Rashtreeya Sikshana Samithi Trust

R.V. College of Engineering

(Autonomous Institution affiliated to VTU, Belagavi)

Department of Telecommunication Engineering

Master of Technology (M.Tech.)

RF and Microwave Engineering

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

R.V. College of Engineering, Bengaluru – 59

(Autonomous Institution affiliated to VTU, Belagavi)

Department of Telecommunication Engineering

Vision:

Imparting quality education in Electronics and Telecommunication Engineering through focus on fundamentals, research and innovation for sustainable development

Mission:

- Provide comprehensive education that prepares students to contribute effectively to the profession and society in the field of Telecommunication.
- Create state-of-the–art infrastructure to integrate a culture of research with a focus on Telecommunication Engineering Education
- Encourage students to be innovators to meet local and global needs with ethical practice.
- Create an environment for faculty to carry out research and contribute in their field of specialization, leading to Center of Excellence with focus on affordable innovation.
- Establish a strong and wide base linkage with industries, R&D organization and academic Institutions.

Program Educational Objectives (PEO)

M. Tech. in RF and Microwave Engineering, graduates will be able to:

PEO 1: Analyze, evaluate, design and solve complex technical problems using modern tools

PEO 2: Carry out research and innovation in the core areas like RF Circuit analysis, sub system design and Wireless Communication.

PEO 3: Demonstrate the skills required in Defense, Microwave and RF communication sectors

PEO 4: Adapt to the technological changes through lifelong learning for global acceptance.

Program Outcomes (PO)

M. Tech. in RF and Microwave Engineering graduates will be able to:

PO1. Scholarship of Knowledge: Acquire in-depth knowledge of RF and Microwave communication with an ability to evaluate, analyze and Synthesize complex problems.

PO2. Critical Thinking: Analyze complex engineering problems to make intellectual and/or creative advances for conducting research

PO3. Problem Solving: Conceptualize and solve engineering problems, to arrive at optimal solutions, considering public health and safety, societal and environmental factors.

PO4. Research Skill: Formulate research problem through literature survey, apply appropriate research methodologies to solve and contribute to the development of technological knowledge.

PO5. Usage of modern tools: Learn and apply modern engineering tools to solve complex engineering problems

PO6. Collaborative and Multidisciplinary work: Contribute positively to collaborative-multidisciplinary scientific research, in order to achieve common goals.

PO7. Project Management and Finance: Manage projects efficiently in RF and Microwave disciplines after Consideration of financial factors

PO8. Communication: Communicate with the engineering community regarding complex engineering activities confidently and effectively

PO9. Life-long Learning: Ability to engage in life-long learning independently, to improve knowledge and competency

PO10. Ethical Practices and Social Responsibility: Practice professional code of conduct, ethics of research in profession with an understanding of responsibility to contribute to the community for sustainable development of society.

PO11. Independent and Reflective Learning: Introspect critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

MASTER OF RF AND MICROWAVE ENGINEERING – Program

Program Specific Criteria (PSC)

Lead Society: Institute of Electrical and Electronics Engineers

1. Curriculum:

The curriculum must include Advanced mathematics applied to telecommunication 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 Telecommunication 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, Telecommunication System design and integration.

Program Specific Outcomes (PSO)

Graduates in M. Tech (RF and Microwave Engineering) will be able to:

PSO 1. Analyze, design and implement devices, sub-systems, propagation models for Wired and Wireless communication systems.

PSO 2. Exhibit technical skills necessary to enter careers in design, installation, testing and operation of wireless Communication systems.

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Department of Telecommunication Engineering

M. Tech. in RF and Microwave Engineering

THIRD SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Experiential Learning S**	
1	16 MDC31/ 16MRM31	Wireless Communication (Theory and Practice)	TE	4	0	1	0	5
2	16 MRM32x	Elective -5	TE	4	0	0	0	4
3	16 MRM33x	Elective -6	TE	4	0	0	0	4
4	16 MRM34x	Elective -7	TE	4	0	0	0	4
5	16 MRM35	Internship/Industrial Training	TE	0	0	3	0	3
6	16 MRM36	Technical Seminar	TE	0	0	2	0	2
		Total		**16**	**0**	**6**	**0**	**22**

Elective –5			
16 MRM321	Smart Antenna and MIMO	16 MRM322	Advanced Mobile Networks
Elective –6			
16 MRM331	Monolithic Microwave Integrated Circuits	16 MDC332/16MRM332	Satellite Navigation Systems
Elective –7			
16 MRM341	Terahertz Communication	16 MDC342/16MRM342	Broadband networks

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Department of Telecommunication Engineering

M. Tech. in RF and Microwave Engineering

FOURTH SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Experiential Learning S**	
1	16 MRM41	Major Project	TE	0	0	26	0	26
2	16 MRM42	Seminar	TE	0	0	2	0	2
		Total		**0**	**0**	**28**	**0**	**28**

III SEMESTER

WIRELESS COMMUNICATION						
Course Code	:	**16MDC31/ 16MRM31**		**CIE Marks**	:	**100+50**
Hrs/Week	:	**L:T:P:S :**	**4:0:1:0**	**SEE Marks**	:	**100+50**
Credits	:	**5**		**SEE Duration**	:	**3 + 3 Hrs**

Course Learning Objectives (CLO):

This course will enable student to:

1. To describe physical modeling for wireless channel, diversity techniques and capacity of wireless channel.
2. To explain the Space diversity in MIMO system, MIMO channel modeling and multiplexing capability of MIMO channels
3. To analyze the antenna considerations in MIMO Channels, Modelling of MIMO fading channels.
4. To identify and justify MIMO in wireless communication applications.

Unit – I	**10Hrs**

Wireless channel: physical modeling for wireless channels, input/output model of wireless channel, time and frequency response.

Point to point communication: detection in Rayleigh fading channel, time diversity, antenna diversity, frequency diversity

Unit – II	**10Hrs**

Diversity: Introduction, Microdiversity, Microdiversity and simulcast, Combination of Signals, Error Probability in fading channels with diversity Reception, transmit diversity.

Unit – III	**10Hrs**

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

Unit – IV	**10Hrs**

MIMO Systems: Introduction, Space Diversity and Systems Based on Space Diversity, Smart antenna system and MIMO, MIMO based System architecture, MIMO exploits multipath, Space time Processing, Antenna considerations for MIMO, MIMO channel Modeling, MIMO Channel measurement, MIMO Channel capacity, Space Time Coding, Advantages and Applications of MIMO, MIMO applications in 3G

Unit – V	**10Hrs**

Spatial multiplexing and channel modeling: multiplexing capability of MIMO channels, physical modeling of MIMO channels, modeling MIMO fading channels.

Laboratory Component

MATLAB, Aero hive simulator, System vue, Qualnet.

1. Implementation of an adaptive equalizer based on LMS algorithm and studies the effect of step size on MSE.
2. Determination of error probabilities for orthogonal signaling using MATLAB employing (i) Hard Decision (ii) Soft decision decoding.
3. Simulation and analysis of the performance of a QPSK digital radio link in a Rayleigh fading environment.
4. Comparison of Digital modulation schemes over AWGN and flat fading channels.
5. Setup and analyse WiMax, UMTS, 2G, Wireless senor networks with different energy models and VoIP

6. Case Study: Link Budget Calculation in WPAN using the AeroHive Simulator**.**

Expected Course Outcomes:

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

CO1: Describe physical modeling for wireless channel and diversity techniques.
CO2: Analyze the Modeling of MIMO fading channels.
CO3: Evaluate diversity techniques and multiplexing capability of MIMO channels.
CO4: Design a MIMO system with smart antennas in wireless communication applications

Reference Books:

1. David Tse, P. Viswanath, "Fundamentals of wireless communication", Cambridge, 2006.ISBN 0-521-68749-7
2. Andreas Molisch, "Wireless communications", John Wiley & Sons , 2012
3. Upen Dalal, "Wireless communication", Oxford university Press, 2009

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

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

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

SMART ANTENNA AND MIMO						
Course Code	**:**	**16MRM321**		**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):

This course will enable student to:

1. Understand the concept of Beam forming in smart antenna design and its various configurations.
2. Explain and Analyze principles involved in designing Meta material Antennas and Reconfigurable Antennas.
3. Design Adaptive Antennas, Meta material Antennas and Reconfigurable Antennas for future applications.
4. Evaluate various design techniques of Adaptive Antennas, Meta material Antennas and Reconfigurable Antennas.

Unit – I	**10Hrs**

Introduction: Basic Antenna parameters, Types of linear arrays, Antenna synthesis techniques, Phased Array Antenna and Switched array antennas - Power Pattern, Beam Steering, Degree of Freedom, Optimal Antenna, Adaptive Antenna, Smart Antenna.

Narrowband Processing: Signal Model**,** Steering Vector Representation**,** Eigen value Decomposition**,** Conventional Beamformer**,** Source in Look Direction**,** Directional Interference**,** Random Noise Environment, Signal-to-Noise Ratio, Null Steering Beamformer, Optimal Beamformer, Constrained and Unconstrained Beamformers

Unit – II	**10Hrs**

Adaptive Processing: Sample Matrix Inversion(SMI) Algorithm, Unconstrained Least Mean Squares Algorithm, Gradient Estimate, Covariance of Gradient, Convergence of Weight Vector, Convergence Speed, Transient Behavior of Weight Covariance Matrix, Excess Mean Square Error, Misadjustment, Normalized Least Mean Squares Algorithm, Constrained Least Mean Squares(LMS) Algorithm, Gradient Estimate, Recursive Least Mean Squares (RLS) Algorithm.

Unit – III	**10Hrs**

Direction-of-Arrival Estimation Methods: Spectral Estimation Methods, Bartlett Method, Minimum Variance Distortion less Response Estimator, Linear Prediction Method, Maximum Entropy Method, Maximum Likelihood Method, Eigen structure Methods, MUSIC Algorithm, Spectral MUSIC, Root-MUSIC, Constrained MUSIC, Beam Space MUSIC, Minimum Norm Method, CLOSET method, ESPRIT method

Unit – IV	**10Hrs**

Meta material Antennas

Introduction , Negative Refractive Index (NRI) Meta materials , Meta material Antennas Based on NRI Concepts ,High-Gain Antennas Utilizing EBG Defect Modes, Antenna Miniaturization Using Dispersion Properties of Layered Anisotropic Media, Platform/Vehicle Integration of Meta material Antennas (Irci, Sertel, Volakis) , Wideband Metamaterial Antenna Arrays (Tzanidis, Sertel, Volakis)

Unit – V	**10Hrs**

Reconfigurable Antennas

Introduction ,Analysis ,Overview of Reconfiguration Mechanisms for Antennas ,Control, Automation, and Applications

Expected Course Outcomes:

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

CO1: Explain parameters and principles of Adaptive Antennas, Metamaterial Antennas and Reconfigurable Antennas.
CO2: Apply Signal processing concepts in analyzing beamforming techniques.
CO3: Analyze and Compare various techniques employed in designing Adaptive Antennas, Metamaterial Antennas and Reconfigurable Antennas.
CO4: Compute design parameters of Adaptive Antennas, Metamaterial Antennas and Reconfigurable Antennas.

Reference Books:

1.	Lal Chand Godara, ”Smart antenna” CRC press, London, 2004.ISBN:9780849312069
2.	Frank B gross, "Frontiers in Antennas: Next Generation Design & Engineering" Mcgraw Hill Publications, 2011. ISBN : 9780071637930
3.	Balanis A.,”Antenna Theory analysis and Design”, Second Edition, John Wiley & Sons, New York,1997. ISBN: 9780471592686
4.	David Tse,” Fundamentals of Wireless Communication”, Cambridge University Press, 2005. ISBN 0-521-68749-7

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

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

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

ADVANCED MOBILE NETWORKS						
Course Code	**:**	**16MRM322**		**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):

This course will enable student to:

1. Understand the basic concepts like architecture, components and services related to GSM networks.
2. Identify the key components and services of GPRS network.
3. Compare and contrast UMTS, HSPA, LTE, and LTE-Advanced technologies and use it to predict improvements in network performance.
4. Develop lifelong learning and research skills by undertaking a comprehensive study of an emerging research topic and effectively presenting it to the class

Unit – I	**10Hrs**

Introduction to GSM, GPRS and EDGE Technologies:

Circuit-Switched Data Transmission, Transmission speeds, SS7 Protocol Stack, GSM Architecture, BSS and Voice Processing, Mobility Management (MM) and Call Control, Mobile device, SIM card, The Intelligent Network Subsystem and CAMEL. Packet-Switched Data Transmission over GPRS, GPRS Air Interface, GPRS State Model, GPRS Network Elements, MM & Session Management, Small Screen Web Browsing & MMS over GPRS and EDGE, Impact of Delay on the Web-Browsing Experience, Web Browser Optimization for Mobile Web Browsing.

Unit – II	**10Hrs**

Universal Mobile Telecommunications Systems (UMTS) and High-Speed Packet Access (HSPA):

Overview, History, Important New Concepts of UMTS, CDMA, UMTS Channel Structure on the Air Interface, The UMTS Terrestrial Radio Access Network (UTRAN), Call establishment, security, HSDPA and HSPA+, HSUPA, HSPA performance in practice, UMTS and CDMA 2000.

Unit – III	**10Hrs**

4G - Long Term Evolution (LTE):

Introduction and Overview, Network architecture, FDD air interface and Radio Network, TD-LTE air interface, Scheduling, Mobility management & power optimization, LTE security architecture, Interconnection with GSM, UMTS, & CDMA 2000 networks, Voice and SMS over LTE, Recent advances in LTE.

Unit – IV	**10Hrs**

Mm Wave Massive MIMO: A paradigm for 5G:

Requirements of Key capabilities for 5G, 5G Network architecture based on mmWave Massive MIMO, Challenges, Hybrid Antenna array, encoding and detection, channel estimation, channel modeling, MAC Layer design and mm-Wave cellular networks Stochastic geometry modeling analysis and experimental validation.

Unit – V	**10Hrs**

Machine to Machine Communications in 5G:

Introduction, Fundamental techniques for machine type communications (MTC), Massive MTC, Ultra reliable low latency MTC, D2D communications: research challenges, CoMP techniques, Proximity Services and Device to Device Communications, Enhancements for Machine-Type Communications and Mobile Data, Traffic Offloading Enhancements.

Self Study Component
Topics on latest/ emerging technology will be assigned. Students are required to read white papers, publications, patients, and prepare a report, give a seminar on the study undertaken.

Expected Course Outcomes:

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

CO1: Explain the theoretical concepts of GSM, GPRS architectures and their services.
CO2: To analyze and design wireless and mobile cellular systems.
CO3: Analyze the performance parameters of various existing mobile standards.
CO4: Perform a LTE network link planning computation to check the feasibility of 4G radio network operation.

Reference Books:

1.	Martin Sauter, "From GSM to LTE-Advanced: An Introduction to Mobile Networks and Mobile Broadband", Revised Second Edition, ISBN: 978-1-118-86195-0, 456 pages, July 2014.
2.	Shahid Mumtaz, Jonathan Rodriguez, Linglong Dai, "mmWave Massive MIMO: A Paradigm for 5G", Academic Press, ISBN: 0128044780, 9780128044780, 372 pages, December 2016.
3.	Cox C, "An Introduction to LTE: LTE, LTE-Advanced, SAE, VoLTE and 4G Mobile Communications". 2nd Edition, Wiley, ISBN: 978-1-118-81803-9, 486 pages, July 2014.
4.	Sesia, S., Baker, M., Toufik, I., "LTE - the UMTS long term evolution: from theory to practice." 2nd Edition, Wiley 2011 (ISBN 978-0-470-69716)
5.	Afif Osseiran, Jose F. Monserrat and Patrick Marsch, "5G Mobile and Wireless Communications Technology", 1st Edition, Cambridge University Press, June 2016, ISBN 978-1-107-13009-8.

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

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

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

MONOLITHIC MICROWAVE INTEGRATED CIRCUITS						
Course Code	**:**	**16 MRM331**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3Hrs**

Course Learning Objectives (CLO):

This course will enable student to:

1. Understand the basics of MMIC design, components, devices and packaging.
2. Analyze the design challenges of passive and active MMIC Circuits
3. Analyze the characteristics of passive and active MMIC Circuits.
4. Learn the fabrication steps of MMICs.

Unit – I	**10Hrs**

Introduction to MMIC Design:
Types**:** HMICs, MMICs, Comparison of Advantages and tradeoffs
Applications**:** Satellite communications, wireless LANs, microwave links, cellular networks etc.
Material properties: Silicon, Germanium, Compound semiconductors - GaAs, GaN, SiC, InP
Design cycle: process selection, device characterization, circuit topology decision, design, taping-out, testing.
Choosing among device technologies: Diodes, BJTs, MOSFETs, MESFETs, LDMOSFETs, HBTs, HEMTs.
HMIC Technologies, Thick film and Thin film, Co-fired,
MMIC technology, MMIC design using CAD Tools

Unit – II	**10Hrs**

Passive Elements on RFICs:
Lumped element design - Resistors, Capacitors, Inductors.
Distributed element design – microstrip lines, coplanar lines.
Tools for Network analysis: S parameters, Signal flow graphs, Smith charts
Power dividers, Hybrids, Couplers – Wilkinson combiners, N-way combiners, Corporate combiners.
Impedance matching networks – design of Narrow band and Wide band matching networks.

Unit – III	**10Hrs**

Active Devices on RFICs:
Hybrid Amplifiers LNAs- Narrow band and wide band, Power Amplifiers - Narrow band and wide band,
Monolithic Amplifiers –Technology, Design, Examples, Stability analysis – even mode, odd mode, low frequency, spurious oscillations.
Mixers , Oscillator, VCO

Unit – IV	**10Hrs**

MMIC Fabrication Principles:
Crystal growth, Doping, Diffusion, Epitaxy, Ion Implantation, Thermal Oxidation, Plasma Process, Deposition of films,

Unit – V	**10Hrs**

MMIC Fabrication Principles: Etching, Cleaning, Lithography, Device and circuit fabrication,
Thermal Considerations - basics, transistor thermal design, heat sink design
Packaging - Overview, Materials for Packaging, Ceramic Package, Plastic Package, Package Assembly, Thermal design, CAD Tools Packaging.

Expected Course Outcomes:

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

CO1: Understand the basics of MMIC design, components, devices and packaging.

CO2: Analyze the design challenges of passive and active MMIC Circuits

CO3: Analyze the characteristics of passive and active MMIC Circuits.

CO4: Follow the fabrication steps of MMICs

Reference Books:

1. Inder J Bahl, "Fundamentals of RF and Microwave Transistor Amplifiers", John Wiley & sons Inc, 2009. ISBN: 978-0-470-39166-2
2. Michaael Steer, "Microwave and RF design – A systems approach ", Scitech publishing, Inc, 2010. ISBN: 978-97-465-2175-8
3. Sorab. K. Ghandhi, "VLSI Fabrication principles – Silicon and Gallium Arsenide", Wiley India, 2ND Edition, 2009, ISBN: 978-81-265-1790-9
4. Paolo Colantonio, Franco Giannini, Ernesto Limiti, "High Efficiency RF and Microwave Solid State Power Amplifiers", John Wiley and Sons Inc, 2009.
5. I. D. Robertson, S. Lucyszyn, " RFIC and MMIC design Technology", IEE Publications, 2001, ISBN: 0- 85296- 786 -1

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

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

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

SATELLITE NAVIGATION SYSTEMS						
Course Code	**:**	**16MDC332\ 16MRM332**		**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):

This course will enable student to:

1. Understand basic concepts of radar components and apply these concepts in the Communication to extract information.
2. Analyze the Radar signal in presence of noise and clutter.
3. Describe Signal Structure, Characteristics, and Information Utilization and Antenna Characteristics required for Satellite Navigation System.
4. Describe and analyze data errors in Satellite Navigation System.

Unit – I **10Hrs**

An Introduction to Radar:

Basic Radar, The simple form of the Radar Equation, Radar Block Diagram, Radar Frequencies, Application of radar, Types of Radars.

The Radar Equation:

Introduction, Detection of signals in Noise, Receiver Noise and the Signal-to Noise Ratio, Probability of Detection and False alarm, Integration of radar Pulses, Radar Cross Section of the targets, Radar Cross sections of Fluctuations, Transmitter power, Pulse repetition Frequency, Antenna Parameters, System Losses.

Fundamentals of Pulse Compression Waveforms:

Range Resolution, Straddle Loss, Pulse Compression Waveforms, Pulse Compression Gain, Linear Frequency Modulation Waveform, Matched filter implementations, Sidelobe reductions in an LFM waveforms, Ambiguity Function, Phased Coded waveforms, Biphase codes, Polyphase codes.

Unit – II **10Hrs**

Information Available from Radar Signals:

Basic Radar measurement, Theoretical Accuracy of Radar Measurement, Ambiguity Function, Pulse Compression, Target reorganization.

Radar Antenna

Reflector antennas, Electronically steered phased array antennas, Phased shifters, Low side lobes antennas

MTI and Pulse Doppler Radar:

Introduction to Doppler and MTI Radar, Delay-Line Cancellers, Staggered Pulse Repetition frequencies, Doppler Filter Banks, Digital MTI processing, Moving Target detector, Limitations to MTI Platform, Pulse Doppler Radar.

Unit – III **10Hrs**

Terrestrial Network based positioning and navigation :

Fundamentals, positioning in cellular networks, positioning in WLANs, Positioning in Wireless sensor networks, Ranging and Navigation in RADAR systems-Radar equation, clutter, Digital MTI, Tracking.

Unit – IV **10Hrs**

Orbits and Reference Systems:

Basics of satellite orbits and reference systems, two body problem, orbit elements, timer system and timer transfer using GPS, coordinate systems, GPS orbit design, orbit determination problem, tracking networks, GPS force and measurement models for orbit determination, orbit broadcast ephemeris, precise GPS ephemeris, Tracking problems.

Unit – V	10Hrs

Satellite-based navigation systems:
Global Navigation satellite systems (GNSS), GNSS receivers, Augmented systems and assisted GNSS.

Expected Course Outcomes:

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

CO1: Applying radar concepts to analyze radar signal.
CO2: Explain the basic principles, Signal structure and performance parameters, Signal Acquisition and Tracking, Data Errors of the satellite navigation System.
CO3: Compute the user position, velocity and system parameters in Satellite Navigation System
CO4: Analyze the signal acquisition and tracking system and design of Satellite Navigation Receiver Components/System.

Reference Books:

1.	M. L Skolnik, "Introduction to RADAR Systems", TATA Mcgraw-Hill, 2001.
2.	Mark A Richards, James A scheer, William A Holam, "Principles of Modern Radar Basic principles", Yes Dee Publishing Pvt Ltd, 2012
3.	Mohinder S. Grewal, Angus P. Andrews ,Chris G. Bartone "Global Navigation Satellite Systems, Inertial Navigation, And Integration " Third Edition, John Wiley and Sons , 2013, ISBN 978-1-118-44700-0
4.	B. Hoffman, Wellenhof, H. Lichtenegger and J. Collins, "GPS - Theory and Practice", 5th revised edition, Springer, NewYork, 2001.
5.	Davide dardari, Emanuela Falletti, Marco Luise, " Satellite and Terrsetrial Radio Positioning techniques- A signal processing perspective", Elsevier Academic Press, First edition, 2012

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

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

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

TERAHERTZ COMMUNICATION						
Course Code	**:**	**16MRM341**		**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):

This course will enable student to:

1. To learn THz overview principles, components technologies
2. To learn about THz sources and detectors
3. To Analyze THz signal sources and applications
4. To learn about THz applications for Industry and wireless communication

Unit – I	**10Hrs**

Terahertz Overview and Principles: Electromagnetic Radiation and Propagation Fundamentals, Terahertz Principles, Behavior of Atmosphere in the Terahertz region, Key technological issues for Terahertz technology, Fundamental limits, power combining, Experimental approach, Terahertz technology Applications and opportunities**.**

Unit – II	**10Hrs**

Terahertz Sources : The development of Terahertz sources, Terahertz sources based on Schottky diode frequency multipliers, Free Electron based Tera Hertz sources, Compact Tunable Terahertz Sources very short wave length Vacuum Electronic devices, Photo mixing Tunable Terahertz sources, Terahertz magnetic response from artificial material, Continuous wave THz radiation generation through non linear processes, Terahertz sources using Triply resonant non liner crystal cavities, Silicon wave guide based Terahertz sources.

Unit – III	**10Hrs**

THz Detectors: Pyroelecrtic detectors, gallium doped Germanium photoconductive detector, Bolometer detectors, composite Germanium Bolometer, unturned Indium Antimode, Go lay Cell detectors, Terahertz Electronic components, Travelling Wave Terahertz detector, Tunable Plasma Wave-HEMT THz Detector, Terahertz detector on a single chip, Quantum dot Photo detector, Multiband Terahertz detection and imaging devices, Integrated Terahertz Imager based on quantum dots, CNT based QD frequency tunable THz detector, On Chip Terahertz detection, Wide Band width Hot electron Bolometer Heterodyne detector.

Unit – IV	**10Hrs**

Low coherence THz signal sources and applications and THz chemical spectroscopy : Introduction, Schemes for Noise generation, Characterization of noise signals,Imaging,2D imaging, Tomographic imaging, spectroscopy, amplifier characterization, Terahertz chemical spectroscopy Introduction, THZ TDS, Application: Quantitive analysis of Amino Acids in supplements, Terahertz spectroscopic imaging, overview, measurement system, Application(1):chemical mapping of pharmaceuticals in medicine, Application (2):chemical mapping of pharmaceuticals cocrystals

Unit – V	**10Hrs**

Industrial and Wireless communications Applications of Terahertz waves : Different kinds of Terahertz systems, Optoelectronic generation and detection of the Terahertz waves, using photoconductive antennas ,Polymer Industry, Polymeric compounds, Paper Industry, Food Industry, Pharmaceuticals Industry, crops Industry why the terahertz waves for communication, Application scene of terahertz communication, current technologies, frequency dispersion, Ray shadowing by moving persons Modeling of the Terahertz Indoor Radio channel.

Expected Course Outcomes:

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

CO1: Identify THz principles and components.
CO2: Select THz sources and detectors for a given for different applications.
CO3: Analyze suitability of THz imaging and spectroscopy systems for different applications.
CO4: Apply THZ systems knowledge for different Industrial and communication applications.

Reference Books:

1.	Rostami, Ali Rasooli, Hassan Baghban "Terahertz Technology: Fundamentals and applications", New York, Springer, 2011
2.	RE Miles,P Harisson, D Lippens "Terahertz Sources and Systems ",Springer Science + Business media, BV 2000
3.	Kiyomi Sakai, "Terahertz Optoelectronics", Springer, 2004
4.	Ho-Jin Song,Tadao Nagatsuma, "Handbook of Terahertz Technologies , Devices and applications", Pan Stanford Publishing Pte. Ltd. 2015
5.	Yun-Shik lee, "Principles of Terahertz Science and Technology, Springer Science + Business media, BV 2009.

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

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

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

BROADBAND NETWORKS						
Course Code	**:**	**16 MDC342/ 16MRM342**		**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):

This course will enable student to:

1. Analyze the transmission mechanism in the physical layer.
2. Apply QoS Mechanism in MAC layer design
3. Design a WiMAX system with Radio considerations

Unit – I	**10Hrs**

Review Of Access Technologies: Phone Line modem, cable access, ISDN, Emerging Broad band Technologies: Cable DSL, Fiber and Wireless.

Digital Subscriber Lines: Asymmetric Digital subscriber lines (ADSL) ,Rate Adaptive subscriber line (RADSL),ISDN Digital subscriber line (IDSL) ,High bit rate DSL (HDSL),Single line DSL (SDSL),very high bit rate DSL (VDSL), Standards for XDSL & Comparison.

Unit – II	**10Hrs**

Cable Modem: Cable Modem, DOCSIS- Physical Cabling, Dual Modem Operation, Hub Restriction, Upstream Operation, Downstream operation ,Access control, framing Security sub layer, Data link layer, LLC & Higher layers, ATM centric VS IP, centric cable modem.

Unit – III	**10Hrs**

Fiber Access Technologies: Optical Fiber in access networks, Architecture and Technologies- Hybrid fiber – Coax (HFC) system, Switched Digital Video (SDV) – Passive optical networks (PON) – FTTX (FTTH, FTTB, FTTC, FTT cab) comparison.

Unit – IV	**10Hrs**

Introduction to Broadband Wireless Access : The Need for Wireless Data Transmission, Wireless Networks and Broadband Wireless Access (BWA), Applications of BWA, History of BWA Technologies

3G Networks : Evolution from GSM, 3G Services and Applications - UMTS network structure - Protocol stack

4G – LTE: Overview of LTE Networks - Need for LTE- LTE Architecture, Radio Protocol stack , Interfaces, Security Protocols.

Unit – V	**10Hrs**

802.11n: Introduction, Channel Structure and Layout ,802.11n Speed, Mandatory PHY Features, Mandatory MAC Features, Network Architecture for 802.11n, 802.11n Hardware Coverage and Capacity Planning ,Network Management Design and Implementation issues

Expected Course Outcomes:

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

CO1: Understand the framework of broad band access technologies.
CO2: Analyze the architectures of broad band access technologies.
CO3: Compare the functionalities, protocols and architectures of broad band access technologies.
CO4: Design broad band access systems.

Reference Books:

1.	Niel Ransom and Albert A. Azzam, "Broadband Access Technologies: ADSL, VDSL Cable Modem, Fiber and LMDS", McGraw Hill, 1999.

2.	Gilbert Held, "Next Generation Modems: A Professional Guide to DSL and cable modems", John Wiley & sons.
3.	Walter j Woralski, "ADSL and DSL Technologies", McGraw Hill computer Communication series, 1998.
4.	Matthew S. Gast," 802.11n: A Survival Guide", O'Reilly Media, 2012

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and self-study. The test will be for 30 marks each and the quiz for 10 marks each. The self-study component will be for 20 marks and the students are supposed to share orally in the class and submit optimized solution after discussions to faculty in-charge. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

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

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

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

INTERNSHIP / INDUSTRIAL TRAINING						
Course Code	**:**	**16MRM35**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**0:0:6:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**3**		**SEE Duration**	**:**	**30 min**

GUIDELINES FOR INTERNSHIP

Course Learning Objectives (CLO):

This course will enable student 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):

This course will enable student 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.

1) 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.
2) 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):

This course will enable student 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. 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	**:**	**16MRM36**		**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):

This course will enable student 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

IV SEMESTER

MAJOR PROJECT						
Course Code	**:**	**16MRM41**		**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:

This course will enable student 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	Oral presentation, demonstration and submission of project report.	40%

15th week	After this presentation, the student will have one week time to correct / modify his report to address the issues raised by the committee members.	

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	**:**	**16MRM42**		**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):

This course will enable student 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