithm, Minimum Norm Method, ESPRIT Method**,** Weighted Subspace

Course Outcomes:

After going through this course the student will be able to:

1. Explain the concept of spatial spectrum of a planar array antenna understand the estimation process for a spatially distributed statistical signal being received by the antenna.
2. Analyze appropriate complex weighting technique for array elements that provide desirable spatial response and beam pattern.
3. Analyze the spatially sampled spectrum by an array and verify the performance of known spatial estimation algorithms like Bartlett, MUSIC and MVDR.
4. Evaluate and develop an array with spatial estimation algorithms that meet a specified spatial performance requirements including resolution and SNR.

Reference Books:

1.	Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. KogonStatistical and Adaptive Signal Processing, Artech House , 2005 ISBN 1-58053-610-7

2.	Lal Chand Godara SMART ANTENNAS, CRC PRESS.-2004, ISBN 9780849312069
3.	Don H. Johnson Dan E. Dugeon Array Signal Processing: Concepts and Techniques (Prentice-Hall Signal Processing Series)by, Prentice Hall Signal Processing Series. ISBN 0130485136
4.	Constantine A. Balanis "Antenna Theory: Analysis and Design, 3rd edn. John Wiley & Sons, 2009,, ISBN 8126524227

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Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	H	M	M	L	L	L	L	M	L	L	L
CO2	H	H	H	M	L	L	L	M	M	L	M
CO3	H	H	H	M	L	L	L	M	M	L	M
CO4	H	H	H	H	M	L	L	M	H	L	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	M	H
CO2	H	M
CO3	M	H
CO4	H	H

Microwave Sources &Synthesizer						
Course Code	**:**	**16MCS322**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Explain the theoretical foundations and concepts of RF circuits, mathematical analysis and measurement techniques
2. Calculate the RF Circuit design parameters like input & output impedance , S- parameter using mathematical tool like Smith chart and analytical expression
3. Design, simulate, draw the layout and measure the various elements of an RF or microwave front end: low-noise amplifier, Filters ,matching circuits, Mixer and Oscillator
4. Analyze different RF Circuits and components including linear, nonlinear and active and passive network

Unit – I	**10 Hrs**

Loop Fundamentals

Introduction to Linear Loops, Characteristics of a Loop, Digital Loops Type 1 First-Order Loops, Type 1 Second-Order Loops,Type 2 Second-Order Loop, Transient Behavior of Digital Loops Using Tri-state Phase Detectors

Unit – II	**10 Hrs**

Loop Fundamentals

Type 2 Third-Order Loop, Transfer Function of Type 2 Third-Order Loop, FM Noise Suppression, Higher-Order Loops, Fifth-Order Loop Transient Response, Digital Loops with Mixers, Acquisition, Pull-in Performance of the Digital Loop, Coarse Steering of the VCO as an Acquisition Aid, Loop Stability

Unit – III	**10 Hrs**

Special Loops

Direct Digital Synthesis Techniques, A First Look at Fractional N Digital Waveform Synthesizers, Signal Quality, Future Prospects, Multiple Sampler Loops, Loops with Delay Line as Phase Comparators, Fractional Division N Synthesizers, Special Patents for Fractional Division N Synthesizers

Unit – IV	**10 Hrs**

Loop Components-1

Oscillator Design, Basics of Oscillators, LowNoise LC Oscillators, Switchable/Tunable LC Oscillators, Use of Tuning Diodes, Use of Diode Switches, Use of Diodes for Frequency Multiplication, Reference Frequency Standards, Requirements Specifying oscillators , Typical

Examples of Crystal Oscillator Specifications , Crystal Resonators , Crystal Specifications , Crystal Oscillators , Effect of External Influences on Oscillator Stability , High Performance Oscillator Capabilities , Surface Acoustic Wave (SAW) Oscillators Mixer Applications.

Unit – V	**10 Hrs**

Loop Components-II

Phase/Frequency Comparators , Diode Rings , Exclusive Ors Sample/Hold Detectors , Digital Tristate Comparators , Programmable Dividers , Asynchronous Counters , Programmable Synchronous ,Up/DownCounters

Loop Filters Passive RC Filters , Active RC Filters , Active SecondOrder LowPass Filters , Passive LC Filters Microwave Oscillator Design , The Compressed Smith Chart , Series or Parallel Resonance, TwoPort Oscillator Design

Expected Course Outcomes:

After going through this course the student will be able to:

CO1: Analyse RF Circuits, impedance matching & working of small & large signal microwave amplifier

CO2: Calculate the RF circuits parameters like S-Parameter, SNR and VSWR and impedance transformation and also impedance matching

CO3: Analyse the performance of RF Circuits in terms of gain, stability & noise

CO4: Design impedance matching circuits & small , large signal amplifiers

Reference Books:

1.	Ulrich L. Rohde , "Microwave and Wireless Synthesizers: Theory and Design",Wiley, 1st edition, ISBN: 978-0-471-52019-1
2.	Ulrich L. Rohde ,Jerry C. Whitaker ,Hans Zahnd "Communications Receivers: Principles and Design", Fourth Edition (2017),McGraw Hill Publication"
3.	Vadim Manassewitsch, " Frequency Synthesizers: Theory and Design", Wiley-Blackwell; 3rd Revised edition edition (21 October 2005),
4.	Simon Haykin ,"Digital Communications Systems",2e,Wiley(2013),ISBN:978-8126542314

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Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	H	M	M	H	H	H	L	M	H	L	L
CO2	H	H	H	H	H	M	L	M	H		H
CO3	H	H	H	H	H	H			H		H
CO4	H	H	H	H	H	H			H	L	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	H
CO2	H	M
CO3	M	H
CO4	H	H

Course Code	**:**	**16MCS331**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Analyze the performance of two wire lines for DSL operation.
2. Explain and demonstrate the various impediments to DSL operation viz; interferences and cross talk.
3. Explain the model for a DMT based modem for training and steady state functions.
4. Explain various types of equalizers used for DSL channel.

Unit – I **9 Hrs**

Plain Old Telephone System (POTS)

The Network Structure, Network Demarcation Points, Customer Premise Wiring, Hybrid circuits, High speed Voice band Modems, ADSL and VDSL: Definition and Reference Model.

Copper Channel

Physical and Electrical Characteristics of Shielded Twisted pair, Models of DSL cables.

Unit – II **10 Hrs**

Noise and Noise Modelling on Twisted Pair Channel

Cross Talk Models, Impulsive noise, Noise from faults, Engineering measures, Mathematical Modeling of Crosstalk NEXT and FEXT.

Twisted pair channels capacity

Transmission Rate and Channel Capacity in Presence of Additive Gaussian Noise, Theoretical Rate Computations for PAM, QAM, and DMT Systems. Ideal DMT Data Rate Calculations

Overview of DSL

Performance Requirements for ADSL , VDSL, Representative DSL Multicarrier system, ADSL Frame and Multiframe structure.

Unit – III **10 Hrs**

Fundamentals of Multicarrier Modulation

Basics of MCM, DMT,Initialization, Timing and Performance – Initialization Methods, Adaptation of Receiver and Transmitter – Activation, Channel discovery (Gain Initialization, Clock Synchronization, First channel Identification(equalization, filter training), Channel analysis (Gain Estimation), Bit allocation for Target Noise margin and Target Rate, Secondary channel Identification, Parameter exchange.

Steady State Adaptation of Tx and Rx – Receiver Equalizer Update, Noise monitoring, Channel gain and response Update, FEQ adaptation. Dynamic Measurement of Performance - Bit swapping, Seamless rate adaptation, Power management state machine.

Unit – IV **10 Hrs**

Error Control in DSL

Basic background of ECC, Reed Solomon Codes in DSL, Decoding of RS codes, Uncorrectable codes, Interleaving Methods (Tong's Method, Forney Interleaver), Erasures, Concatenated Coding, Coding Gain.Principles of Trellis Coded Modulation, Trellis coding and decoding

Unit – V **9 Hrs**

DSL Channel Equalization

Basic background, Optimization Criteria, Equalizer Structures, Closed form equalizers, Adaptive

equalizers, Training, Examples and Practical Design Issues.
DSL Synchronization: Overview, DMT synchronization, Timing Recovery Methods – Open loop Timing Recovery, Pilot based Timing Recovery, Decision directed Timing recovery, Frame Synchronization.

Expected Course Outcomes:

After going through this course the student will be able to:

CO1. Understand the technology issues and DSL Standards for broadband over wireline.

CO2. Apply a variety of signal processing algorithms to DSL modem in a wireline channel environment to improve specific performance parameters.

CO3. Test and validate performance parameters for DSL links for a variety of known channel topologies and channel noise profiles.

CO4. Demonstrate by simulation or emulation, different functional blocks of DSL Modem to meet performance parameters for specified channel environment.

Reference Books:

1.	Philip Golden Hervé Dedieu Krista Jacobsen. Fundamentals of DSL Technology. Auerbach Publications -Taylor & Francis Group. 2006.
2.	T. Starr, J.M. Cioffi, and P.J. Silverman. Understanding Digital Subscriber Line Technology. Prentice-Hall, Upper Saddle River, NJ, 1999.
3.	Philip Golden Hervé Dedieu Krista Jacobsen, ' Implementation and Application of DSL' Auerbach Publications -Taylor & Francis Group. 2008.
4.	D. Rauschmayer. ADSL/VDSL Principles: A Practical and Precise Study of Asymmetric Digital Subscriber Lines and Very High Speed Digital Subscriber Lines. Macmillan Technical Publishing, 1998.
5.	J.A.C. Bingham. ADSL, VDSL and Multi-Carrier Modulation. Wiley-Interscience, New York, NY, 2000.

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Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	H	M	M	L	L	L	L	M	L	L	L
CO2	H	M	M	M	M	M	L	M	M	M	M
CO3	H	M	M	M	M	M	L	M	M	M	M

CO4	H	M	H	M	M	H	L	M	H	M	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	M	H
CO2	H	M
CO3	M	H
CO4	H	H

Fiber Optic Communications						
Course Code	**:**	**16MCS332**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Understand the different kinds of losses, signal distortion in optical wave guides and other signal degrading factors, and study of various Optical components.
2. Analyze the Optical Modulation and Demodulation techniques, power penalty, need for amplifiers in transmission system engineering.
3. Apply different optical Layer concept, optical network components, variety of networking aspects, FDDI, SONET/SDH, QOS and flow control
4. To express operational principles of WDM, Routing and wavelength assignment

Unit – I	**10 Hrs**

Introduction

Overview of optical fiber communications, Basic principles of light propagation, Ray-Model, Wave-Model, Optical fiber modes, single and multi-mode fibers, single and multi-core fibers.

Signal degradation in optical fibers

Loss and Bandwidth windows, Intermodal Dispersion, Chromatic Dispersion, Practical issues in Implementation of fiber Link. .

Unit – II	**10 Hrs**

Optical Components

Couplers**,** Isolators and Circulators**,** amplifier Multiplexers and filters**,** Fiber Gratings**,** Mach-Zehnder Interferometers**.**

Non-linear effects in optical fiber

Non–Linear Schrodinger Equation, Group velocity dispersion, Stimulated Brillouin scattering, stimulated Raman scattering, Self -Phase Modulation, Cross-Phase Modulation, Four-wave Mixing, Solitons. .

Unit – III	**10 Hrs**

Modulation and Demodulation

Modulation, Signal formats, Subcarrier Modulation and Multiplexing, Spectral efficiency, Optical Duo-binary Modulation, Capacity Limits of Optical Fiber, An Ideal receiver, Practical detection Receivers, Noise considerations, Bit error rates, coherent detection.

Transmission System Engineering

System Model, Power penalty, Transmitter, Receiver, Different optical amplifiers - SOA, EDFA.

Unit – IV	**9 Hrs**

Intensity Modulated Optic Fiber Sensors

Introduction, General features-Intensity modulation through through light interruption, shutter/schlineren multimode fiber optic sensors, Reflective fiber optic sensor, Evanescent-wave fiber sensor, Micro bend optical fiber sensors, Fiber optic refractometers,Intensity modulated optic fiber thermometers.

Unit – V	**9 Hrs**

Optical Networks

WDM network elements: Optical line terminal, Optical line amplifiers, Optical cross connectors, Dense WDM, WDM network design,

Client layers of optical layer, SONET/SDH, Optical switches, Multiplexing layers, Frame Structure, ATM functions, Adaptation Layers, QoS and Flow control, ESCON, HIPPI..

Expected Course Outcomes:

After going through this course the student will be able to:

1. Select the proper Optical spectral band and incorporate the standards for optical fiber communication.
2. Analyze the Optical Fiber Modes and Configurations and express the Single-mode Fibers, Graded-index Fiber Structure
3. Express various WDM Concepts and Components and Apply different Optical Network concepts and topologies and design WDM Network
4. Prepare an Optical Link Power Budget.

Reference Books:

1.	John M. Senior, "Optical Fiber Communications", Pearson edition, 2000.
2.	Rajiv Ramswami, N Sivaranjan, "Optical Networks- A Practical Perspective", M. Kauffman publishers, 2000
3.	Gerd Keiser, "Optical Fiber Communication", MGH, 1991.
4.	G. P. Agarwal, "Fiber Optics communication" , John Wiley, New york, 1997
5.	P. E. Green, "Optical Networks", Prentice Hall, 1994

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Mapping of Course Outcomes (CO) to Program Outcomes (PO)

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CO2	H	H	H	H	H	M	L	M	H		H
CO3	H	H	H	H	H	H			H		H
CO4	H	H	H	H	H	H			H	L	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	M	H
CO2	H	M
CO3	M	H
CO4	H	H

Wireless Cellular and LTE 4G Broadband						
Course Code	**:**	**16MCS341**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**5**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Understand the basics of LTE standarization phases and specifications.
2. Explain the system architecture of LTE and E-UTRAN, the layer of LTE, based on the use of OFDMA and SC-FDMA principles.
3. Analyze the role of LTE radio interface protocols to set up, reconfigure and release the

Radio Bearer, for transferring the EPS bearer.

4. Analyze the main factors affecting LTE performance including mobile speed and transmission bandwidth.

Unit – I	**10 Hrs**

LTE Standardization Phases, Evolution Beyond Release 8, LTE-Advanced for IMT-Advanced, LTE Specifications and 3GPP Structure.

System Architecture Based on 3GPP SAE

Basic System Architecture Configuration with only E-UTRAN Access Network ,System Architecture with E-UTRAN and Legacy 3GPP Access Networks,System Architecture with E-UTRAN and Non-3GPP Access Networks ,Architecture Configuration IMS Architecture PCC and QoS

Unit – II	**10 Hrs**

OFDMA

SC-FDMA and MIMO in LTE,LTE Multiple Access Background, OFDMA Basics

SC-FDMA Basics MIMO Basics, Physical Layer- Transport Channels and their Mapping to the Physical Channels, Modulation Uplink User Data Transmission Downlink User Data Transmission, Uplink Physical Layer Signaling Transmission PRACH Structure, Downlink Physical Layer Signaling Transmission Physical Layer Procedures, UE Capability Classes and Supported Features Physical Layer Measurements, Physical Layer Parameter Configuration

Unit – III	**10 Hrs**

LTE Radio Protocols

Protocol Architecture, The Medium Access Control The Radio Link Control Layer, Packet Data Convergence Protocol, Radio Resource Control (RRC) X2 Interface Protocols Understanding the RRC ASN.1 Protocol Definition Early UE Handling in LTE

Unit – IV	**08 Hrs**

Mobility

Mobility Management in Idle State, Intra-LTE Handovers 190, Inter-system Handovers Differences in E-UTRAN and UTRAN Mobility

Unit – V	**10 Hrs**

Radio Resource Management

Overview of RRM Algorithms, Admission Control and QoS Parameters, Downlink Dynamic Scheduling and Link Adaptation, Uplink Dynamic Scheduling and Link Adaptation, Interference Management and Power Settings, Discontinuous Transmission and Reception (DTX/DRX), RRC Connection Maintenance, Performance- Layer 1 Peak Bit Rates, Terminal Categories Link Level Performance, Link Budgets Spectral Efficiency Latency, LTE Reframing to GSM Spectrum, Dimensioning, Capacity Management Examples from HSPA Networks

Expected Course Outcomes:

After going through this course the student will be able to:

CO1: Understand the system architecture and the functional standard specified in LTE 4G.

CO2: Analyze the role of LTE radio interface protocols and EPS Data convergence protocols to set up, reconfigure and release data and voice from users.

CO3: Demonstrate the UTRAN and EPS handling processes from set up to release including mobility management for a variety of data call scenarios.

CO4: Test and Evaluate the Performance of resource management and packet data processing and

transport algorithms.	
Reference Books:	
1.	Arunabha Ghosh, Jan Zhang, Jefferey Andrews, Riaz Mohammed, 'Fundamentals of LTE', Prentice Hall, Communications Engg and Emerging Technologies.
2.	'LTE for UMTS Evolution to LTE-Advanced' HarriHolma and Antti Toskala, Second Edition - 2011, John Wiley & Sons, Ltd. Print ISBN: 9780470660003.
3.	'EVOLVED PACKET SYSTEM (EPS) ; THE LTE AND SAE EVOLUTION OF 3G UMTS' by Pierre Lescuyer and Thierry Lucidarme, 2008, John Wiley & Sons, Ltd. Print ISBN:978-0-470-05976-0.
4.	'LTE – The UMTS Long Term Evolution ; From Theory to Practice' by Stefania Sesia, IssamToufik, and Matthew Baker, 2009 John Wiley & Sons Ltd, ISBN 978-0-470-69716-0.

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CO2	H	M	M	M	M	M	L	M	M	M	M
CO3	H	M	M	M	M	M	L	M	M	M	M
CO4	H	M	H	M	M	H	L	M	H	M	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	H
CO2	H	M
CO3	M	H
CO4	H	H

Wireless Local Area Networks						
Course Code	**:**	**16MCS342**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students shall be able to

1. Understand the media access techniques for WLAN 802.11 various standards.
2. Analyze the model of discrete time channel model of 802.11 WLAN.
3. Apply an understanding of communications with the channel model to realize high through

puts over 802.11n and 802.11ad WLAN.

4. Develop the concepts interoperability and coexistence with earlier versions of WLANs.

Unit – I	**10 Hrs**

Introduction – History of IEEE 802.11, IEEE802.11.

Physical Layer – OFDM, MIMO, SDM basics; 802.11n propagation model, Linear Receiver Design, Maximum Likelihood estimation.

Interoperability with 11a/g legacy OFDM devices- 11a packet structure review, Mixed format high throughput packet structure,

Unit – II	**10 Hrs**

802.11n High Throughput - 40 MHz channel, 20 MHz enhancements: Additional data subcarriers, MCS enhancements: Spatial streams and code rate, Greenfield (GF) preamble, Short guard interval.

Robust performance - Receive diversity, Spatial expansion, Space-time block coding, Low density parity check codes,

Unit – III	**10 Hrs**

Medium access control: Protocol layering, Management functions, Distributed channel access, Data/ACK frame exchange, Hidden node problem, Enhanced distributed channel access, Block acknowledgement.

MAC throughput enhancements - Reasons for change, Aggregation, Block acknowledgement, HT-immediate block ack.

Unit – IV	**10 Hrs**

Advanced channel access techniques – PCF, HCCA, Reverse Direction Protocol, PSMP

Interoperability and coexistence - Station and BSS capabilities, Controlling station behavior, 20 MHz and 20/40 MHz operation, A summary of fields controlling 40 MHz operation, Phased coexistence operation (PCO), Protection.

Transmit Beam Forming - Eigenvalue analysis, Unequal MCS, Receiver design, Channel sounding, Channel state information feedback, Improved performance with transmit beamforming, Degradations, MAC considerations, Comparison between implicit and explicit, Fast link adaptation.

Unit – V	**10 Hrs**

WiGiG – IEEE802.11ac and ad key features, 11ac and 11ad Physical Layer (Channels, Phy layer, Phy control, Single carrier Phy, Low Power SC Phy, OFDM Phy (Packet Structure, Modulation and coding) Beam forming and Beam form Training. D-Band measurement requirements for channel estimation and testing.

Course Outcomes:

CO1: Explain the use of OFDM, MIMO and SDM in WLAN 802.11n, ac & ad media access.

CO2: Analyze Physical and MAC access layers for performance and throughput for typical Transmitters and Receivers using specified 802.11n channel models.

CO3: Evaluate the performance and throughput using advanced channel access techniques as specified by 802.11ac and 802.11ad standards.

CO4: Develop Evaluate schemes to ensure interoperability of 802.11 ac and ad with advanced access techniques with earlier 802.11a/b/g/n WLANs.

Reference Books:

1.	Eldad Perahia and Robert Stacey, 'Next Generation Wireless LANs Throughput, robustness, and Reliability in 802.11n', Cambridge University Press 2008, ISBN-13 978-0-521-88584-3.
2.	Jeff Smith, Jake Woodhams, Robert Marg, 'Controller-Based Wireless LAN Fundamentals', Cisco Press 2011, ISBN-13: 978-1-58705-825-7.
3.	Matthew Gast, '802.11® Wireless Networks: The Definitive Guide', O'Reilly Publishers April 2002, ISBN: 0-596-00183-5.
4.	Naresh Gupta, 'Inside Bluetooth Low Energy (Mobile Communications)' Artech House; 2nd edition (June 30, 2016) ISBN-13: 978-1630810894
5.	Kevin Townsend and Carles Cufí, ' Getting Started with Bluetooth Low Energy: Tools and Techniques for Low-Power Networking', O'Reilly Media; 1 edition (May 22, 2014), ISBN-13: 978-1491949511.

Scheme of Continuous Internal Evaluation (CIE) for Theory

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	H	M	M	L	L	L	--	M	L	--	L
CO2	H	M	M	M	M	M	L	M	M	M	M
CO3	H	M	M	M	M	M	L	M	M	M	M
CO4	H	M	H	M	M	H	L	M	H	M	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	M	H
CO2	H	M
CO3	M	H
CO4	H	H

INTERNSHIP / INDUSTRIAL TRAINING						
Course Code	:	**16 MCS 35**		**CIE Marks**	:	**100**
Hrs/Week	:	**L:T:P:S**	**0:0:6:0**	**SEE Marks**	:	**100**
Credits	:	**3**		**SEE Duration**	:	**3 Hrs**

GUIDELINES FOR INTERNSHIP

Course Learning Objectives (CLO):

The students shall be able to:

(1) Understand the process of applying engineering knowledge to produce product and provide services.
(2) Explain the importance of management and resource utilization
(3) Comprehend the importance of team work, protection of environment and sustainable solutions.
(4) Imbibe values, professional ethics for lifelong learning.

1) The duration of the internship shall be for a period of 8 weeks on full time basis between II semester final exams and beginning of III semester.
2) The student must submit letters from the industry clearly specifying his / her name and the duration of the internship on the company letter head with authorized signature.
3) Internship must be related to the field of specialization or the M.Tech program in which the student has enrolled.
4) Students undergoing internship training are advised to use ICT tools such as skype to report their progress and submission of periodic progress reports to the faculty members.
5) Every student has to write and submit his/her own internship report to the designated faculty.
6) Students have to make a presentation on their internship activities in front of the departmental committee and only upon approval of the presentation should the student proceed to prepare and submit the hard copy of the internship final report. However interim or periodic reports and reports as required by the industry / organization can be submitted as per the format acceptable to the respective industry /organizations.
7) The reports shall be printed on bond paper – 80GSM, back to back print, with soft binding – A4 size with 1.5 spacing and times new roman font size 12.
8) The broad format of the internship final report shall be as follows
    - Cover Page
    - Certificate from College
    - Certificate from Industry / Organization
    - Acknowledgement
    - Synopsis
    - Table of Contents

- Chapter 1 - Profile of the Organization – Organizational structure, Products, Services, Business Partners, Financials, Manpower, Societal Concerns, Professional Practices,
- Chapter 2 - Activities of the Department -
- Chapter 3 – Tasks Performed – summaries the tasks performed during 8 week period
- Chapter 4 – Reflections – Highlight specific technical and soft skills that you acquired during internship
- References & Annexure

Course Outcomes:

After going through the internship the student will be able to:

CO1: Apply engineering and management principles

CO2: Analyze real-time problems and suggest alternate solutions

CO3: Communicate effectively and work in teams

CO4: Imbibe the practice of professional ethics and need for lifelong learning.

Scheme of Continuous Internal Evaluation (CIE):

A committee comprising of the Head of the Department / Associate Dean, Associate Professor, Assistant Professor and Guide would review the presentation and the progress reports in two phases. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

(1) Explanation of the application of engineering knowledge in industries	35%
(2) Ability to comprehend the functioning of the organization/ departments	20%
(3) Importance of resource management, environment and sustainability	25%
(4) Presentation Skills and Report	20%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		M	H	M		M				L	
CO2				H	M	M		L			
CO3					L		M	H	H		
CO4					L		H			M	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	
CO2	L	L
CO3		M
CO4	M	H

GUIDELINES FOR INDUSTRIAL TRAINING

Course Learning Objectives (CLO):

The students shall be able to:

(1) Understand the process of applying engineering knowledge to industrial products & processes

(2) Explain the importance of skilling, training and resource management.

(3) Comprehend the importance of team work, communication and sustainable solutions.

(4) Imbibe values, professional ethics for lifelong learning.

1) The duration of industrial training must be for a minimum of 1 week and maximum of 8 weeks on full time basis.
2) Industrial Training in which students pays a fee to the organization / industry will not be considered.
3) He/she can undergo training in one or more industry /organization.
4) The student must submit letters from the industry clearly specifying his / her name and the duration of the training provided by the company with authorized signatures.
5) Industrial training must be related to the field of specialization or the M.Tech program in which the student has enrolled.
6) Students undergoing industrial training are advised to use ICT tools such as skype to report their progress and submission of periodic progress reports to the faculty members.
7) Every student has to write and submit his/her own industrial training report to the designated faculty.
8) Students have to make a presentation on their industrial training in front of the departmental cmmittee and only upon approval of the presentation should the student proceed to prepare and submit the hard copy of the final report.
9) The reports shall be printed on bond paper – 80GSM, back to back print, with soft binding – A4 size with 1.5 spacing and times new roman font size 12.
10) The broad format of the industrial training report shall be as follows
    - Cover Page
    - Certificate from College
    - Training Certificate from Industry / Organization
    - Acknowledgement
    - Executive Summary
    - Table of Contents
    - Chapter 1 - Profile of the Organization –Organizational structure, Products, Services, Business Partners, Financials, Manpower, Societal Concerns, Professional Practices
    - Chapter 2 – Details of the Training Modules
    - Chapter 3 – Reflections – Highlight specific technical and soft skills that you acquired References & Annexure

Course Outcomes:

After going through the industrial training the student will be able to:

CO1: Understand the process of applying engineering knowledge to solve industrial problems

CO2: Develop skills through training relevant to industrial requirement

CO3: Communicate effectively and work in teams

CO4: Imbibe ethical practices and develop it as life skill.

Scheme of Continuous Internal Evaluation (CIE):
A committee comprising of Head of the Department / Associate Dean, Associate Professor, Assistant Professor and Guide would review the presentation and the progress reports in two phases. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

(1) Explanation on the application of engineering knowledge 25%

(2) Ability to comprehend the importance of skilling and training 25%

(3) Importance of communication, professional ethics, sustainability 20%

(4) Oral Presentation and Report 30%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		M	H	M		M				L	
CO2				H	M	M		L			
CO3					L		M	H	H		
CO4					L		H			M	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	
CO2	L	L
CO3		M
CO4	M	H

GUIDELINES FOR INDUSTRIAL VISITS

Course Learning Objectives (CLO):
The students shall be able to:

(1) Understand the role of industries and service organization in meeting the demands of the society.

(2) Explain the working of different industries and organizations with an engineering perspective

(3) Comprehend the importance of team work, communication and sustainable solutions.

(4) Imbibe values, professional ethics for life long learning.

1) Student must visit a minimum of THREE organizations/industry. The duration of the visit per organization must be for ONE full day, during which he/she must comprehend the importance of organization structure, function of various departments, application of engineering knowledge, resource management, importance to environment and safety, professional ethics.
2) It is mandatory to visit ONE private multi-national company or public sector industry / organization, ONE medium-small enterprise and ONE rural based or NG organization.
3) The student must submit letter from the industry clearly specifying his / her name and the date of visit to the industry with authorized signatures.
4) Industrial visit must be related to the field of specialization or the M.Tech program in which the student has enrolled.
5) Every student has to write and submit his/her own report on each industrial visit and submit the report to the designated faculty advisor for evaluation.
6) A photograph outside the industry with the name and logo of the industry in the background along with the students and faculty members could be included in the report.
7) Students have to make a presentation on their industrial visit in front of the departmental committee and only upon approval of the presentation should the student proceed to prepare and submit the hard copy of the final report.
8) The reports shall be printed on bond paper – 80GSM, back to back print, with soft binding – A4 size with 1.5 spacing and times new roman font size 12.
9) The broad format of the industrial visit report shall be as follows
    - Cover Page
    - Certificate from College
    - Acknowledgement
    - Synopsis / Executive Summary
    - Table of Contents
    - Chapter 1 - Profile of the PSU or MNC – must include Organizational structure, Products, Services, Financials, Manpower, Societal Concerns, Professional Practices
    - Chapter 2 – Profile of the SME – must include Organizational structure, Products, Services, Financials, Manpower, Societal Concerns, Professional Practices
    - Chapter 3 - Profile of the NGO – must include Organizational structure, services, Manpower, Societal Concerns, Professional Practices
    - Chapter 4 – Comparative Analysis of PSU/MNC – SME – NGO
    - References & Annexure (Permission letters from the organizations for the visit & photographs)

Course Outcomes:

After going through this course the student will be able to:

CO1: Classify the role of different industries and organization in addressing the needs of the society.

CO2: Explain the process of applying engineering knowledge in industries and organizations.

CO3: Describe the importance of communication and team work
CO4: Recognize the importance of practicing professional ethics and need for life skills.

Scheme of Continuous Internal Evaluation (CIE):

A committee comprising of Head of the Department / Associate Dean, Associate Professor, Assistant Professor and Guide would review the presentation and the progress reports in two phases. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

(1) Explanation of the application of engineering knowledge in industries 25%

(2) Ability to comprehend the functioning of the organization/ departments 30%

(3) Importance of resource management, environment and sustainability 20%

(4) Presentation Skills and Report 25%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1		M	H	M		M				L	
CO2				H	M	M		L			
CO3					L		M	H	H		
CO4					L		H			M	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	H	
CO2	L	L
CO3		M
CO4	M	H

TECHNICAL SEMINAR						
Course Code	**:**	**16MCS36**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L:T:P:S**	**0:0:4:0**	**SEE Marks**		**50**
Credits	**:**	**2**		**SEE Duration**		**30 min**

Course Learning Objectives (CLO):

The students shall be able to:

(1) Understand the technological developments in their chosen field of interest
(2) Explain the scope of work and challenges in the domain area
(3) Analyze these engineering developments in the context of sustainability and societal concerns.
(4) Improve his/her presentation skills and technical report writing skills

GUIDELINES

1) The presentation will have to be done by individual students.
2) The topic of the seminar must be in one of the thrust areas with in-depth review and analysis on a current topic that is relevant to industry or on-going research.
3) The topic could be an extension or complementary to the project
4) The student must be able to highlight or relate these technological developments with sustainability and societal relevance.
5) Each student must submit both hard and soft copies of the presentation.

Course Outcomes:

After going through this course the student will be able to:

CO1:Identify topics that are relevant to the present context of the world
CO2: Perform survey and review relevant information to the field of study.
CO3: Enhance presentation skills and report writing skills.
CO4: Develop alternative solutions which are sustainable

Scheme of Continuous Internal Evaluation (CIE): Evaluation would be carried out in TWO phases. The evaluation committee shall comprise of Head of the Department / Associate Dean, Associate Professor, Assistant Professor and Guide. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

Rubrics for Evaluation:

1) Topic – Technical Relevance, Sustainability and Societal Concerns 15%
2) Review of literature 25%
3) Presentation Skills 35%
4) Report 25%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1		H	M	M	L	H	H	--	---	---	M
CO2	L	M								H	
CO3							L	M	H		
CO4		L	M		H	H					H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	H	L
CO2	M	H
CO3	M	L
CO4	H	L

MAJOR PROJECT						
Course Code	:	**16MCS41**		**CIE Marks**	:	**100**
Hrs/Week	:	**L:T:P:S**	**0:0:52:0**	**SEE Marks**	:	**100**
Credits	:	**26**		**SEE Duration**	:	**3 Hours**

Course Learning Objectives:

The students shall be able to

1. Understand the method of applying engineering knowledge to solve specific problems.
2. Apply engineering and management principles while executing the project
3. Demonstrate good verbal presentation and technical report writing skills.
4. Identify and solve complex engineering problems using professionally prescribed standards.

GUIDELINES

1. Major project will have to be done by only one student in his/her area of interest.
2. Each student has to select a contemporary topic that will use the technical knowledge of their program of specialization.
3. Allocation of the guides preferably in accordance with the expertise of the faculty.
4. The number of projects that a faculty can guide would be limited to three.
5. The project can be carried out on-campus or in an industry or an organization with prior approval from the Head of the Department.
6. The standard duration of the project is for 16 weeks, however if the guide and the evaluation committee of the department, after the assessment feel that the work is insufficient and it has to be extended, then the student will have to continue as per the directions of the guide and the committee.
7. It is mandatory for the student to present his/her work in one of the international conferences or publish the research finding in a reputed unpaid journal with impact factor.

Course Outcomes:

After going through this course the students will be able to

CO1: Conceptualize, design and implement solutions for specific problems.
CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply project and resource managements skills, professional ethics, societal concerns
CO4: Synthesize self-learning, sustainable solutions and demonstrate life long learning

Scheme of Continuous Internal Examination (CIE)
Evaluation will be carried out in THREE Phases. The evaluation committee will comprise of: guide, two senior faculty members, one industry member and Head of the Department.

Phase	Activity	Weightage
I 5th week	Synopsis, Preliminary report for the approval of selected topic along with literature survey, objectives and methodology.	20%
II 10th week	Mid-term progress review shall check the compliance with the objectives and methodology presented in Phase I, review the work performed.	40%

III 15th week	Oral presentation, demonstration and submission of project report. After this presentation, the student will have one week time to correct / modify his report to address the issues raised by the committee members.	40%

CIE Evaluation shall be done with marks distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/experimental setup 25%
- Conducting experiments / implementation / testing / analysis 25%
- Demonstration & Presentation 20%
- Report writing 20%

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

1. Brief write-up about the project 5%
2. Formulation of Project Objectives & Methodology 20%
3. Experiments / Analysis Performed; Results & Discussion 25%
4. Report 20%
5. Viva Voce 30%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	H	H	H	M	L	M	L				
CO2				L				M	H		
CO3					L	M	M			H	
CO4					L	M	H	M			H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	H	L
CO2	L	H
CO3	M	H
CO4	H	H

SEMINAR						
Course Code	**:**	**16MCS42**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L:T:P:S**	**0:0:4:0**	**SEE Marks**		**50**
Credits	**:**	**2**		**SEE Duration**		**30 min**

Course Learning Objectives (CLO):

The students shall be able to:

1) Understand the technological developments in their chosen field of interest
2) Explain the scope of work and challenges in the domain area
3) Analyze these engineering developments in the context of sustainability, societal concerns and project management.
4) Improve his/her verbal presentation and report writing skills

GUIDELINES

1) The presentation will have to be done by individual students.
2) The topic of the seminar must be in one of the thrust areas with in-depth review and analysis on a current topic that is relevant to industry or on-going research.
3) The topic could be an extension or complementary to the project topic.
4) Topics could be in multidisciplinary areas and strongly address the technical design issues.
5) The student must be able to highlight or relate these technological developments with sustainability and societal relevance.
6) The students must mandatorily address legal, ethical issues as related to the topic of study.
7) The student shall make an attempt to perform financial / cost analysis or apply project management tools as related to his/her topic of study.
8) Each student must submit both hard and soft copies of the presentation.

Course Outcomes:

After going through this course the student will be able to:

CO1: Identify topics that are relevant in the present context of the world and relate it to sustainability and societal relevance.
CO2: Perform literature/market/product survey and analyse information to the field of study.
CO3: Enhance presentation and report writing skills.
CO4: Develop creative thinking abilities.

Scheme of Continuous Internal Evaluation (CIE): Evaluation would be carried out in TWO phases. The evaluation committee shall comprise of TWO senior faculty members. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

Rubrics for Evaluation:

- Topic – Technical Relevance, Sustainability and Societal Concerns 15%
- Literature Review 25%
- Presentation Skills 35%
- Report 25%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1		H	M	M	L	H	H	--	---	---	M
CO2	L	M								H	
CO3							L	M	H		
CO4		L	M		H	H					H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	H	L
CO2	M	H
CO3	M	L
CO4	H	L