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**

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.

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**

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

1.	Constantine A Balanis, "Advanced engineering electromagnetics", John Wiley & Sons, 1st edition, 1989, ISBN: 0-471-62194-3.
2.	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

1. Introduced to the basic definitions and relationships that analyzes and synthesizes arrays.
2. Introduced to various weighting techniques for arrays to obtain desirable frequency wavenumber response and beam pattern with desirable properties.
3. Introduced to various techniques for characterization of space time random process and their interaction with arrays and apertures.
4. Various beamforming algorithm are introduced are that require less computations are introduced for arrays
5. 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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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	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

Scheme of Continuous Internal Evaluation (CIE) for Theory

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Scheme of Semester End Examination (SEE) for Theory

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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

Wireline Broadband Communications						
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.

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	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

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	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

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.

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	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

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

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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	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