RashtreeyaSikshanaSamithi Trust

R.V. College of Engineering

(Autonomous Institution Affiliated to VisvesvarayaTechnologicalUniversity, Belagavi)

Department of Electrical and Electronics Engineering

Master of Technology (M.Tech.)

Power Electronics

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

R.V. College of Engineering, Bengaluru – 59

(Autonomous Institution Affiliated to VisvesvarayaTechnologicalUniversity, Belagavi)

Department of Electrical and Electronics Engineering

Vision:

Promotion of technical excellence in Electrical and Electronics Engineering by offering programs to produce Engineers with dynamic well rounded personalities adaptable to ever increasing demands of emerging technologies involving analytical and practical skills, with commitment to research and development.

Mission:

- To provide technical education that combines rigorous academic study and the excitement of innovation enabling the graduates to engage in lifelong learning which is essential to improve performance continuously and excel in their career.
- To establish research and development center of repute so as to encourage active participation with industry by faculty and students to take on practical problems of industry and to provide feasible solutions.
- To establish tie-ups with institutions of national and international repute and to foster building up of a wide knowledge base to keep in tune with ever increasing demands of technologies

POWER ELECTRONICS – Program

Program Specific Criteria (PSC)

Lead Society: IEEE

1. **Curriculum**

   The curriculum must prepare graduates to understand and analyze technical specifications and standards of Power Electronic devices and circuits; design and implement Power Electronic Systems in areas such as Power & Energy Systems, Electric Drives, Space technology, etc. The curriculum must also enable graduates to carry out innovative projects using state-of-the-art technology and integrate Power Electronics with other related domains, to facilitate collaborative multi-disciplinary research with integrity and ethics for benefit of the society

2. **Faculty**

   The major professional competence of the faculty must be in electrical engineering, and the faculty should be experienced in the areas of power electronics engineering and applied domains such as power system, control system and instrumentation.

Program Educational Objectives (PEO)

M. Tech. in Power Electronics Program, graduates will be able to:

PEO 1. Design, implement, protect, test and validate systems for Power Electronic Applications in Electric Drives and Power & Energy Systems.

PEO 2. Apply basic and advanced engineering knowledge to solve complex problems for integrated industrial power electronic systems.

PEO 3. Pursue research, communicate effectively, imbibe professional ethics and a desire for life-long learning.

Program Outcomes (PO)

M. Tech. in Power Electronics Graduates will be able to:

PO 1. Scholarship of Knowledge: Acquire in-depth knowledge of power electronic circuits for real time applications and an ability to evaluate, analyze and synthesize using existing modern tools for enhancement of knowledge.

PO 2. Critical Thinking: Analyze complex engineering problems critically; apply independent judgment for synthesizing information to make intellectual and /or creative advances for conducting research in the domain of power electronic systems in a wider theoretical, practical and policy context.

PO 3. Problem Solving: Think independently, conceptualize and evaluate a wide range of solutions and methods to solve problems in Power Electronics, with due consideration to society.

PO 4. Research Skill: Conduct literature review, apply appropriate techniques and carry out research in the domain of Power Electronics and its industrial applications.

PO 5. Usage of modern tools: Learn, choose, apply and develop appropriate techniques using modern simulation and IT tools related to power electronics.

PO 6. Collaborative and Multidisciplinary work: Integrate Power Electronics with other related domains, to facilitate collaborative multi-disciplinary research.

PO 7. Project Management and Finance: Understand and demonstrate management skills, assess and evaluate the economic feasibility; work effectively as a leader and a team member.

PO 8. Communication: Communicate effectively with all stakeholders, create documents and reports as per the standards.

PO 9. Life-long Learning: Infuse the desire and ability to engage in lifelong learning in the emerging area of power electronics.

PO 10. Ethical Practices and Social Responsibility: Acquire professional integrity and ethics, understand the responsibility for sustainable development of the society.

PO 11. Independent and Reflective Learning: Identify the shortcomings, examine the outcomes of one's actions and implement corrective measures.

Program Specific Outcomes (PSO)

M. Tech. in Power Electronics Graduates will be able to:

PSO 1. Specify, select, test and characterize modern power electronic devices for an application.

PSO 2. Design, implement, protect, test and validate Power Electronic system for applications in the areas of Power Systems, Electric Drives and Space technology.

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Department of Electrical and Electronics Engineering

M. Tech. in Power Electronics

FIRST SEMESTER								
Sl No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture **L**	**Tutorial** **T**	**Practical** **P**	**Experiential Learning/ Self Study** **S**	
1	16MEM11R	Research Methodology	IM	3	1	0	0	4
2	16MPE12	Power Electronic Devices	EE	4	0	0	0	4
3	16MPE13	Solid State Power Converters	EE	4	0	1	0	5
4	16MPE14	Modeling and Simulation of Power Electronic System	EE	4	0	0	1	5
5	16MPE15x	Elective -1	EE	4	0	0	0	4
6	16HSS16	Professional Skill Development	HSS	0	0	2	0	2
		Total		**19**	**1**	**3**	**1**	**24**

Elective 1			
16MPE151	Digital System Design	16MPE152	Advanced Control Systems

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M. Tech. in Power Electronics

SECOND SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Self Study S**	
1	16MEM21P	Project Management	IM	3	1	0	0	4
2	16MPE22	Control of AC and DC Electric Drives	EE	4	0	1	0	5
3	16MPE23x	Elective-2	EE	4	0	0	0	4
4	16MPE24x	Elective -3	EE	4	0	0	0	4
5	16MPE25x	Elective -4	EE	4	0	0	0	4
6	16MPE26	Minor Project	EE	0	0	5	0	5
		Total		**19**	**1**	**6**	**0**	**26**

Elective 2			
16MPE231	Power Quality Enhancement	16MPE232	Intelligent Control Techniques in Drives
Elective 3			
16MPE241	Flexible AC Transmission System	16MPE242	Programmable Logic Controller and Supervisory Control & Data Acquisition
Elective 4			
16MPE251	DSP Application to Drives	16MPE252	PWM Techniques for Converters

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M. Tech. in Power Electronics

THIRD SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Self Study S**	
1	16MPE31	Switched Mode Power Converters	EE	4	0	1	0	5
2	16MPE32x	Elective -5	EE	4	0	0	0	4
3	16MPE33x	Elective -6	EE	4	0	0	0	4
4	16MPE34x	Elective-7	EE	4	0	0	0	4
5	16MPE35	Internship / Industrial Training*	EE	0	0	3	0	3
6	16MPE36	Technical Seminar	EE	0	0	2	0	2
		Total		**16**	**0**	**6**	**0**	**22**

*To be completed during summer vacations and report to be submitted in the beginning of the third semester

Elective 5			
16MPE321	High Voltage DC Transmission	16MPE322	Modern Industrial Instrumentation
Elective 6			
16MPE331	Modern Rectifiers and Resonant Converters	16MPE332	Computational Electromagnetic Compatibility
Elective 7			
16MPE341	Electric Hybrid Vehicles	16MPE342	Wind and Solar Technologies

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FOURTH SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Self Study S**	
1	16MPE41	Major Project	EE	0	0	26	0	26
2	16MPE42	Seminar	EE	0	0	2	0	2
		Total		**0**	**0**	**28**	**0**	**28**

THIRD SEMESTER

SWITCHED MODE POWER CONVERTERS						
Course Code	**:**	**16MPE31**		**CIE Marks**	**:**	100+50
Hrs/Week	**:**	**L:T:P:S**	**4:0:2:0**	**SEE Marks**	**:**	100+50
Credits	**:**	**5**		**SEE Duration**	**:**	**3+3Hrs**

Course Learning Objectives (CLO):

Graduates shall be able to

1. Analyse the working of isolated, non isolated and resonant converters
2. Design the converters
3. Design magnetic components
4. Model converters.
5. Analyze error amplifiers in control of converters.

Unit I	**12 Hrs**

Introduction-Introduction to Switch mode power converters, Comparison between Linear and Switch mode Regulators, Classification **Non-Isolated DC-DC Converters-** Analysis and Design of non isolated converters Buck-Boost, C'uk and SEPIC topologies in continuous and Discontinuous current mode of operation.

Unit – II	**10 Hrs**

Isolated DC- DC converters: Analysis and Design of isolated DC- DC converters Flyback, Forward, Push Pull, Half Bridge and Full bridge topologies in continuous and discontinuous current mode operation.

Unit – III	**10 Hrs**

Resonant Converters: Introduction to soft witching,comparison between zero voltage and zero current switching, classification, ZVS, ZCS converters, series resonant, parallel resonant and series-parallel resonant converter topologies-analysis and design.

Unit – IV	**9 Hrs**

Control of DC-DC converters: Voltage control, current control, Design of type 2 and type 3 error amplifiers. Stability analysis of converters. PWM IC's

Unit – V	**10 Hrs**

Design of magnetic components-inductors and transformers

Modeling of converters- small signal modeling, State space average modeling of non isolated converters. Design

Lab Experiments

1. Design and simulate Buck-Boost Converter
2. Implementation of BUCK- Boost Converter.
3. Design and simulate Cuk Converter
4. Implementation of Cuk Converter

5. Design and simulate SEPIC Converter
6. Implementation of SEPIC Converter
7. Design and simulate Forward Converter
8. Implementation of Forward Converter.
9. Design and simulate Flyback Converter
10. Design, Simulate and implement ZVS/ZCS converter

Expected Course Outcomes:

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

1. Analyze the working of different DC-DC converter for continuous and discontinuous operation .
2. Design procedure for designing inductors and transformers.
3. Analysis of design of controllers.
4. Design of magnetic components and analyse modeling of converters.

Reference Books:

1.	Ned Mohan, "Power Electronics converters,applications and design", 3rd edition, Wiley India pvt Ltd 2011,**ISBN**: 978-0-471-22693-2
2.	Daniel w Hart, " Power Electronics", McGrawHill Education 2014, ISBN-13: 978-0073380674
3.	Rashid M H, "Power Electronics: Circuits, Devices, and Applications", 2nd Edition, Publisher: Prentice Hall, ISBN 13: 9780136789963
4.	Paperback, L. Umanand, S. R. Bhat , "Design of Magnetic Components for Switched Mode Power Converters", Publisher: New Age International Publishers Ltd. 1st Edition, ISBN: 9788122403398, 8122403395

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

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

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

HIGH VOLTAGE DC TRANSMISSION(ELECTIVE 5)						
Course Code	**:**	**16MPE321**		**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):

Graduates shall be able to

1. Understand the modern trends in long distance DC transmission and related issues
2. Analyse the control strategies and the importance of reactors in DC transmission system
3. Analyse the reactive power control requirement for stable operation of the system
4. Design the DC reactor and converter control circuits for HVDC system

Unit I	**10 Hrs**

HVDC Power Transmission Technology: Historical sketch, existing HVDC projects, Classification of HVDC links, Components of HVDC transmission system, Comparison of AC and DC Transmission, Application of DC Transmission, Modern trends in DC Transmission, Ground Return- advantages and disadvantages. Choice of converter configuration.

Unit II	10Hrs

HVDC CONVERTER: Introduction to line commutated converter, analysis of six and twelve pulse converter without overlap. Effect of smooting reactor, effect of smoothning reactor. Two and three level voltage source converter, pulse width modulation. Analysis of converter two and three , three and four valve conduction. Conduction modes. 12 pulse detailed analysis

Unit III	**10 Hrs**

CONTROL OF CONVERTERS AND HVDC LINK: Converter control characteristics, firing angle control,CEA control, Starting and stopping of DC link, Power control , frequency control. Reactive power control, tap changer control. Control of voltage source converter.

CONVERTER FAULTS AND PROTECTION:

Converter faults, protection against over voltages, over currents in converter station. Surge arrester. Protection agains faults in voltage source converter..

Unit IV	**10 Hrs**

SMOOTHING REACTOR AND DC LINE:

Smooting reactors, effects of corona loss, DC line insulators, Transient over voltages in DC line, protection in DC line. Detection and protection of faults, DC breakers.

REACTIVE POWER CONTROL:

Reactive power control in steady state and transient state. Sources of Reactive power, SVC and STATCOM.

Unit V	10 Hrs
POWER FLOW ANALYSIS IN AC/DC SYSTEM: Introduction to DC system model, procedure, inclusion of constraints, Power flow analysis under dynamic conditions, power flow with VSC based HVDC system. Introduction to stability concepts, analysis of voltage stability in asynchronous AC/DC system. **MULTI TERMINAL DC SYSTEM**: Introduction, types , control and protection.	
Course Outcomes: CO1: Understand the importance of modern long distance transmission technology, and related issues. CO2: Analyze the control of converter and faults in the system CO3: Evaluate the power control in AC/DC systems and its modeling. CO4: Design DC reactor, filters and transmission line as per the specifications.	

Refernce Books:

1.	KimbarkE.W. ,"Direct current Transmission", Vol 1, Wiley Interscience,1971. ISBN 0471475807, 9780471475804
2.	Padiyar K R , "High Voltage Direct Current Power Transmission system- Technology and Systems Interactions" .,Wiley Eastern Ltd, 1992.ISBN-13: 978-1906574772
3.	Arrillage , ' High voltage direct current transmission", Peter pregrinus , London , 1983. ISBN 0906048974, 9780906048979
4.	Adamson C Hingorani N G " High voltage direct current power transmission", Grraway ltd, London, 1960.
5.	S Kamakshaiah and V Kamaraju, " HVDC Transmssion", Tata McGraw-Hill Education Pvt. Ltd., 2011, ISBN 10: 0071072535 / ISBN 13: 9780071072533

Scheme of Continuous Internal Evaluation (CIE)

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

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

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

MODERN INDUSTRIAL INSTRUMENTATION (ELECTIVE 5)

Course Code	**:**	**16MPE322**		**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):

Graduates shall be able to

1. Explain the function of different types of sensors
2. Choose a sensor for a particular application
3. Classify and select transducers
4. Understand the application of laser for measurements
5. Apply concepts of physics and electronics to laser and optical instrumentation
6. Compare digital meters with analog meters
7. Have a knowledge of communication interfaces with measuring instruments

Unit – I **10Hrs**

Sensor Technologies

Sensors, Signals, and Systems , Sensor Classification , Potentiometric Sensors ,Capacitive Sensors, Inductive and Magnetic Sensors, LVDT and RVDT, Eddy Current Sensors, Hall Effect Sensors, Optical Sensors, Proximity Detector with Polarized Light, Fiber-Optic Sensors, thickness and level sensors, Ultrasonic Sensors, Thin Film Sensors, Liquid Level Sensors.

Unit – II **12 Hrs**

Transducers : Classification, selection of transducers, Resistance, inductance and capacitance type of transducers, measurement of displacement, strain, force, torque, liquid level, pressure, velocity and acceleration

Unit – III **12Hrs**

Laser Instrumentation:

Laser principles, characteristics, classification and construction; Measurement of distance - Interferometric methods, beam modulation telemetry, pulse echo techniques. Laser Doppler velocimetry- Holography- principle, applications of holography, holographic computer memories, laser welding, laser machining, laser printing and laser spectroscopy

Unit – IV **8 Hrs**

Optical Fiber Instrumentation - principles of light propagation through a fiber – Different types of fibers and their properties –Transmission characteristics of optical fiber –Absorption losses – Scattering losses – Dispersion- advantages and disadvantages of optical fibers. Fiber optic Instrumentation system - Interferometric method of measurement of length - Moire fringes – Measurement of pressure, temperature, current, voltage, liquid level and strain. Fiber optic gyroscope – polarization maintaining fibers – applications

Unit – V **10 Hrs**

Digital Instrumentation : Digital counter-timer, frequency meter, digital voltmeter and multimeter, digital storage oscilloscope, Digital Encoder-Disc type, Digital Tachometer, Frequency Output type transducers, The signal and conversion, The Instrument System, Virtual Instrumentation,. Modulation of Digital Data, Transmission Channels, Wireless I/O, Data Loggers – Introduction to IEEE 488/GPIB Buses, Communication with Instruments by RS232 cable .

Course Outcomes

At the end of the course the student will be able to

1. Distinguish between different sensor and transducers
2. Apply the concepts of physics and electronics to laser and optical instrumentation
3. Justify the need for digital instrumentation and its application to measure different parameters
4. Design and propose a measuring system with associated sensors and transducers for a particular application.

References

1.	Doeblin, **"**Measurement System", Tata McGraw Hill, ISBN : 9780070699687
2.	Jon S. Wilson , " Sensor Technologies", Elsevier&Newnes, ISBN : 0-7506-7729-5
3.	C.K.Sarkar and D.C. Sarkar, "Optoelectronics and Fiber Optics Communication", New Age Int. Pub., 2nd edition, 2012, ISBN : 978-81-224-3457-6
4.	Wilson and Hawkes, "Laser principles and applications", Prentice Hall of India, 9780135236970
5	Kalsi, "Electronic Instrumentation ",Tata McGraw Hill, ISBN : 978007070206-6

Scheme of Continuous Internal Evaluation (CIE)

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

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

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

MODERN RECTIFIERS AND RESONANT CONVERTERS (ELECTIVE 6)						
Course Code	**:**	**16MPE331**		**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):

Graduates shall be able to

1 compare ideal and practical rectifier circuits in terms of losses and efficiency.
2Analyzeseries and parallel resonant converters
3Analyze various resonant DC-DC converter topologies
4Design series and parallel resonant inverters
5 Evaluate the load network parameters for ZVS and ZCS inverters

Unit – I	**9 Hrs**

Pulse Width Modulated Rectifiers

Properties of Ideal rectifiers-Realization of non-ideal rectifier-Control of current waveform-Averagecurrent control-Current programmed Control- Hysteresis control- Nonlinear carrier control-Singlephase converter system incorporating ideal rectifiers- Modeling losses and efficiency in CCM highquality rectifiers-Boost rectifier Example-expression for controller duty cycle-expression for DCload current-solution for converter Efficiency η.

Unit – II	**12 Hrs**

Series and Parallel Resonant Converters

Half-Bridge Series-Resonant Converter, Full-Bridge Series-Resonant Converter, Design of Half-Bridge SRC, Half-Bridge and Full-Bridge Parallel Resonant Converters, Half-Bridge Series-Parallel-Resonant Converter, Design of Half-Bridge SPRC, Full-Bridge Series-Parallel-Resonant Converter

Unit – III	**12Hrs**

Quasi-resonant and Multi-resonant DC-DC Power Converters

Zero-Voltage-Switching Quasi-resonant DC-DC Converters, Buck ZVS Quasi-resonant DC-DC Converter, Boost ZVS Quasi-resonant DC-DC Converter, Buck-Boost ZVS Quasi-resonant DC-DC Converter, Zero-Current-Switching Quasi-resonant DC-DC Converters, Buck ZCS Quasi-resonant DC-DC Converter, Boost ZCS Quasi-resonant DC-DC Converter, Buck-Boost ZCS Quasi-resonant DC-DC Converter, Zero-Voltage Switching Multi-resonant DC-DC Converters, Zero-Current Switching Multi-resonant DC-DC Converters, Zero-Voltage Transition PWM Converters, Zero-Current Transition Converters

Unit – IV	9Hrs

Resonant Inverters

Series Resonant Inverter: Principle of Operation, Topologies of Class D Voltage-Source Inverters, Analysis, Voltage Transfer Function, Efficiency, Design Example, Class D Full-Bridge Series-Resonant Inverter, Relationships Among Inverters and Rectifiers, **Parallel-Resonant Inverter,** Analysis, Short-Circuit and Open-Circuit Operation, Electronic Ballast for Fluorescent Lamps, Design Example, Full-Bridge Parallel-Resonant Inverter, **Series-Parallel-Resonant Inverter,** Analysis, Design Example, Full-Bridge Series-Parallel-Resonant Inverter

Unit – V	8Hrs

Zero-Voltage and Zero-Current Switching Resonant Inverter

Principle of Operation and Analysis of ZVS Inverters, Matching Resonant Circuits, Design Example, Push-Pull Class E ZVS Inverter, Principle of Operation and Analysis of ZCS Inverters, Power Relationships, Element Values of Load Network, Design Example

Expected Course Outcomes:

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

CO1: Explain basic concepts of modern rectifiers and resonant converters.
CO2: Describe ZVS and ZCS for inverters and converters.
CO3: Analyse different resonant converter topologies
CO4: Design high quality rectifiers and resonant converters.

Reference Books:

1.	Mohan, Undeland and Robbins,"Power Electronics: Converter, Applications and Design", Wiley India, 2011, ISBN-13: 9781848003170
2.	Erickson R W,"Fundamentals of Power Electronics", Chapman Hall, 1997, ISBN 0-412-08541-0
3.	Marian K. Kazimierczuk, DariuszCzarkowski, "Resonant Power Converters", 2nd Edition, Wiley-IEEE Press, March 2011, ISBN: 978-0-470-90538-8
4.	Technical literature – papers published in power electronics related journal

Scheme of Continuous Internal Evaluation (CIE)

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

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

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

COMPUTATIONAL ELECTRO MAGNETIC COMPATIBILITY(ELECTIVE 6)						
Course Code	**:**	**16MPE332**		**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):

Graduates shall be able to

1. To Apply the knowledge of interference and compatibility methods to solve the equipment noise problem
2. To Design and Analyzethroughcircuits like cabeling,grounding,shieldingetc
3. To reduce the risk of external noise harming the general conditions electromagnetic compatibility should be a major design objective.
4. To distinguish between different methods and also various concept theory present in complexity of EMI study and structuring.
5. To develop the ability to analyze the conditions of EMI related problems in power electronics devices.

Unit – I	**10Hrs**

INTRODUCTIONEMC regulation, Typical noise path and use of network theory,Methods of noise coupling,Method of eliminating interferences,-STD explanation

SHIELDING: Near fields and Far fields**,** Shielding effectiveness, Absorption and Reflection losses ,different analysis with respect to Absorption losses and Reflection losses ,Apertures, Conductive gaskets and windows

Unit – II	**10Hrs**

GROUNDING: safety grounds, signal grounds, single point ground and multi point ground systems, Hybrid grounds, Functional Ground layout, Practical Low-frequency grounding, Hardware grounds, Grounding of cable shields, Guard shields, Guard meters.

Contact protection ; Glow Discharge ,Arc Discharges, contact materials, contact Rating Loads with high inrush current Contact protection fundamentals, Transient suppression for inductive loads Inductive loads controlled by Transistor switch, Resistive load contact protection, Contact protection networks for inductive loads

Unit – III	**10Hrs**

Intrinsic Noise Sources :

Thermal noise,Characteristics of Thermal Noise, Equivalent noise band width, Shot noise ,Contact noise, Pop corn noise, Addition of noise voltages, Measuring Random noises

ACTIVE Device Noise;Noise factor, Measurement of noise factor, Calculating S/N ratio and input Noise voltages from noise factor ,Noise voltage and current model, Measurement of Vn and In ,Calculation of Noise factor and S/N Ratio from Vn –In characteristic, optimum source resistance ,Noise temperature, Noise factor of cascaded stages

Unit – IV	10 Hrs
Digital circuit Noise and layout: Frequency versus time domain,Analog v/s Digital circuits, Digital Logic Noise Internal noise sources,Digital circuit ground noise, Power distribution,Noise voltage objectives, Measuring noise voltages ,Unused inputs, static pcb effects , dynamic pcbeffects**Basic linear design**: Parasitic Effects in Inductors ,Q or "Quality Factor" , Designing Controlled Impedances Traces on PCBs, Micro strip PCB Transmission Lines, Grounding and Decoupling Mixed-Signal ICs with Low Digital Currents, Sensitive analog components:	
Unit – V	**8Hrs**
Digital circuit Radiation: Problems caused by radiation , Differential-mode radiation, Controlling differential mode radiation, Common mode radiation, Controlling common mode radiation, Engineering documentation and EMC Radiation hardening,Radiation-hardening techniques,Military and space industry applications.	
Expected Course Outcomes: After going through this course the student will be able to: 1. Understand the concept of EMI and EMC 2.Analyze the causes of occurrence and minimizing of EMI 3. Evaluate, assess and compare the, operation of equipments, under EMI and EMC 4 Design different steps, to obtain EMI controlled conditions for equipments	
Reference Books:	
1.	Henry .W. Ott, "Noise reduction techniques in electronics systems", 4thdedition, John Wiley publication 2014,ISBN: 978-0-470-18930-6
2.	William D Greason , "Electrostatic Damage in Electronics: Devices and Systems", John Wiley and sons INC 1986, 4th edition, ISBN:10: 0471915394;
3.	Tim Williams , "EMC for Product Designers" Elsevier Fourth Edition, 2007, ISBN – 13: 978-0-75-068170-4
4.	Clayton R Paul, "Intoduction to Electro Magnetic compatibility", Wiley-Blackwell Publication, Revised 4th Edition 2010, **ISBN:** 978-0470189306

Scheme of Continuous Internal Evaluation (CIE)

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

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

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

ELECTRIC HYBRID VEHICLES (ELECTIVE 7)						
Course Code	**:**	**16MPE341**		**CIE Marks**	**:**	100
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	100
Credits	**:**	**4**		**SEE Duration**	**:**	**2 Hrs**

Course Learning Objectives (CLO):

Graduates shall be able to

1. Understand the fundamental concept and architecture of Hybrid Electric Vehicles -EHVs
2. Understand and analyzePlug-in hybrid vehicle and Fuel cell vehicles
3. Analyze the application of power electronics in EHVs
4. Understand and analyze the electric machines and drives used in hybrid Electric vehicles
5. Understand the Design and Modeling of components of HEV system
6. Analyze the case studies and implement the concept for adding novelty in design and manufacturing of EHVs

Unit – I	**10Hrs**

Review and Introduction to Hybridization of Automobile: History of hybrid vehicles, architectures of HEVs, series and parallel HEVs, complex HEVs. Fundamentals of vehicle,
components of conventional vehicle and propulsion load; Drive cycles and drive terrain; Concept of electric vehicle and hybrid electric vehicle; Plug-in hybrid vehicle, constituents of PHEV, comparison of HEV and PHEV; Fuel Cell Vehicles and its constituents.

Unit – II	**10Hrs**

Plug-in Hybrid Electric Vehicle:

PHEVs and EREVs, blended PHEVs, PHEV Architectures, equivalent electric range of blended PHEVs; Fuel economy of PHEVs, power management of PHEVs, end-of-life battery for electric power grid support, vehicle to grid technology, PHEV battery charging.

Unit – III	**11Hrs**

Power Electronics in HEVs:

Rectifiers used in HEVs, voltage ripples; Buck converter used in HEVs, non-isolated bidirectional DC-DC converter, regenerative braking, voltage source inverter, current source inverter, isolated bidirectional DC-DC converter, P WM rectifier in HEVs, EV and PHEV battery chargers.

Unit – IV	**10 Hrs**

Electric Machines and Drives in HEVs (part 1): Induction motor drives, Field oriented control of induction machines; Permanent magnet motor drives; Case studies

Unit – V	**08 Hrs**

Electric Machines and Drives in HEVs (part 2): Switched reluctance motors; Doubly salient ,permanent magnet machines. Case studies

Expected Course Outcomes:

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

CO1: Understand the concepts and basic operation of Hybrid Electric Vehicle system

CO2: Analyze the plug in operation of Hybrid Electric Vehicle system

CO3: Understand the design techniques of Electric Drive system.

CO4: Analyze the issues in the application of control of Electric Drive system.

Reference Books:	
1.	Mi Chris, Masrur A. and Gao D.W., " Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives", **ISBN**:0-824-77653-4
2.	Dubey G.K. "Power Semiconductor controlled drives", Prentice Hall PTR, A division of Simon andSchester England cliffs, New Jersey 1989.ISBN 0136868908, 9780136868903
3.	M. H. Rashid, "Power Electronics - Circuits, Devices and Applications", P.H.I Private Ltd. NewDelhi, Second Edition, 1994
4.	3R. Krishnan, "Electric motor drives: modeling, analysis and control, P.H.I Private Ltd. NewDelhi, Second Edition ISBN-81-203-2168-5
5.	Bimal K Bose, " Modern Power Electronics and AC Drives" P.H.I Private Ltd. New Delhi, Second Edition**ISBN-13:** 978-0130167439

Scheme of Continuous Internal Evaluation (CIE)

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 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)

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

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

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

WIND AND SOLAR TECHNOLOGIES(ELECTIVE 7)						
Course Code	**:**	**16MPE342**		**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:

1. To provide opportunity for students to Learn and work on multidisciplinary projects.
2. To familiarize the students with the basic concepts of nonconventional energy sources and allied technological systems for energy conversion
3. To impart skill to formulate, solve and analyze basic Non – conventional energy problems and prepare them for graduate studies.
4. To enable the student to design primarily solar and wind power systems.
5. To expose the students to various applications of solar, wind systems.

Unit I	**10 Hrs**

An introduction to energy sources:

Industry overview, incentives for renewable, utility perspective, relevant problems discussion, current positions of renewable energy conditions

Over view of electrical design of wind power plant:

Electrical design of wind power plant, Wind plant performance requirement, Economic evaluation factor, collection system Electrical Design,

Over view of electrical design of solar power plant: Electrical design of solar power plant, Economic analysis of thermal applications

Unit – II	**13 Hrs**

Solar collectors and Energy storage

Solar collectors: classification, comparison of concentrating and non- concentrating types, performance indices, Liquid flat plate collector, calculation of efficiency, Effect of various parameters on performance, Flat plate Air heating collector, Evacuated tube collector,ModifiedFlat-plate collector compound parabolic concentrator

Solar Energy storage: Introduction, sensible heat storage, Analysis of liquid storage, tank Analysis of packed bed storage, Latent heat storage, Thermo chemical storage **solar pond**-principle of working, Extraction of thermal energy and applications of solar pond

Wind energy storage : introduction, Storage technologies-pumped hydro storage, compressed air energy storage, Battery storage, Fly Wheel, Storage **for wind integration: Applications** of storage with High wind, integration of wind generation with storage, **Studies on operation of storage with High wind penetration:** curtailment, costs, operation of storage and effects on system

Unit – III	13 Hrs
Power quality characteristics with wind turbines: introduction power quality standards, **power quality characteristics**,-Rated data, Emission of voltages fluctuations and flicker, Current harmonics,inter harmonics and Higher frequency components, Response to voltage dips, Active power capabilities and control, Reactive power capabilities and control, Grid protection and Reconnection times **impact on voltage quality:** introduction ,case study specifications, slow voltage variation Flicker, voltage dips, Harmonic voltage **Measurement of electrical characteristics;** introduction, powerquality measurement procedure specification, **Practical experience with power quality and power:** introduction, voltage variation, Flicker, Harmonics, Transients, Frequency **Technical regulations for the inter connections of wind power:** introduction, over view of technical regulations, comparison of technical interconnection regulations, new interconnection requirements at wind plant level, interconnection practice	
Unit – IV	**10 Hrs**
Transmission systems for offshore wind power plant and operation planning: Introduction, General Electrical aspects, Transmission system to shore,From cluster approach to offshore transmission grid, off shore grid system, New system solution, **New cable systems for offshore wind power plant**: introduction, Technical Background, Power transmission with Bipolar HVAC cable system, voltage definitions and Transformer groups, Submarine cable, HVAC Bipolar land cable system **Control concept: Introduction**, model, power limitation, calculation, Results	
Unit – V	**10 Hrs**
PV Technology: Photovoltaic power, Building integrated PV system,PV cell technologies, solar energy maps, Technology trends, **Photovoltaic Power Systems**:PV cell, Module and Array, Equivalent electrical circuit, open-circuit voltage and short-circuit current, i-v and p-v curves, Array design(different methodologies),peak-power operation,system components	
Expected Course Outcomes: After going through this course the student will be able to: CO1: Demonstrate an understanding of the scientific principles of methodology of Non-conventional energy CO2: Acquire working knowledge of different Renewable energy science-related topics. CO3: Ability to analyze the system related concepts effectively in the wind energy designing CO4: Students will be able to decide the appropriate procedures to ensure that the working model has developed properly	
Reference Books:	
1.	Thomas Ackermann, "Wind Power in Power Systems", Wiley publishers,2nd edition,2008,ISBN978-0-470-1570-1

2.	Mukund R Patel, "Wind and Solar Power Systems Design,Analysis and Operation "Taylor and Francis publishers ,2nd edition,2006,ISBN978-0-8493-1570-1
3.	Fang linluohongye, " Renewable energy systems "CRCpress 2009, ISBN:978-1-470-4398
4.	Solar energy hand book – edited by William. Dickenson ASISES, Network, ISBN -13: 978-0865716216.
5.	Partain, L. D., "Solar Cells and Their Applications". John Wiley & Sons, 3rd edition, 2003, ISBN: 9780470539675.
6.	Green, M.A., et al. Solar Cell Efficiency Tables (Version 30). 2007. Prog. Photo volt: Res. Appl. ISBN: 15:425-430.

Scheme of Continuous Internal Evaluation (CIE)

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 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)

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

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

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

INTERNSHIP / INDUSTRIAL TRAINING						
Course Code	**:**	16MPE35		**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):

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 committee 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	**:**	16MPE36		**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 ofHead 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	**:**	16MPE41		**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	**:**	16MPE42		**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) Analyse 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