RashtreeyaSikshanaSamithi Trust

R.V. College of Engineering

(Autonomous Institution Affiliated to Visvesvaraya Technological University, 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 Visvesvaraya Technological University, 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

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 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 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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Department of Electrical and Electronics Engineering

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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Department of Electrical and Electronics Engineering

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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M. Tech. in Power Electronics

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	16 MPE42	Seminar	EE	0	0	2	0	2
		Total		**0**	**0**	**28**	**0**	**28**

FIRST SEMESTER

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

Course Learning Objectives:

Students are able to

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

Unit – I	**7 Hours**

Overview of Research

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

Unit – II	**7 Hours**

Methods of Data Collection

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

Unit – III	**8 Hours**

Sampling Methods

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

Unit – IV	**7 Hours**

Processing and analysis of Data

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

Unit-V	**7 Hours**

Essential of Report writing and Ethical issues:

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

Syllabus includes 12 hours of tutorials in which:

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

Course Outcomes:

After going through this course the students will be able to

CO 1. Explain various principles and concepts of research methodology.

CO 2. Apply appropriate method of data collection and analyze using statistical methods.

CO 3. Analyze research outputs in a structured manner and prepare report as per the technical and ethical standards.

CO 4. Formulate research methodology for a given engineering and management problem situation.

Reference Books:

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

Scheme of Continuous Internal Evaluation (CIE)

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)

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

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

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

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

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

POWER ELECTRONIC DEVICES						
Course Code	**:**	**16MPE12**		**CIE Marks**	**:**	100
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	100
Credits	**:**	**04**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Students will be able to

1. Understand the structure of power electronic devices such as diode, BJT, SCR, IGBT, MOSFET and advanced devices such as MCT, IGCT.
2. Analyze the operation of these devices.
3. Based on the static and dynamic characteristics, their limitation chooses these devices for various applications.
4. Understand and analyze various gate drive circuits and protection circuits of devices.
5. Model various devices using modern tools.

Unit I	**9 Hrs**

Introduction: Status of development of power semiconductor Devices – Types of static switches, Static and dynamic performance. **Power Diodes:** Basic structure and V-I characteristics, breakdown voltages and control, on-state losses, switching characteristics, modelling of power diode. Schottky diodes- structure, working comparison with power diodes.

Power BJT's: Basic structure, operation, Static and switching characteristics.

Unit – II	**11Hrs**

Power MOSFETs: -Basic structure, V-I characteristics, Physics of device operation, switching characteristics, resistive switching specifications, Operating limits and safe operating areas.

Insulated Gate Bipolar Transistors (IGBTs): Basic structure, physics of device operation, latch up in IGBTs, V-I characteristics, switching characteristics, device limits and SOAs. Series and Parallel operation of devices,

Unit – III	**11Hrs**

Thyristors:-Basic structure, V-I characteristics, device operation, switching characteristics, Gate drive circuits, protection, series and parallel operation and modelling.

Gate Turn off Thyristor (GTO): Basic structure and operation, GTO switching characteristics, GTO turn-on transient, GTO turn -off transient, minimum on and off state times, maximum controllable anode current, over-current protection of GTOs

Unit – IV	**9 Hrs**

Emerging Power Semiconductor Devices: IGCT, MCT: Structure, device operation and Characteristics. Device Concept based on SiC and GAN material, electrical performance, Device limits and benefits in applications. Future development trends, Ultrafast switching, challenges in Power Converter Systems.

Unit – V	**10Hrs**

Gate drive, Base drive and Protection Circuits Significance and design of different base drive and Gate drive circuits. Evaluation of switching losses, use of Heat sinks – Thermal modelling of power switching devices, design of heat sinks. Electromagnetic Interference-sources of EMI in power electronic system, Overview of methods to minimize EMI as per standards. Noise- sources of noise, effects and methods to reduce noise.

Expected Course Outcomes:

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

CO1: Describe the structure, working and protection techniques of power devices.

CO2: Analyse Static and Dynamic behaviour of devices.

CO3: Distinguish different gate drive circuits for the devices

CO4: Design snubber circuits by choosing appropriate device and select heat sink for protection of devices

Reference Books:

1.	B. JayantBaliga, "Fundamentals of Power Semiconductor Devices", 1stEdition,International Thompson Computer Press, 1995, ISBN:9780387473130.
2.	G. Massobrio, and P. Antognetti, "Semiconductor Device Modeling with Spice", McGraw-Hill, 2nd Edition, ISBN : 0-07-002469-3
3.	M. H. Rashid, "Power Electronics Handbook", Academic Press, 2001, ISBN 978-0-12-382036-5
4.	V. Benda, J. Gowar, and D. A. Grant, "Discrete and Integrated Power Semiconductor Devices: Theory and Applications", John Wiley & Sons, 1999, ISBN :9780471976448.

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

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

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

Solid State Power Converters (Theory and Practice)						
Course Code	**:**	**16MPE13**		**CIE Marks**	**:**	**100+50**
Hrs/Week	**:**	**L:T:P:S**	**4:0:2:0**	**SEE Marks**	**:**	**100+50**
Credits	**:**	**5**		**SEE Duration**	**:**	**3+3 Hrs**

Course Learning Objectives (CLO):

Graduates shall be able to

1. Understand, analyze and explain the operation of DC-DC converters for different load conditions.
2. Compare , model and simulate the performance of various line commutated converters
3. Specify the performance parameters of various types of inverters, analyze and compare different PWM techniques for their control
4. Explain the application of cycloconveters and dual converters
5. Analyze, model and simulate advanced converters such as multi level inverters, choppers etc.

Unit – I	**9Hrs**

DC-DC Converters: Principle of operation, analysis of step-down and step-up converters, classification of chopper, Design of DC-DC Converters for R-L-E Load

Unit – II	**11Hrs**

Line Commutated Converters: Phase control, single phase semi-converter & fully controlled converter, three phase semi controlled & fully controlled converter, power factor improvement methods, effect of source inductance, single phase series converters, twelve pulse converter and design of converter circuits. Power factor improvement techniques

Unit – III	**11Hrs**

Inverters: Principle of operation, performance parameters, single phase bridge inverters and three phase inverters, current source inverter, comparison between VSI & CSI, series resonant inverters.

Output Voltage Control of Inverters: Single/multiple, pulse/SPWM/ modified SPWM methods, voltage control of three phase inverter, SPWM/third harmonic PWM/Space vector modulation, harmonic reduction

Unit – IV	**9 Hrs**

Ac Voltage Controllers: Static Characteristics of TRIAC- Principle of phase control: single phase controllers – Design and analysis with R and R-L-E loads.

Cycloconverters: Principle of operation – Single phase and Three-phase Dual converters with & without circulating converters - Single phase and three phase cyclo-converters, dc link converters & its comparison with dual converters.

Unit – V	**10Hrs**

Multilevel Inverters: Introduction, types, diode clamped multi-level inverters, features & applications, capacitor clamped multilevel inverter, cascaded H-bridge multilevel inverter, multilevel inverters for hybrid converter- mixed level hybrid, asymmetric hybrid and soft switched multilevel inverters, super-lift multilevel inverters

Introduction to matrix converters

UNIT VI Lab Component

1. Analysis of static and dynamic characteristic of MOSFET and IGBT
2. Performance testing of single phase fully controlled and semi-controlled converter for RL load for continuous & discontinuous current mode
3. Study of effect of source inductance on the performance of single phase fully controlled converter
4. Performance analysis of three phase fully controlled and semi-controlled converter for RL load for continuous & discontinuous current mode
5. Performance analysis of single phase bridge inverter for RL load and voltage control by single pulse width modulation
6. Performance analysis of two quadrant chopper
7. Diode clamped multilevel inverter
8. ZVS operation of a Synchronous buck converter
9. Design and Performance analysis of FOUR quadrant chopper using a modern design software tool.
10. Design and Performance analysis of single phase bridge inverter for RL load and voltage control by sinusoidal pulse width modulation using a modern design tool.

Expected Course Outcomes:

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

CO1: Analyze, model and simulate various converters such as DC-DC converters, single-phase and three phase inverters, multi-level inverters and choppers.

CO2: Compare, evaluate and choose appropriate converter topology for a given application.

CO3: Design suitable PWM technique for a given converter application.

CO4:Choose appropriate control techniques and design the controller for various converters.

Reference Books:

1.	Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters, Applications, and Design", 3rd Edition. Wiley India Pvt Ltd, 2011. ISBN: 978-0-471-22693-2
2.	Fang Lin Luo, Hong Ye, "Advanced DC/AC converters- Applications to Renewable Energy", CRC Press, 2013, ISBN 9781466511354
3.	M D Singh, K B Khanchandani, "Power Electronics", Mc. Gram Hill, Second Edition 2012, ISBN 9780070583894
4.	M. H. Rashid, "Power Electronics, Circuit Devices and Applications", PHI, 1988, ISBN-10: 0131011405

Scheme of Continuous Internal Evaluation (CIE) for Theory

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

Scheme of Continuous Internal Evaluation (CIE) for Practical

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

Scheme of Semester End Examination (SEE) for Theory

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

Scheme of Semester End Examination (SEE) for Practical

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

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

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

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

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

Modelling and Simulation of Power Electronic Systems						
Course Code	**:**	**16MPE14**		**CIE Marks**	**:**	100
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:1**	**SEE Marks**	**:**	100
Credits	**:**	**5**		**SEE Duration**	**:**	**3 Hrs.**

Course Learning Objectives (CLO):

Graduates shall be able to

1 Understand the challenges in simulation process and issues in modelling power electronic systems.

2 Solve linear, non – linear systems and ODE

3 Model the system to evaluate the dynamic performance of the power electronic devices, circuits and machines

4 Simulate steady state and transient studies on converters and Drives

Unit – I	**10Hrs**

Computer Simulation of Power Electronic Converters and Systems Challenges in computer simulation, simulation process, Types of analysis, mechanics of simulation, circuit-oriented simulators, equation solvers, comparison of circuit oriented simulators and equation solvers.

Modelling of Systems: Input-Output relationship, differential equation representation, linearization, state space and transfer function representations.

Unit – II	**11Hrs**

MNA and ST approaches: Nodal analysis, Modified Nodal analysis, sparse tableau approach. Nonlinearcircuits,Newton-Raphson Method, computation time, convergence issues, Practical limitations.

Introduction to transient simulation: Discretization of time, transient analysis, Accuracy and stability, Explicit and Implicit Schemes.

Unit – III	**11Hrs**

Method of Transient Simulation: Introduction, Numerical methods for solving ODEs, Stability of numerical methods. Stiff equations, Adaptive step size, Transient analysis in circuit simulation, Equivalent circuit approach, and practical aspects.

Unit – IV	**08Hrs**

Dynamic performance of switched mode power converters: Introduction, PWM converter, Average model of the converter, Circuit Average model of the converter. Introduction toClosed loop control of switching converters, closed loop performance functions.

Unit – V	**10Hrs**

Advanced topics in Switching converters: Current control of DC to DC converters, Soft switching converters.

Self Study	

Faculty is expected to give task to students to study literature, white papers and standards; analyze, suggest solutions and share the same.

Expected Course Outcomes:

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

CO1: Analyze performance parameters of various circuits, Power electronic converters and Drives by modelling and simulating with appropriate time steps

CO2: Solve steady state and transient problems of Power electronic systems

CO3: Apply numerical techniques to solve ODE.

CO4: Design, Analyse and Implement open loop and closed loop systems

Reference Books:

1.	Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters, Applications, and Design", 3rd Edition. Wiley India Pvt Ltd, 2011, ISBN : 978-81-265-1090-0
2.	L.Umanand,"Power Electronics Essentials and Applications",1st Edition, John Wiley & Sons, 2009, ISBN: 978-81-265-1945-3
3.	M.B.Patil, V.Ramanarayanan, V.T.Ranganathan, "Simulation of Power Electronic Circuits", Narosa Publishing House, 2013, ISBN: 978-81-7319-989-9

Note: For Unit I Reference books 1 and 2
For Unit III to Unit V, Reference book 3

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

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

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

Digital System Design (Elective Group 1)						
Course Code	**:**	**16MPE151**		**CIE Marks**	**:**	100
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	100
Credits	**:**	**4**		**SEE**	**:**	**3 Hrs**

Course Learning Objectives

In this course the student shall be able to

1. Compare methodologies for designing sequential and combinational circuits
2. Acquire knowledge of hardware description languages and use it for digital system modelling and simulation
3. Analyze digital circuits and systems using ASM charts
4. Acquirein-depth knowledge of input/output modules, their timing parameters and the interfacing
5. Read data sheets of PLDs , analyze them and select appropriate device for a given application
6. Design digital circuits using programmable logic devices and FPGAs

Unit – I	**10Hrs**

Review of Digital Logic Design Fundamentals: Development and evolution digital devices, design and verification tools. Abstraction levels of digital system design. Designing of combinational circuits. Design of sequential circuits- Finite State machine; mealy and moore machines. Sequential packages;

Unit – II	**11Hrs**

Design Development flow : Overview of PLDs and EDA Software: Introduction of PLDs, general FPGAs devices, Overview of the hardware platform, EDA Tools: Integrated software Environment, creation of design project and HDL codes, test-bench and perform the RTL simulation, RTL Design with HDLs: Combinational circuits design and verification, regular sequential circuits and components, Finite state machine(FSM), Finite State Machine with Datapath (FSMD) code development of FSMD- design examples, CPU design, Algorithmic state machine charts (ASM), code conversion of ASM

Unit – III	**11Hrs**

Input / Output Modules: UART: Introduction, UART receiving subsystem, Oversampling procedure, Baud rate generator, UART receiver, Interface circuit, UART transmitting subsystem, Overall UART system, Complete UART core, example circuits. PS2: Introduction, PS2 receiving subsystem, Device-to-host communication protocol, Design and code, PS2 keyboard scan code, example circuits. External SRAM: Introduction, Specification of SRAM, Architectural Block diagram, Timing parameters, Timing requirement, Design ASMD chart, Timing analysis

Unit – IV	**10Hrs**

Customized Hardware and Software: Special-purpose FSMD, general-purpose microcontroller, embedded microcontrollers. Xilinx'sPico Blaze Overview: Overview of Pico Blaze, Internal Architecture, Development flow, Instruction set, Programming model, Instruction format, Interfacing, Interrupt handling, KCPSM3 directives Pico Blaze Assembly Code Development: Development tools- Xilinx's KCPSM3 and PBlazeIDE - Assembler directives, useful code constructs, control structure, subroutine development, example programme and their verification through PBlaze IDE

Unit – V	10Hrs
FPGA Implementation of Digital Circuits: Constraint files development, synthesis and implementation of HDL codes. Generation and downloading of the configuration file to a PLD device; Soft core microcontroller implementation: Picoblaze use in HDL design flow, implementation of programmed processor, development of SOPC.	
Expected Course Outcomes: After going through this course the student will be able to: CO1 : Formulate and solve problems in Sequential and combinational circuits CO2 : Design digital circuits using HDL CO3 : Implement digital systems using FPGA CO4 : Develop design flow for SOPC	
Reference Books:	
1.	Mano M. M. and Ciletti M. D., "Digital Design", 4th Edition, Pearson Education, 2008. **ISBN:**9788131714508
2.	Charles H Roth Jr., *Digital Systems Design Using VHDL*, PWS Publishing Company, 2nd Edition 1998, ***ISBN***-13: 978-0-495-66776-6, ***ISBN***: 0-495-66776-5
3.	Maxfield C. M., "The Design Warrior's Guide to FPGAs – Devices, Tools and Flows", Newnes.2006, ISBN-13: 978-0750676045, ISBN-10: 0750676043
4.	Brown S. and Vranesic Z., "Fundamentals of Digital Logic with VHDL Design", 3rd Edition., Tata McGraw-Hill Publishing Company Limited., 2008, ISBN:9781259025976

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

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

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

Advanced Control Systems (Elective Group 1)						
Course Code	**:**	**16MPE152**		**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. Represent discrete systems using difference equations, transfer functions, all-delay blockdiagrams and state-space models; apply sampling and reconstruction processes to signals and systems
2. Familiarize the concepts of state space, controllability and observability, pole placement, non linear systems and Liapunov stability.
3. Perform analysis for stability of linear time-invariant, continuous & discrete time control systems using both classical & state space methods.
4. Apply the concept of optimal and adaptive control in both continuous and discrete systems.
5. Design controllers to meet specifications and requirements using pole placement method.

Unit – I	**10 Hrs**

Digital Control Systems: Review of difference equations and Z - transforms, sampled data systems: ideal sampler, sample and hold operations, Z- transfer function (Pulse transfer function), pulse transfer functions and different configurations for closed loop discrete-time control systems. Z - Transforms analysis of sampled data systems.

Unit – II	**11 Hrs**

Mapping between the s-plane and the z-plane, stability analysis of closed loop systems in the z-plane Stability analysis (Jury's Stability Test and Bilinear Transformation), State model for continuous time and discrete time systems, Solutions of state equations(for both continuous and discrete systems), Discretization of continuous time state equations.

Unit – III	**11 Hrs**

Concepts of controllability and observability (for both continuous and discrete systems), design of state feedback controllers via pole placement, design of full and reduced order state observers and design of servo systems using pole placement technique. (for both continuous and discrete systems), full order and reduced order observers (for both continuous and discrete systems), dead beat control by state feedback

Unit – IV	**10 Hrs**

Optimal control problems using state variable approach, state regulator and output regulator, Linear regulator problem: matrix Riccati equation and its solution, concepts of model reference control systems, adaptive control systems and design.

Unit – V	**10 Hrs**

Non Linear Control Systems: Characteristics of nonlinear systems, Singular points, stability of nonlinear systems - phase plane analysis and describing function analysis, Lyapunov's stability criterion, Popov's criterion.

Expected Course Outcomes:

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

CO1: Identify, Formulate and obtain transfer function models, solve discrete control engineering problems, use the techniques, tools and skills related to discrete signals to solve complex control engineering problems.

CO2: Apply the concepts of state space, controllability and observability, pole placement

	technique, optimal & adaptive control and Liapunov stability. CO3: Analyze and obtain state space models, solution of state equation, state feedback controllers and observers, stability of linear nonlinear systems using phase plane and linear & nonlinear Liapunov method. CO4: Assess and design of state feedback controllers and observers, using pole placement for continuous and discrete systems.
Reference Books:	
1.	M. Gopal, "Digital Control & State Variable Methods", 4th Edition, McGraw Hill Education, 2012, ISBN: 9780071333276.
2.	Ogata. K. "Modern Control Engineering", 5th Edition, PHI, 2010, ISBN: 9788120340107.
3.	Ogata K "Discrete Time Control Systems", 2nd Edition, PHI, 2011, ISBN: 9788120327603.
4.	Nagarath and Gopal, "Control Systems Engineering", New Age International Publishers, 2012, ISBN: 9788122420081.

Scheme of Continuous Internal Evaluation (CIE) for Theory:

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

Scheme of Semester End Examination (SEE) for Theory:

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

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

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

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

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

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

Course Learning Objectives:

Students are able to

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

UNIT 1	**5 Hours**

Communication Skills: Basics of Communication, Personal Skills & Presentation Skills, Attitudinal Development, Self Confidence, SWOC analysis.

Resume Writing: Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts.

UNIT 2	**6 Hours**

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

UNIT 3	**4 Hours**

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

UNIT 4	**5 Hours**

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

UNIT 5	**4 Hours**

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

Note: The respective departments should discuss case studies and standards pertaining to their domain

Course Outcome:

After going through this course the students will be able to

CO1: Develop professional skill to suit the industry requirement

CO2: Analyze problems using quantitative and reasoning skills

CO3: Develop leadership and interpersonal working skills

CO4: Demonstrate verbal communication skills with appropriate body language.

References

1. Stephen R Covey, “The 7 Habits of Highly Effective People”, Free Press, 2004 Edition, ISBN: 0743272455
2. Dale Carnegie, “How to win friends and influence people”, General Press, 1st Edition, 2016,

ISBN: 9789380914787
3. Kerry Patterson, Joseph Grenny, Ron Mcmillan, "Crucial Conversation: Tools for Talking When Stakes are High", McGraw-Hill Publication, 2012 Edition, ISBN: 9780071772204
4. Ethnus, "Aptimithra: Best Aptitude Book", Tata McGraw Hill, 2014 Edition, ISBN: 9781259058738

Scheme of Continuous Internal Examination (CIE)

Evaluation will be carried out in TWOPhases.

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

CIE Evaluation shall be done with weightage as follows:

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

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

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

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

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

SECOND SEMESTER

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

Course Learning Objectives:

Students are able to

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

Unit – I	**7 Hours**

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

Unit – II	**8 Hours**

Generation and Screening of Project Ideas: Generation of ideas, monitoring the environment, corporate appraisal, scouting for project ideas, preliminary screening, project rating index, sources of positive net present value. Project costing,

Project Scope Management: Project scope management, collect requirements define scope, create WBS, validate scope, control scope.

Organizational influences & Project life cycle: Organizational influences on project management, project state holders & governance, project team, project life cycle.

Unit – III	**7 Hours**

Project Integration Management: Develop project charter, develop project management plan, direct & manage project work, monitor & control project work, perform integrated change control, close project or phase.

Project Quality management: Plan quality management, perform quality assurance, control quality.

Unit – IV	**7 Hours**

Project Risk Management: Plan risk management, identify risks, perform qualitative risk analysis, perform quantitative risk analysis, plan risk resources, control risk.

Project Scheduling: Project implementation scheduling, Effective time management, Different scheduling techniques, Resources allocation method, PLM concepts. Project life cycle costing.

Unit-V	**7Hours**

Tools & Techniques of Project Management: Bar (GANTT) chart, bar chart for combined activities, logic diagrams and networks, Project evaluation and review Techniques (PERT) Planning, Computerized project management.

Syllabus includes tutorials for two hour per week:

- Case discussions on project management
- Numerical problems on PERT & CPM
- Computerized project management exercises using M S Project Software

Course Outcomes:

After going through this course the student will be able to

CO1: Explain the process of project management and its application in delivering successful projects.

CO2: Illustrateproject management process groupsfor various project / functional applications.

CO3: Appraise various knowledge areas in the project management framework.
CO4: Develop project plans and apply techniques to monitor, review and evaluate progress for different types of projects.

Reference Books:

1. Project Management Institute, "A Guide to the Project Management Body of Knowledge (PMBOK Guide)", 5th Edition, 2013, ISBN: 978-1-935589-67-9
2. Harold Kerzner, "Project Management A System approach to Planning Scheduling & Controlling", John Wiley & SonsInc., 11th Edition, 2013, ISBN 978-1-118-02227-6.
3. Prasanna Chandra, "Project Planning Analysis Selection Financing Implementation & Review", Tata McGraw Hill Publication, 7th Edition, 2010, ISBN 0-07-007793-2.
4. Rory Burke, "Project Management – Planning and Controlling Techniques", John Wiley & Sons, 4th Edition, 2004, ISBN: 9812-53-121-1

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

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

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

Control of AC and DC Drives Theory and Practice						
Course Code	**:**	**16MPE22**		**CIE Marks**	**:**	100+50
Hrs/Week	**:**	**L:T:P:S**	**4:0:2:0**	**SEE Marks**	**:**	100+50
Credits	**:**	**5**		**SEE Duration**	**:**	**3+3 Hrs**

Course Learning Objectives (CLO):

Graduates shall be able to

1. Comprehend the AC and DC motor characteristics in different quadrants.
2. Understand the use of choppers and inverters to control the speed of machines for various applications
3. Analyze the effect of harmonics on the motor performance
4. Design the control strategies for electric drives..

Unit – I	**10Hrs**

Review of Conventional Drives: speed –torque relation, Steady state stability, methods of speed control, DC motor braking – Multi quadrant operation, Speed torque relation of AC motors, Methods of speed control and braking for Induction motor, Synchronous motor. Parameter estimation of motors. Criteria for selection of motor for drives.

Unit – II	**11Hrs**

Converter Control of DC Drives: Analysis of series and separately excited DC motor with single phase and three phase converters operating in different modes and configurations.

Chopper Control of DC Drives: Analysis of series and separately excited DC motors fed from choppers for both time ratio control and current limit control, four quadrant control.

Design of DC Drives: Single quadrant variable speed chopper fed DC drives, Four quadrant variable speed chopper fed DC Drives, Single phase/ three phase converter, Dual converter fed DC Drive, current loop control, Armature current reversal, Field current control, Different controllers and firing circuits, simulation.

Unit – III	**11Hrs**

Inverter fed AC Drives: Analysis of different AC motors with single phase and three phase inverters, Operations in different modes and configurations. Problems and strategies. Vector Control and Rotor side Control. Analysis of 5^{th} and 7^{th} space harmonics on Torque. Doubly fed induction motor. V/f control of Induction motor, and braking, Operations in different modes. Problems and strategies.

Unit – IV	**09Hrs**

Control and estimation of AC drives: Induction motor, Small signal model, scalar control, FOC control, sensor less control, DTC.

Unit – V	**09Hrs**

Synchronous motor: sine SPM, synchronous reluctance machines, sensor-less operation, switched reluctance machines, BLDC drive control, Dynamics and Modelling of AC Drives.

Unit – VI (Lab Component)	

1. Analysis of single phase fully controlled converter fed separately excited DC motor for continuous current mode.
2. Performance analysis of three phase fully controlled converter fed separately excited DC motor for continuous current mode.
3. Simulation of three phase fully controlled converter fed separately excited DC motor for continuous current mode.
4. Analysis of chopper fed DC drive system Class A and Class C commutation and analysis of wave form for continuous current mode
5. Simulation study of Buck, boost and buck boost converter and analysis of waveforms for continuous conduction mode
6. Simulation study of Buck, boost and buck boost converter and analysis of waveforms for discontinuous conduction mode
7. Resonant converter simulation study and analysis
8. Closed loop operation of buck and boost converter.
9. Simulation study of forward converter and fly back converter
10. Speed control of motor using DSP controller.

Expected Course Outcomes:

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

CO1: Understand the design techniques of drive system.

CO2: Build an electric drive system as per the given specification.

CO3: Simulate and build control modules for closed loop operation of an electric drive system.

CO4: Analyze the issues related to effect of harmonics on AC and DC drives.

Reference Books:

1.	Bimal.K. Bose, "Power Electronics and Variable frequency drives", Standard PublishersDistributors, New Delhi, 2000. ISBN No: 9780700310841
2.	Murphy J.M.D, Turnbull, F.G, "Thyristor control of AC motor", Pergamon press, Oxford, 1988. ISBN No; 083069806
3.	M. H. Rashid, "Power Electronics - Circuits, Devices and Applications", P.H.I Private Ltd. New Delhi, Second Edition, 1994. ISBN No: 0201529831
4.	N. Mohan et.al. "Power Electronics- Converters, Applications and Design", John Wiley & Sons (Asia) Private Ltd., Singapore, 1996.ISBN No: 9780471226932

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

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

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

Power Quality Enhancement (Elective Group 2)						
Course Code	**:**	**16MPE231**		**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):

Graduates shall be able to

1 Define PQ terms and the standards for them

2 Understand and analyze sources and effects of harmonics

3 Compute level of PQ disturbance under different operating conditions

4 Design good grounding systems

5 Apply concepts of power electronics to design custom power devices

Unit – I	**9Hrs**

INTRODUCTION: Introduction, power quality issues, remedial measures, power quality vs equipment immunity, power quality concerns, power quality standards IEEE P1159, power quality monitoring, common power frequency disturbances, source of steady state disturbances, the effect of steady state disturbance on loads, techniques to reduce disturbances.

Unit – II	**10Hrs**

PQ MEASUREMENT, GROUNDING AND BONDING: Power quality measurement devices, power quality measurements, number of test locations, test duration, instrument setup and guidelines. Shock And Fire Hazards, National Electrical Code Grounding Requirements, Essentials of a Grounded System, Ground Electrodes, Earth Resistance Tests, Earth-Ground Grid Systems, Power Ground System, Signal Reference Ground, Signal Reference Ground Methods, Single Point And Multipoint Grounding, Ground Loops, Electrochemical Reactions Due To Ground Grids, Examples of Grounding Anomalies or Problems; Electromagnetic Interference Terminology, EMI Mitigation.

Unit – III	**11Hrs**

HARMONICS: Definition of Harmonics, harmonic number (h) , odd and even order harmonics, harmonic phase rotation and phase angle relationship, causes of voltage and current harmonics, individual and total harmonic distortion, harmonic signatures, Sources and effects of harmonics on power system devices, guidelines for harmonic voltage and current limitation, harmonic current mitigation, filters, harmonic analyzers, standards for harmonics IEEE 519-1992

Unit – IV	**10Hrs**

ELECTRICAL TRANSIENTS : Introduction, Transient System Model, Examples of Transient Models and their Response, Power System Transient Model, Types and Causes of Transients, Examples of Transient Waveforms

Unit – V	**10Hrs**

CUSTOM POWER DEVICES: Dynamic Voltage Restorer (DVR), D-STATCOM, Unified Power Quality Conditioner (UPQC), Unified Power Quality Conditioner based on current source convert topology, principles, configuration and types of Uninterruptable Power Supplies (UPS).

Expected Course Outcomes:

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

CO1: Understand and define different power quality problems and concepts of monitoring for PQ

CO2: Build models to describe transient phenomenon and harmonics

CO3: Evaluate, assess and design good grounding systems

CO4: Choose and design the custom power device for a given PQ disturbance

Reference Books:

1.	C.Sankaran, "Power Quality", First Indian reprint, CRC press, 2009, ISBN 9780849310409
2.	J.B Dixit, Amit Yadav, "Electric Power Quality", First Edition, Laxmi Publications Pvt. Ltd 2010, ISBN 9789380386744
3.	Math H.J. Bollen, "Understanding Power Quality Problems:Voltage Sags and Interruptions", IEEE Press, 2001. ISBN: 978-0-7803-4713-7
4.	Roger Dugan, Surya Santoso, Mark F. McGranaghan, H.Beaty, "Electrical Power Systems Quality", McGraw-Hill Professional Publishing, Second Edition, November 2002.

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

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

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

Intelligent Control Techniques in Drives (Elective Group 2)						
Course Code	**:**	**16MPE232**		**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 fundamental concept of ANN and Fuzzy logic (FL).
2. Compare various learning methods and apply to feedback systems
3. Analyze the techniques involved in the application ANN and Fuzzy Logic
4. Apply ANN and FLalgorithms to various drives.

Unit – I	**11 Hrs**

Fuzzy Logic Systems::Basic concepts of fuzzy logic, fuzzy Vs crisp set, linguistic variables, membership functions, fuzzy sets and operations on fuzzy sets, Fuzzy relations, operations on fuzzy relation, fuzzy if then rules, compositional rule of inference, fuzzy reasoning

Unit – II	**12 Hrs**

Fuzzy Logic Control: Basic concept of fuzzy logic control ,reasoning with an FLC, relationship to PI, PD and PID control, design of FLC: determination of linguistic values, construction of knowledge base, inference engine, tuning, fuzzification and de-fuzzification, Mamdani type models, Takagi-Sugeno-Kang (TSK) fuzzy models and Adaptive Fuzzy control

Unit – III	10 Hrs

Neural network: characteristics, history of development of neural network principles, artificial neural net terminology, models of neuron and topology

Learning methods and neural network models,

types of learning, supervised, unsupervised, reinforced learning, knowledge, representation and acquisition, Basic Hopfield model, basic learning laws, unsupervised learning, competitive learning, Kmeans clustering algorithm. Kohnen's feature maps, pattern recognition &mapping,

Unit – IV	**9 Hrs**

Neural Networks for feedback Control: Identification of system models using neural networks, Model predictive control, feedback linearization and model reference control using neural networks,Neural Network Reinforcement Learning Controller, Radial basis function neural networks, Basic learning laws in REF nets, Recurrent back propagation, introduction to counter propagation networks, CMAC networks and ART networks.

Unit – V	**8 Hrs**

Hybrid algorithms: Neuro- fuzzy systems, ANFIS and extreme-ANFIS, derivative free optimization methods, genetic algorithm, particle swarm optimization, Solution of typical control problems derivative free optimization and Case studies on Application to Drives.

Expected Course Outcomes:

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

CO1: Understand the concepts and fundamentalsof ANN and Fuzzy Logic

CO2: Analyze the techniques involved in ANN and fuzzy logic applications

CO3: Design and model independent/hybrid system with ANN and FL.

CO4: Application of ANN and FL techniques to modern industrial drives and power electronic systems

Reference Books:	
1.	John Yen and Reza Langari, "Fuzzy Logic – Intelligence, Control and Information" Pearson Education Inc, 2009 3rd Edition ISBN 978-81-317-0534-6
2.	Simon Haykin, " Neural Networks – A Comprehensive Foundation" 2nd Edition, PHI, ISBN978-81-203-2373-5
3.	D Driankov, H Hellendoorn and M Reinfrank, "An Introduction to Fuzzy Control", Narosa Publishing House, ISBN 81-7319-069
4.	Timothy J. Ross., "Fuzzy Logic with Engineering Applications", 3rd edition, John Wiley and Sons,2011 ISBN 978-0-470-74376-8

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

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

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

Flexible AC Transmission System (FACTS) (Elective Group 3)						
Course Code	**:**	**16MPE241**		**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 need for FACTS and distinguish between series and shunt FACTS devices
2. Model, Analyze and design SVC and TCSC controllers for stability
3. Model, analyze and design VSC based devices
4. Understand the importance of coordination and apply optimization techniques for location of FACTS devices.

Unit – I	**9 Hrs**

Introduction to facts: Review of basics of power transmission networks-control of power flow in AC transmission line- Analysis of uncompensated AC Transmission linePassive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS controllers- types of FACTS controllers.

Unit – II	**13 Hrs**

Static var compensator (svc) Configuration of SVC- voltage regulation by SVC-Modeling of SVC for load flow analysis- Modeling of SVC for stability studies-Design of SVC to regulate the mid-point voltage of a SMIB system- Applications: transient stability enhancement and power oscillation damping of SMIB system with SVC connected at the mid-point of the line.

Thyristor controlled series capacitors (TCSC) - Concepts of Controlled Series Compensation – Operation, modeling, analysis and control of TCSC.

Unit – III	**13 Hrs**

Voltage source converter based facts controllers: Static synchronous compensator(STATCOM)- Static synchronous series compensator(SSSC)- Operation of STATCOM and SSSC-Power flow control with STATCOM and SSSC- Modeling of STATCOM and SSSC for power flow and transient stability studies; of Unified Power Flow Controllers(UPFC) - Modeling, Operation and control.

Unit – IV	**9 Hrs**

Static Voltage and Phase Angle Regulators: Power flow control, TCVR and TCPAR, improvement of transient stability with these.

GCSC _ operation, modeling and analysis. Comparison with TCSC

IPFC – Block diagram, operation and comparison with UPFC

Unit – V	**8 Hrs**

Controllers and their co-ordination: Location of FACTS devices, Controller interactions – SVC–SVC interaction - co-ordination of multiple controllers using linear control techniques – Quantitative treatment of control coordination.; Coordination of FACTS with HVDC links

Expected Course Outcomes:

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

CO1: Analyze, model and describe operation of different FACTS devices.

CO2: Select and Design FACTS device for a given system.

CO3: Design controller for various FACTS devices CO4: Analysethe interaction between different FACTS devices and HVDC links
Reference Books:

1.	Mohan Mathur, R., Rajiv. K. Varma, "Thyristor – Based FACTS Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc, 2002 edition, ISBN:978-0-471-20643-9.
2.	K.R.Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International (P) Ltd., Publishers, New Delhi, Reprint, 2008. ISBN : 978-81-224-3989-2
3.	A.T.John, "Flexible AC Transmission System", Institution of Electrical and Electronic Engineers (IEEE), 1999.
4.	NarainG.Hingorani, Laszio. Gyugyl, "Understanding FACTS Concepts and Technology of Flexible AC Transmission System", Standard Publishers, Delhi, 2001. ISBN : 978-81-224-3887-2

Scheme of Continuous Internal Evaluation (CIE)

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

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

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

Program Logic Controller and Supervisory control & data acquisition (PLC and SCADA) (Elective Group 3)						
Course Code	**:**	**16MPE242**		**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. Recognize industrial control problems and access suitability of using PLC for control.
2. Understand PLC architecture including timers, counters, sequencers and Programme PLC's using ladder logic.
3. Compare different SCADA Architecture and choose appropriate one and integrate SCADA with PLC.
4. The ability to select the essential elements and practices needed to develop and implement the Engineering Automation using PLC approach.

Unit – I	**9 Hrs**

Programmable Logic Controller (PLC) Basics: Introduction, Parts of PLC, Principles of operation, PLC size and applications, PLC Advantages and Disadvantages, PLC Manufacturers, PLC hardware components, I/O section, Analog I/O modules, Digital I/O modules, CPU- Processor memory module, Programming devices, Devices which can be connected to I/O modules, Relay, Contactor, SPST, Push Buttons, NO/NC Concept.

Unit – II	**11 Hrs**

Programming of Programmable Logic Controller: General PLC Programming Procedures, Contacts and Coils, Program SCAN, Programming Languages, Ladder Programming, Relay Instructions, Instruction Addressing, Concept of Latching, Branch Instructions, Contact and Coil I/O Programming Examples, Relation of Digital Gate Logic to Contact/Coil Logic.

Unit – III	**10Hrs**

Programmable Logic controller Functions: Timer Instructions: ON DELAY Timer and OFF DELAY timer.

Counter Instructions: UP/DOWN Counters, Timer and Counter Applications, Program Control Instructions: Master Control Reset, Jump and Subroutine, Math Instructions- ADD, SUB. Data Handling: Data Move, Data Compare, Data Selection, Electro-pneumatic Sequential Circuits and Applications. Analog input output communication with PLC. Programming examples.

Unit – IV	**9 Hrs**

Communication with different sensors: Proximity sensors :Inductive, capacitive sensors,PhotoelectricSensors and Switches, Encoders, Temperature sensors, position and displacement sensors, pressure sensors

Industrial Communication Protocols: RS232/RS485 Interface Standard, Modbus Protocol, ProfibusProtocol, Industrial Ethernet,ETHERCAT, Profinet Protocol.

Unit – V	**9 Hrs**

SCADA: Definition of SCADA, Elements of SCADA System, SCADA architecture, Communication Access and Master-Slave architecture; determining scan interval; Introduction to Remote Control and RTU, Long Distance Communication, Communication System components in brief; - Protocols, Modems, Synchronous/Asynchronous telephone cable/radio, Half Duplex, Full Duplex System, Brief introduction to RTU and MTU, Applications-Automatic Control, Advisory Applications.

Expected Course Outcomes:

After going through this course the student will be able to

CO1: Understand the basic concepts of PLC and SCADA systems.

CO2: Assess the control needs of a process industry and evaluate various options of using PLC or SCADA

CO3: Design and program the PLC to meet a specified control objective

CO4: Build a complete control system through integration of sensor with PLC in a SCADA environment.

Reference Books:

1.	Frank D. Petruzella "Programmable Logic Controllers", McGraw-Hill Book Company. ISBN 13: 9780073510880
2.	John w. Webb and Ronald A. Reis, "Programmable Logic Controllers", PHIISBN: 9788120323087, 8120323084
3.	W.Bolton, "Programmable Logic Controllers", Elsevier Fourth edition ISBN-13: 978-0-7506-8112-4
4.	John R. Hackworth and Frederick D. Hackworth, Jr., "Programmable Logic Controllers: Programming Methods and Applications", Pearson/Prentice Hall, 2004 ISBN-9780130607188.

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Scheme of Semester End Examination (SEE) for Theory:

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

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

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

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

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

DSP Applications to Drives (Elective Group 4)						
Course Code	**:**	**16MPE251**		**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 architecture and operation of Digital Signal Processors.
2. Study various peripherals for data acquisition and their functions.
3. Managing the frames and using them for various control techniques and analyze them.
4. Design control technique using DSPs for to the drives

Unit – I	**10Hrs**

Introduction to the DSP core and code generation, The components of the DSP core, Mapping external devices to the DSP core, peripherals and Peripheral Interface, System configuration registers , Memory, Types of Physical Memory, memory Addressing Modes , Assembly Programming, Instruction Set, Software Tools

Unit – II	**11 Hrs**

GPIO FUNCTIONALITY: Pin Multiplexing (MUX) and General Purpose I/O Overview, Multiplexing and General Purpose I/O Control Registers.

INTERRUPTS: Introduction to Interrupts, Interrupt Hierarchy, Interrupt Control Registers, Initializing and Servicing Interrupts in Software.

ADC CONVERTER: ADC Overview, Operation of the ADC in the DSP, Analog to Digital Converter Usage.

Unit – III	**11 Hrs**

THE EVENT MANAGERS: Overview of the Event manager (EV), Event Manager Interrupts, General Purpose (GP) Timers, Compare Units, Capture Units, Quadrature Enclosed Pulse (QEP) Circuitry, General Event Manager Information, PWM Signal Generation

DSP Based Control of Buck-Boost Converters: Control of Buck-Boost DC-DC converter; DSP based control of dual converter fed dc motor Implementation of Clarkes and Park's transformation, Implementation of Space Vector Modulation for inverters, Control of matrix converters.

DSP Based Control of Stepper Motors: Introduction, the Principle of Hybrid Stepper Motor, The Stepper Motor Drive System, The Implementation of Stepper Motor Control System Using DSP.

Unit – IV	**9 Hrs**

DSP Based Control of BLDC Motor: Introduction, Principles of the BLDC Motor, BLDC Motor Control System, Implementation of the BLDC Motor Control System Using DSP

SVPWM Technique: Principle of Constant V/Hz Control for Induction Motors, Space Vector PWM Technique, DSP Implementation.

Unit – V	**9 Hrs**

DSP-based vector control of induction motors: Introduction, Three-Phase Induction Motor Basic Theory, Model of the Three-Phase Induction Motor in Simulink, Reference Frame Theory, Induction Motor Model in the Arbitrary q-d-0 Reference Frame, Field Oriented Control, DC Machine Torque Control, Field Oriented Control, Direct and Indirect Approaches, Simulation of the Induction Motor Control System, Induction Motor Speed Control System,

Expected Course Outcomes:

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

CO1: Comprehend the different peripherals and the operation of DSP core processor with its architecture

CO2: Analyze the functions of peripherals

CO3: Develop program and demonstrate execution to evaluate the performance of control technique

CO4: Design suitable control technique for the implementation of control systems using DSP for drives.

Reference Books:

1.	Hamid A. Toliyat, Steven G. and Campbell, "DSP Based Electromechanical Motion Control", CRC Press, 2004 edition, ISBN 9780849319181
2.	Steven W Smith, "Digital Signal Processing:", California Technical Publishing, 2nd Edition, 1999, *ISBN* 0-9660176-7-6
3.	RulphChassaing A., "Digital Signal Processing and Applications with theC6713 and C6416 DSK", John Wiley & Sons, Inc., Publication, 2005 edition, ISBN: 9780471690078,ISBN: 9780471704072
4.	Kenjo T., "Power Electronics for the Microprocessor Age", Oxford University Press.1994, ISBN-10: 0198565089, ISBN-13: 978-0198565086

Scheme of Continuous Internal Evaluation (CIE):

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Scheme of Semester End Examination (SEE):

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

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

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

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

PWM Techniques for Converters (Elective Group 4)						
Course Code	**:**	**16MPE252**		**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 PWM and its characteristics, the effects of harmonics and harmonic elimination techniques
2. Analyse basic and advanced PWM control techniques
3. Estimate torque ripple and current ripple in converters employing PWM techniques
4. Evaluate the losses due to switching, conduction and dead-time in PWM inverters

Unit – I	**9 Hrs**

Introduction to pulse width modulation (PWM)- Review of Fourier series, Harmonic voltages and their undesirable effects. Control strategies for dc-dc converters

Pulse width modulation at low switching frequency - Low switching frequency operation of a VSI -(square wave operation, one switching angle per quarter), Low switching frequency operation of a VSI – II (Two switching angles per quarter), Selective harmonic elimination and THD optimized PWM .

Unit – II	**12Hrs**

Triangle-comparison based PWM: single pulse. Multiple pulse, SPWM, modified SPWM and phase displacement techniques, Third harmonic injection PWM (THIPWM), Bus-clamping PWM

Space vector-based PWM: Concept of space vector, Conventional space vector PWM and bus-clamping PWM, Advanced bus-clamping PWM.

Unit – III	**12Hrs**

Analysis of line current ripple: Transformation from stationary reference frame to synchronously revolving dq reference frame, Volt-second balance and instantaneous error voltage, Calculation of RMS line current ripple, Space vector-based hybrid PWM for reduced line current ripple. Analysis of dc link current, Average and RMS values of dc link current.

Analysis of torque ripple: Calculation of harmonic torques and RMS torque ripple, Hybrid PWM techniques to reduce ripple torque.

Unit – IV	**9 Hrs**

Loss Calculations: Practical devices in converters, calculation of switching and conduction losses, compensation for dead time and DC voltage regulation.

Effect of inverter dead-time: Effect of dead-time with continuous modulation and discontinuous modulation.

Unit – V	**8 Hrs**

Over modulation- Per-phase approach to over modulation, Space vector approach to over modulation, A perspective from the synchronously revolving d-q reference frame.

PWM for multilevel inverters, Extension of sine-triangle modulation to three-level inverters, Extension of conventional space vector modulation to three-level inverters. Bang-bang and bang-hang controllers for multilevel inverter.

Expected Course Outcomes:

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

CO1: Explain basic concepts of PWM controllers.
CO2: Describe PWM methods for inverters and converters.
CO3: Analyse different PWM controller topologies
CO4: Design a PWM controller for a given application

Reference Books:

1.	Mohan, Undeland and Robbins, "Power Electronics: Converter, Applications and Design", Wiley India, 2011 edition, ISBN-13: 9781848003170
2.	Erickson R W," Fundamentals of Power Electronics", Chapman Hall, 1997 edition, ISBN 0-412-08541-0
3.	JosephVithyahil, "Power electronics-Principles and Applications", TMH, 2011 Edition, ISBN 9780070702394
4.	NPTEL materials on 'Pulse width Modulation for Power Electronic Converters'

Scheme of Continuous Internal Evaluation (CIE):

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

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

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

MINOR PROJECT						
Course Code	**:**	**16MPE26**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**0:0:10:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**05**		**SEE Duration**	**:**	**3 Hours**

Course Learning Objectives:

Students are able to

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

GUIDELINES

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

Course Outcomes:

After 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 resource managements skills for projects

CO4: Synthesize self-learning, team work and ethics.

Scheme of Continuous Internal Examination (CIE)

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

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

****Phase wise rubrics to be prepared by the respective departments**

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

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

Scheme for Semester End Evaluation (SEE):

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

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

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

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

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

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