

Government College of Engineering, Chhatrapati Sambhajnagar

(An Autonomous Institute of Government of Maharashtra)

Station Road, Osmanpura, Chhatrapati Sambhaji Nagar – 431005 (M. S.)

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Master of Technology **Curriculum of M. Tech. in Electrical Machines and Drives** **Regular (2026-27 Onwards)**



Vision of the Institute

To be globally recognized leader in technical education through industry integration and societal wellbeing

Missions of the Institute

1. To build career-ready graduates through multidisciplinary learning and industry-sync curricula
2. To promote ecosystem for cutting-edge research, patents, publications, IPR, innovation, technology transfer and entrepreneurship
3. To be a premier trusted partner of government allied bodies, industries, and society.

Vision of the Electrical Engineering Department

To provide technical education in Electrical Engineering that empowers aspiring engineers from the region to become competitive, industry-ready & socially responsible

Missions of the Electrical Engineering Department

- To impart strong fundamental technical knowledge through effective teaching and learning practices
- To encourage innovation, research aptitude & life-long learning
- To strengthen employability and industry readiness through industry-aligned trainings
- To inculcate professional and social ethics through value based activities and community engagement.

Program Outcomes

- PO1: An ability to independently carry out research investigations to solve practical problems.
- PO2: An ability to write technical reports/artifacts.
- PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program, and it should be at the level higher than the requirements of the bachelor program.
- PO4: Ability to enhance experiential learning through project-based activities.
- PO5: Formulate and solve real life electrical problems by applying advanced methods.

Curriculum

For Regular as well as for Working Professionals

(With effect from academic year 2026-27 onwards)

M.Tech. Programme Components

Components		Total Credits
Programme Core Course (PCC)	Program Courses	20
Programme Elective Course(PEC)	Program Electives	10
Open Elective (OEC) other than a particular program	Open Electives	02
Vocational and Skill Enhancement Course(VSE)	Skill Courses	02
Ability Enhancement Course (AEC) Technical Presentation	Humanities Social Science and Management(HSSM)	02
Entrepreneurship / Economics/ Management Courses (EEM)		02
Indian Knowledge System(IKS)		02
Research Methodology(RMC)	Experiential Learning Courses	02
Dissertation / Project / Internship (DIS/INT)		20
Co-curricular Courses(CCC)	Liberal Learning Courses	Audit
Total Credits		62

Department of Electrical Engineering
Teaching and Evaluation Scheme for NEP Compliant Curriculum
M. Tech. (Electrical Machines& Drives) Full Time
(From 2026-2027 onwards)

Semester I

Sr. No.	Category	Course Code	Courses	Scheme of Teaching (Hrs/Week)			Tot al Credits	Scheme of Evaluation(Marks)				
				L	T	P		Theory , Practical				Total
								ISE I	ISE II	ISE III	ESE	
1	PCC	EEPCC6101	Electrical Vehicle & Hybrid Electrical Vehicles	3	-	-	3	20	-	20	60	100
2	PCC	EEPCC5102	Electrical Machine Modeling and Analysis	3	-	-	3	20	-	20	60	100
3	PCC	EEPCC6102	Lab - Advanced Power Electronics	-	-	2	1	-	-	25	-	25
4	PCC	EEPCC6103	Advanced Power Electronics	3	-	-	3	20	-	20	60	100
5	PEC-I			3	-	-	3	20	-	20	60	100
6	PEC -II			3	-	-	3	20	-	20	60	100
7	VSE	EEVSE6101	Lab Simulation	-	-	4	2	-	-	50	-	50
8	RMC	MERMC5002	Research Methodology	2	-	-	2	10	10	0	30	50
9	CCC (Audit Course)	EECCC5101	Stress Management Through Yoga	-	-	2	-	-	-	-	-	-
			Total Semester I	17	-	8	20	110	10	175	330	625

List of Program Electives in Semester I(*Student can choose any NPTEL course from program domain)

*List of Program Electives I, II			
Course Codes	Program Electives	Course Codes	Program Electives
EEPEC6101	Industrial Automation & Control	EEPEC5101	Smart Grid Technology
EEPEC6102	Embedded Systems	EEPEC5102	Restructured Power Systems
EEPEC6103	Electromagnetic Interference	EEPEC5103	Electrical Power Distribution Systems

Semester II

Sr. No.	Category	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation(Marks)				
				L	T	P		Theory, practical				Total
								ISE I	ISE II	ISE III	ESE	
1	PCC	EEPCC6111	Advanced Control Systems	3	-	-	3	20	-	20	60	100
3	PCC	EEPCC6112	Control of Electrical Drives	4	-	-	4	20	-	20	60	100
4	PEC III			3	-	-	3	20	-	20	60	100
5	PEC IV			3	-	-	3	20	-	20	60	100
6	PCC	EEPCC6113	Lab Control of Electrical Drives	-	-	2	1	-	-	25	0	25
7	OEC			2	-	-	2	10	10	00	30	50
8	AEC	EEAEC5110	Lab Software skill	-	-	4	2	-	-	50	-	50
9	DIS	EEDIS6120	Dissertation - I	-	-	4	2		-	50	50	100
			Total Semester II	15	-	08	20	90	10	205	320	625

List of Program Electives in Semester II

*List of Program Electives III, IV			
Course Codes	Program Electives	Course Codes	Program Electives
EEPEC6110	Reliability and Condition Monitoring	EEPEC5112	Machine Learning & Applications
EEPEC6111	Digital Control systems	EEPEC5113	Optimization Techniques
EEPEC6112	Energy Storage Systems	EEPEC5114	Power Quality and Mitigation

Open Elective Equivalent online courses (NPTEL/SWAYAM/MOOC/COURSERA/OTHERS) will be offered and shall be approved by BoS Chairman**

Sr No.	Open Elective Course	Course Offering Department
1	AMOEC5214 - Basics of Finite Element Analysis	Applied Mechanics
2	CSOEC5102 - Professional Ethics & Cyber Law	Computer Science & Engineering
3	CEOEC5003 – Disaster Management	Civil Engineering
4	MEOEC6104-Additive Manufacturing	Mechanical Engineering
5	EEOEC5101 – Data Science for Engineering Applications	Electrical Engineering
6	ECOEC5007 – Artificial Intelligence of Things	Electronics & Telecommunication

Semester III

Sr. No.	Category	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation(Marks)				
				L	T	P		Theory, Practical				Total
								ISE I	ISE II	ISE III	ESE	
1	EEM	EEEEM5101	Energy Audit & Management	2	-	-	2	10	10	-	30	50
2	IKS	EEIKS5101	Vedic Approach to Mathematics	2	-	-	2	10	10	-	30	50
3	DIS	EEDIS6121	Dissertation – II	-	-	16	8	-	-	50	50	100
			Total Semester III	4	-	16	12	20	20	50	110	200

- Student can choose any NPTEL course instead of EEM/IKS course having same contents

HSSM: - Entrepreneurship / Economics / Management Course

Sr. No.	Open Elective – II Course	Course Offering Department
1	CEEEM6001 –Ancient Water Management Systems	Civil Engineering
	MEEEM6101 – Entrepreneurship Skills	Mechanical Engineering
2	EEEEM 5101 – Energy Audit & Management	Electrical Engineering
3	MEEEM6103 – Industrial Management	Mechanical Engineering
4	ECEEEM6004- AI Governance & Ethics	Electronics & Telecommunication

Semester IV

Sr. No .	Categor y	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Cred its	Scheme of Evaluation(Marks)				
				L	T	P		Theory, Practical			ES E	Total
								ISE I	ISE II	ISE III		
1	INT	EEINT 6101	Industrial Training/Internship	-	-	20	10	-	-	50	50	100
			Total of Semester IV	-	-	20	10	-	-	50	50	100

Semester I

EEPCC6101: Electric Vehicle & Hybrid Electrical Vehicles			
Teaching Scheme		Examination Scheme	
Lectures	: 03 Hrs/Week	ISE I	: 20 Marks
Tutorial	: 0	ISE III	: 20 Marks
Total Credits	: 03	End -Semester Exam	: 60 Marks

Course description: This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. Various aspects of hybrid and electric vehicles such as their configuration, types of electric machines that can be used, energy storage devices, etc. will be covered in this course.

Course Objectives: The course introduces

1. The concepts of electrical vehicles and their operation.
2. The basic components of the EV and their design.
3. Power converters & energy storage devices for electrical vehicles

Course Outcomes: After completing the course, students will able to:

CO1	Explain the operation of electrical vehicles.
CO2	Explain Power Converters for Electric and hybrid electrical vehicles
CO3	Identify the Electrical machines for Electric and hybrid vehicles
CO4	Design the components of the electrical vehicles.
CO5	Describe different Energy Storage options for the Electric and hybrid electrical vehicles

Detailed Syllabus:

Unit 1	History of electric & hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Dynamics of the electric and hybrid electrical vehicles- motion and dynamic equation for vehicles, Vehicle Power Plant and Transmission Characteristics, Basic Architecture of Hybrid Drive Trains and Analysis of Series Drive Train, Power Flow in HEVs, Torque Coupling and Analysis of Parallel Drive Train, Basic Architecture of Electric Drive Trains
Unit 2	Power Converters- DC-DC converters for EV and HEV applications, DC-AC converters in EV & HEV
Unit 3	AC Electrical Machines for hybrid and Electric Vehicles- Induction motors, Permanent Magnet Motors. SRM motors, their control and applications in EV/HEV
Unit 4	Design of Electrical EV/HEV-Principles, Drive cycles and its detail analysis, sizing of electrical machines. Different test bench setups for emulating EV on-road conditions.

Unit 5	Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.
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Text and Reference Books

1. James Larminie, John Lowry, "Electric Vehicle Technology Explained", WILEY USA, 2012.
2. Chris Mi, M. Abdul Masrur & David Wenzhong Gao, "Hybrid Electric Vehicles: Principles and Applications with practical perspective", WILEY, 2011
3. Electric Cars The Future is Now!: Your Guide to the Cars You Can Buy Now and What the Future Holds, by Arvids Linde, Veloce Publishing, 2010.
4. Abu-Rub, Malinowski and Al-Haddad, "Power Electronics for renewable energy systems, transportation, Industrial Applications", WILEY, 2014.
5. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", Second Edition (Power Electronics and Applications Series) by CRC Press, 2009
6. John Miller, "Propulsion Systems for Hybrid Vehicles," Institute of Electrical Engineers, UK, 2004

ISE III Assessment: Teachers Assessment of 20 marks is based on one or combination of following. However, the course coordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. MCQ
3. Simulations problems
4. Quiz

Sample Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I Test	ISE III Teachers Assessment	End Semester Examination
K2	Understand			
K3	Apply	05	10	20
K4	Analyze	10	10	20
K5	Evaluate	05		20
K6	Create	-	-	-
Total Marks: 100		20	20	60

Sample Assessment Table :

Assessment Tool	K2+ K3	K2+K3	K2+K3	K2+K3+ K4	K2+K3
	CO1	CO2	CO3	CO4	CO5
ISE I (20 Marks)	10	10	-	-	-
ISE III Assessment (20 Marks)	04	04	04	04	04
ESE Assessment (60 Marks)	12	12	12	12	12

Designed by Prof. S. P. Vasekar

EEPCC5102 : Electrical Machine Modeling and Analysis	
Teaching Scheme Lectures: 03 Hrs/Week Tutorials: 0 Hrs/Week Credits:03	Examination Scheme ISE I : 20 Marks ISE III : 20 Marks End Semester Exam : 60 Marks

Course Description:

Electrical Machines modeling and Analysis is a one-semester course where students can opt this course as a professional elective.

Course Objective: The objectives of the course are to master the various fundamentals, machine design, Machine modeling of various types of electrical machines. This will help you to gain knowledge and to do research in the area of electrical machine modeling.

The main objective of the course is to:

1. understand the concepts of generalized theory of electrical machines.
2. model the electrical machines with voltage, and torque equations.
3. analyze the steady state and transient behavior of the electrical machines.
4. understand the dynamic behavior of the DC/AC, special machines.
5. analyze behavior of different types of machines such as sudden application of loads, short circuit etc.

Course Outcomes: After completing the course, students will be able to:

CO1	explain the concepts of the rotating machine modeling.
CO2	represent and distinguish the different transformations of the systems using transformation techniques
CO3	analyze and model DC machine in state space
CO4	analyze and model three phase Induction Motor
CO5	analyze and model of synchronous machine, BLDC & PMSM machines

Detailed Syllabus:

Unit 1	Basic concepts of Modeling: Basic Principles of Electrical Machine Analysis, Need of modeling, Introduction to modeling of electrical machines
Unit 2	Concept of transformation: Commonly Used Reference Frames, change of variables & m/c variables and transform variables for arbitrary reference frames. Stationary Circuit Variables Transformed to the Arbitrary Reference Frame, Transformation Between Reference Frames, and Transformation of a Balanced Set, Balanced Steady State Phasor Relationships, And Balanced Steady State Voltage Equations
Unit 3	Modeling of Direct-Current Machine: Voltage and Torque Equations in Machine Variables, Mathematical model of separately excited D.C motor – Steady State analysis-Transient State analysis, Application to D.C. machine for steady state and transient analysis,

Unit 4	Modeling of Three phase Induction Machines: Theory of symmetrical Induction Machines: Voltage and torque in machine variables, model for a symmetrical induction machine, Voltage and torque equation in arbitrary reference frame variables, Analysis of steady- state operation, Modeling of 3 phase Induction Motor, Derivation of dq0, Voltage, torque equations, Equivalent circuit, Steady state analysis, Dynamic performance during sudden changes in load torque and three phase fault at the machine terminals.
Unit 5	Modeling of Three phase Synchronous Machine: Equations in arbitrary reference frame, Park's transformation, Derivation of dq0 model for a salient pole synchronous machine with damper windings, Torque expression of a salient pole synchronous machine with damper windings and identification of various components. Modeling Permanent Magnet Synchronous Machine: Introduction, Types of Permanent Magnet Synchronous Machines, PMAC & PMDC(BLDC) ,Voltage and torque equations in machine variables, voltage and torque equations in rotor reference frame variables

Text and Reference Books:

1. P.C. Krause, "Analysis of Electric Machinery, McGraw Hill", NY, 1987
2. C.V. Jones, "The unified Theory of Electrical Machines", Butterworth,-London, 1967
3. P.S. Bhimbra, "The Generalised Theory of Electrical Machines", Tata McGraw Hill
4. B. Adkins & R. G. Harley, "The General theory of AC Machines", Tata McGraw Hill
5. R. Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", PHI Learning Private Limited, New Delhi, 2011.

ISE III Assessment: Teachers Assessment of 20 marks is based on **attendance** of the student and one of the / or combination of few of following. However, the course coordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. Problems based on GATE questions
3. Simulations problems
4. Quiz

Sample Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I Test	ISE III Teachers Assessment	End Semester Examination
K3	Apply	05	10	20
K4	Analyze	10	10	20
K5	Evaluate	05		20
K6	Create	-	-	-
Total Marks: 100		20	20	60

Sample Assessment table

Assessment Tool	K2+ K3	K2+ K3	K2+ K3	K2+ K3	K2+K3
	CO1	CO2	CO3	CO4	CO5
ISE I Test (20 Marks)	10	10			
ISE III Assessment (20 Marks)				10	10
ESE Assessment (60 Marks)	12	12	12	12	12

Teaching Strategies:

The teaching strategy planned through the lectures, and team based home works. Exercises assigned weekly to stimulate the students to actively use and revise the learned concepts, which also help the students to express their way of solving the problems fluently in written form. Most critical concepts and mistakes emphasized

Designed by
Dr. Sandhya Kulkarni

EEPCC6102: Lab-Advanced Power Electronics	
Teaching Scheme	Examination Scheme
Practical: 02 Hrs/Week	ISE III, Term Work : 25 Marks
Tutorial 00	Total : 25 Marks
Total Credits: 01	

Course Outcomes (COs): At the end of the course, student will be able to:

CO1	Determine the characteristics of power devices and converters
CO2	Implement control circuits for power converters
CO3	Determine the performance of power converters
CO4	Determine the performance of Z-source and resonant converters

List of Experiments.

1. Analysis of DC-DC converters (a) Buck converter, (b) Boost converter, and (c) Buck-Boost converter
2. Closed loop control of Buck and Boost converter
3. Quasi-square wave control of a Single phase Full bridge VSI
4. Unipolar and bipolar PWM techniques for single-phase half-bridge and full-bridge inverters.
5. 120° and 180 operation of three-phase inverter and selective harmonic elimination for three- phase inverter
6. Sine-PWM techniques for three-phase two-level inverters.
7. Space vector modulation for a three-phase VSI
8. Pulse width modulation control of Single phase AC voltage controller
9. Single phase Five level cascaded H-Bridge inverter
10. Hysteresis current control of a single phase inverter
11. Control of Front-end active rectifiers/Bidirectional Converters
12. Control of Z-source inverter
13. Control of Resonant DC - DC converters
14. (a) Study of instantaneous power in various frames of reference.
(b) Study of torque produced in an induction machine in 'abc' and 'dq0' frames.
15. Implementation of buck and boost dc-dc converters.
 - a. Design of various elements such as inductor, capacitor for continuous and discontinuous current operation.
 - b. State-space modeling.
 - c. Study the dynamic behavior of the DC-DC converters through numerical integration methods.
16. Study on the design of PI controllers and stability analysis for a DC-DC buck Converter.
17. Sine-PWM techniques for single-phase half-bridge, full-bridge and three-phase inverters.
18. Space vector modulation (SVM) for three-phase two-level inverters using classical and Kim-Sul methods.
19. Closed-loop implementation single-phase high power factor rectifiers (Boost rectifier and PWM rectifier).
20. Multicarrier PWM techniques for three-phase diode clamped and cascaded H-bridge multilevel inverters.
21. Study of the dynamic performance of a V/f controlled induction motor drive using the dq0 model.

EEPCC6103 : Advanced Power Electronics	
Teaching Scheme	Examination Scheme
Lectures : 03 Hrs/Week	ISE I : 20 Marks
Tutorial : 0 Hrs/Week	ISE III : 20 Marks
Credits : 03	End Semester Exam : 60 Marks

Course Description:

Advanced Power Electronics is a one-semester course. It is an advanced course related to power electronics.

Course Outcomes:

After completing the course, students will able to:

CO1	Describe structure, characteristics, and applications of advanced power semiconductor devices
CO2	Explain and analyze AC-AC converters
CO3	Explain and analyze DC-AC converters and various control techniques
CO4	Explain and analyze AC-AC converters
CO5	Design of power converters components for various applications

Detailed Syllabus:

Unit-1	Power Semiconductor Devices: Structure, working principle, V-I characteristics, switching characteristics and protection circuits of Thyristors, TRIAC, GTOs, BJT, Power MOSFETS, SIT, IGBT, MCT, IGCT, PIC
Unit-2	AC-AC Converters: Single phase and three phase converter, dual converter, converter control, EMI and line power quality problems, phase-controlled cycloconverters, control of cycloconverters, matrix converters, high frequency cycloconverter
Unit-3	DC-DC converter: Power factor improvement techniques, Switch mode power converter, Buck, boost, buck boost, Cuk, Fly-back, Forward Converters, operation, modeling, and design of DC-DC converters, Different control strategies of DC-DC converters. Voltage mode and current mode control methods.
Unit-4	Inverters: PWM inverters, resonant pulse inverters, series and parallel resonant inverters, Voltage control of resonant inverters, Class E resonant inverter and rectifier, zero current and zero voltage switching resonant converters, resonant DC link inverters, multilevel inverters, diode clamped multilevel inverters, flying capacitor multilevel inverters, cascaded multilevel inverters, applications and features of multilevel inverters, DC link capacitors voltage balancing
Unit-5	Design of Power Converters Components: Design of magnetic components - design of transformer, design of inductor and current transformer - Selection of filter capacitors, Selection of ratings for devices, input filter design, Thermal design

Text / Reference Books:

1. M. H. Rashid, "Power Electronics", PHI publication
2. B.K. Bose, "Power Electronics and AC Drives", Prentice Hall, 1986
3. Andrzej M. Trzynadlowski, "Introduction to Modern Power Electronics", Wiley

ISE III Assessment:

Assessments will be based on any one or two of the following components -

1. Assignment
2. MCQ
3. PPT
4. Surprise Test

Sample Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I Test	ISE III Assessment	End Semester Examination
K3	Apply	05	10	20
K4	Analyze	10	10	20
K5	Evaluate	05		20
K6	Create	-	-	-
Total Marks: 100		20	20	60

Sample Assessment Table:

Assessment Tool	K2+ K3	K2+K3	K2+K3	K2+K3+ K4	K2+K3
	CO1	CO2	CO3	CO4	CO5
ISE I (20 Marks)	10	10	-	-	-
ISE III Assessment (20 Marks)	04	04	04	04	04
ESE Assessment (60 Marks)	12	12	12	12	12

Designed by
Prof. S. S. Mopari

EEVSE6101: Lab Simulation	
Teaching Scheme Practical: 04 Hrs/Week Credits: 02	Examination Scheme ISE III Term work : 50Marks ESE : 0 Marks Total : 50 Marks

Term Work Shall consist of a record of minimum fourteen experiments/assignments using engineering computation software such as MATLAB, PSCAD, ETAP with moderate to high complexity.

This lab may include the design, development/ simulation of experimental prototypes of following experiments. The students can form a group of two or three and develop at least six prototypes from the following list.

Any 6 from following-

1. Development of a 48 V uncontrolled AC-DC converter using an auto transformer.
2. Development of SCR based full wave converter.
3. Development of control circuit for SCR based full wave converter using either Arduino or microcontroller to generate triggering pulses.
4. Development of single phase/three phase bridge inverter using MOSFET.
5. Control circuit for single/three phase bridge inverter (MOSFET) with sinusoidal PWM. Use preferably Arduino/microcontroller to generate triggering pulses.
6. Development of single/three phase bridge inverter using IGBT.
7. Control circuit for Single/Three phase bridge inverter (IGBT) with single pulse/multi pulse/sinusoidal modulation Use preferably Arduino/microcontroller to generate triggering pulses.
8. Development of MOSFET based DC-DC buck-boost converter.
9. Control circuit for MOSFET based DC-DC buck converter. Use preferably Arduino/microcontroller to generate triggering pulses.
11. Control circuit for MOSFET based DC-DC boost converter. Use preferably Arduino/microcontroller to generate triggering pulses.
12. Design and development of PCB using suitable software.

Any 4 from following-

1. Familiarization with various features of the Scilab / MATLAB/Simulink environment.
2. Demonstrating the phenomenon of aliasing due to under-sampling.
3. Implementation of algorithms based on undistorted sine wave approximation with Sample and its derivative
4. Implementation of algorithms based on undistorted sine wave approximation with First and second derivative technique
5. Implementation of Fourier algorithms using DFT

Any 4 from following-

1. Simulation of DC-DC converters: (i) Buck Converter Boost Converter, and BuckBoost converter.
2. Simulation of single phase and three-phase controlled rectifiers with different loads.
3. Simulation of single phase inverter: (i) Square wave, (ii) Quasi Square wave, (iii) Selective Harmonic Elimination, and (iv) Sine PWM.
4. Simulation of three-phase inverter: (i) 120 Degree conduction, (ii) 180 Degree conduction
5. Simulation of Multi-pulse converter: (i) 12-pulse
6. Simulation of Multi-level inverter: (i) 3-Level

Term work: The term work shall consist of submitting a report based on the selected experimental prototype. The course teacher will assess the term work.

Program Electives in Semester I

EEPEC5101 : Smart Grid Technology	
Teaching Scheme Lectures: 3 Hrs/Week Tutorial: 0 Hrs/Week Credits : 03	Examination Scheme ISE I : 20 Marks ISE III : 20 Marks End-Semester Examination : 60 Marks

Course Description: This course introduces the concepts of smart grid technology & covers the various aspects of smart grid.

Course Objectives:

The objectives of the course are to:

1. Understand concept of smart grid and its advantages over conventional grid
2. Know smart metering techniques
3. Learn wide area measurement techniques
4. Understand concept of power quality issues in Smart grid
5. Appreciate problems associated with integration of distributed generation & its solution through smart grid

Course Outcomes:

After completing the course, students will able to:

CO1	Differentiate between smart grid & conventional grid
CO2	Explain smart grid technologies
CO3	Explain the concept of micro grid & issues of micro grid interconnection
CO4	Identify the power quality issues in Smart grid
CO5	Explain different Communication Technology for Smart Grid

Detailed Syllabus:

Unit 1	Introduction to Smart Grid: Working definitions of Smart Grid and Associated Concepts, Smart Grid Functions, Traditional Power Grid and Smart Grid, New Technologies for Smart Grid, Advantages Indian Smart Grid, key Challenges for Smart Grid, International policies in Smart Grid. Smart Grid Architecture: Components and Architecture of Smart Grid Design. Review of the proposed architectures for Smart Grid
Unit 2	Tools and Techniques for Smart Grid: The fundamental components of Smart Grid designs, Transmission and substation Automation, Distribution Automation, Renewable Integration Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading (AMR), Smart integration of energy resources, Renewable, intermittent power sources, Energy Storage
Unit 3	Distribution Generation Technologies: Introduction to Renewable Energy Technologies, Micro grids- Concept and need, issues of interconnection, Storage Technologies, Electric Vehicles and plug-in hybrids. Environmental impact and Climate Change Economic Issues

Unit 4	Communication Technologies and Smart Grid: Introduction to Communication Technology, Synchro-Phasor Measurement Units (PMUs) Wide Area Measurement Systems (WAMS)- Introduction to Internet of things (IOT)- Applications of IOT in Smart Grid Home Area Network (HAN), Neighborhood Area Network (NAN), Advanced Metering Infrastructure (AMI), CLOUD Computing, Cyber Security for Smart Grid
Unit 5	Control of Smart Power Grid System: Load Frequency Control (LFC) in Micro Grid System Voltage Control in Micro Grid System protection of micro grid, Reactive Power Control in Smart Grid. Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid.

Text and Reference Books

1. Ali Keyhani, Mohammad N. Marwali, Min Dai “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press
3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley
4. Jean Claude Sabonnadiere, Nouredine Hadjsaid, “Smart Grids”, Wiley Blackwell
5. Tony Flick and Justin Morehouse, “Securing the Smart Grid”, Elsevier Inc. (ISBN: 978-1-59749-570-7)

ISE III Assessment: Teachers Assessment of 20 marks is based on one or combination of following.

1. Presentation on latest topics/Real life problems related with the subject
2. Simulations problems
3. Quiz
4. MCQ

Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE III Assignment	End Semester Examination
K2	Understand	10	10	20
K3	Apply	10	10	20
K4	Analyze			20
K5	Evaluate			
K6	Create			
Total Marks 100		20	20	60

Assessment Table:

Assessment Tool	K2	K2+K3	K2+K3	K2+K3	K2+K3
	C01	C02	C03	C04	C05
ISE I Test (20 Marks)	10	10			
ISE III Assessment (20 Marks)			5	10	5
ESE Assessment (60 Marks)	12	12	12	12	12

Designed by Dr. S.P Gghanegaonkar

EEPEC5102 : Restructured Power Systems	
Teaching Scheme Lectures: 3 Hrs/Week Tutorial: 0 Hr/Week Credits: 3	Examination Scheme ISE I : 20 Marks ISE III : 20 Marks End-Semester Examination : 60 Marks

Course Description: This is an elective course & covers the different aspects of power systems in restructured environment.

Course Objectives:

The objectives of the course are to learn:

1. Basic aspects of power system restructuring.
2. Different models of deregulated power systems.
3. Different methods to determine transmission pricing.
4. Available transfer capability.
5. Regulatory issues involved in the deregulation of the power industry.

Course Outcomes : After completing the course, students will able to:

CO1	Explain basic aspects of power system restructuring.
CO2	Explain different models of deregulated power systems.
CO3	Explain different methods to determine transmission pricing.
CO4	Determine available transfer capability.
CO5	Explain Ancillary Services management in various markets & regulatory issues.

Detailed Syllabus:

Unit 1	Introduction: Basic concept and definitions, privatization, restructuring, transmission open access, wheeling, deregulation, components of deregulated system, advantages of competitive system.
Unit 2	Deregulation of Power Sector: Separation of ownership and operation, Deregulated models, pool model, pool and bilateral trade model, multilateral trade model. Competitive electricity market: Independent System Operator activities in pool market, Wholesale electricity market characteristics, central auction, single auction power pool, double auction power pool, market clearing and pricing, Market Power and its Mitigation Techniques, Bilateral trading, Ancillary services.
Unit 3	Transmission Pricing: Marginal pricing of Electricity, nodal pricing, zonal pricing, embedded cost, Postage stamp method, Contract Path method, Boundary flow method, MW-mile method, MVA-mile method, Comparison of different methods.
Unit 4	Congestion Management: Congestion management in normal operation, explanation with suitable example, total transfer capability (TTC), Available transfer capability (ATC), Different Experiences in deregulation: England and Wales, Norway, China, California, New Zealand and Indian power system.

Unit 5	Ancillary Services and System Security in Deregulation: Classifications and definitions, AS management in various markets- country practices. Technical, economic, & regulatory issues involved in the deregulation of the power industry.
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Text and Reference Books

1. Loi Lei Lai, "Power System Restructuring and Deregulation", John Wiley & Sons Ltd.
2. Mohammad shahidehpour, M.alomoush, "Restructured power systems, operation, trading and volatility, ", CRC Press

ISE III Assessment: Teachers Assessment of 20 marks is based on one or combination of following.

1. Presentation on latest topics/Real life problems related with the subject
2. Simulations problems
3. Quiz
4. MCQ

Sample Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I Test	ISE III Teachers Assessment	End Semester Examination
K3	Apply	05	10	20
K4	Analyze	10	10	20
K5	Evaluate	05		20
K6	Create	-	-	-
Total Marks: 100		20	20	60

Sample Assessment table:

Assessment Tool	K2+K3	K2+K3	K2+K3	K2+K3	K2+K3
	C01	C02	C03	CO4	CO5
ISE I Test (20 Marks)	10	10			
ISE III Assessment (20 Marks)			5	5	10
ESE Assessment (60 Marks)	12	12	12	12	12

Designed by Dr. V. A. Kulkarni

EEPEC5103: Electrical Power Distribution Systems	
Teaching Scheme Lectures: 3 Hrs/Week Tutorial: 0 Hr/Week Credits : 03	Examination Scheme ISE I : 20 Marks ISE III : 20 Marks End Semester Exam : 60 Marks

Course Description: This introduces the basic concepts of electrical power distribution

Course Objectives: The objectives of the course are to give exposure to-

1. Distinguish between transmission, and distribution line and design the feeders
1. Design of distribution feeders and select appropriate substation location
3. Compute power loss and voltage drop of the feeders
4. Design protection of distribution systems
5. Apply voltage control techniques for power factor improvement

Course Outcomes:

After completing the course, students will able to:

CO1	Understand the general concepts of distribution systems and difference between transmission systems and distribution systems
CO2	Design the distribution feeders and secondary distribution system and Identify and select appropriate sub-station location
CO3	Analyze a distribution system for voltage drop and power loss calculation
CO4	Explain faults on distribution systems and protective devices and its coordination for protection of distribution systems.
CO5	Analyze Voltage control and Power factor improvement procedures for distribution systems.

Detailed Syllabus:

UNIT I	Introduction and General concepts Introduction to Distribution Systems: Load modeling and Characteristics- Coincidence factor, Contribution factor, loss factor, Relationship between the load factor and loss factor – Classification and characteristics of loads -Residential, commercial, Agricultural and Industrial. Distribution System Planning
UNIT II	Distribution Feeders and Substations Distribution Feeders: Design Considerations of distribution feeders: Radial, loop and network types of primary feeders – Voltage levels, – Feeder loading, general circuit constants (A, B, C, D) to radial feeders, Distribution Sub-Stations: Distribution substations –Bus schemes –comparison of switching schemes- Substation location and rating- Types of feeders – voltage levels

UNIT III	Distribution System Analysis: Voltage drop and power-loss calculations: Derivation for voltage drop and power loss in lines-Uniformly distributed loads and non-uniformly distributed loads -Numerical problems-Three phase balanced primary lines. Power Flow Analysis of balanced distribution system Distributed Generation in Distribution System: Need for Distributed generation, renewable sources in distributed generation, Power flow analysis with DGs, Concept of microgrid
UNIT IV	Protective Devices & Coordination: Objectives of Distribution system protection, Types of common faults and procedure for fault calculation Protective devices: Principle of operation of fuses, circuit reclosers and line sectionalizers and circuit breakers. Coordination of Protective devices: General coordination procedure
UNIT V	Voltage control in Distribution systems Voltage Control in Distribution Systems: Effects of series and shunt capacitors – justification for capacitors – Procedure to determine optimum capacitor size and location. Voltage control – Application of shunt capacitance for loss reduction – Harmonics in the system – static VAR systems – loss reduction and voltage improvement.

Text Books and Reference Books

1. Electrical Power Distribution Systems by V.Kamaraju, Right Publishers.
 2. Electric Power Distribution – by A.S. Pabla, Tata McGraw–hill Publishing company, 4th edition, 1997.
 3. Distribution System Modeling and Analysis by William H Kersting- CRC Press,Taylor and Francis Group 4th Edition, 2017
- Turan Gonen, Electric Power Distribution System Engineering, CRC Press, 3rd Edition 2014.

ISE III Assessment: It is of 20 marks based on one of the / or combination of following,

1. Assignment , 2. MCQ

Sample Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I Test	ISE III Assessment	End Semester Examination
K3	Apply	05	10	20
K4	Analyze	10	10	20
K5	Evaluate	05		20
K6	Create	-	-	-
Total Marks: 100		20	20	60

Sample Assessment table:

Assessment Tool	K2+K3	K2+K3	K2+K3	K2+K3	K2+K3
	C01	C02	C03	C04	C05
ISE I Test (20 Marks)	10	10			
ISE III Assessment (20 Marks)			5	5	10
ESE Assessment (60 Marks)	12	12	12	12	12

**Designed by
Dr. Sunanda Ghanegaonkar**

EEPEC 6101 Industrial Automation & Control			
Teaching Scheme		Examination Scheme	
Lectures	: 3 Hrs/Week	ISE I	: 20 Marks
Tutorial	: 0 Hr/Week	ISE III	: 20 Marks
Total Credits	: 3	End -Semester Exam	: 60 Marks

Course Description: - The course introduces the basic concept of process control, building blocks of automation and various control configurations.

Course Objectives: -The objectives of the course are to

1. Describe various measurement systems using sensors
2. Explain various process control configuration
3. Illustrate various controllers used in industry
4. Explain PLC, SCADA, PDC systems
5. Describe and Illustrate valves used in Industry

Unit wise Course Outcomes expected: At the end of the course students will be able to

CO1	explain various sensors for measurement of physical parameters
CO2	illustrate various control configurations used in process control
CO3	analyze controller performance like P, PI, PID in systems
CO4	understand PLC operation and implement for systems
CO5	compare various SCADA, DCS configurations for application

Detail syllabus:

Unit-I	Introduction to Industrial Automation and Control Architecture of Industrial Automation Systems, Introduction to sensors and measurement systems, Temperature measurement, Pressure and Force measurements, Displacement and speed measurement, Flow measurement techniques, Measurement of level, humidity, pH etc.,
Unit-II	Signal Conditioning: Instrumentation amplifiers, basic characteristics. Chopped and Modulated DC Amplifiers, Isolation amplifiers, Opto-couplers-Buffer amplifiers. Noise Reduction Techniques in Signal Conditioning-Fundamentals of 4-20 mA current loops. Regulators and power supplies for industrial instrumentation. Estimation of errors and Calibration, Bus standard for communication between instruments-GPIB (IEEE-488 bus), RS 232 and RS 485 interface, Optical Fiber Based Signal Transmission-Piezoelectric Couplers, Intelligent transmitters. Interrupt-based Data Acquisition. Software Design Strategies-Hardware Vs Software Interrupts-Foreground/ background Programming Techniques.
Unit-III	Type of Controllers: Open-loop Vs Closed Loop control, Servo Vs Regulator Operation of Closed Loop System, Feedback and Feed forward Control Configuration, Cascade, Feed forward, and Ratio Control, multi loop Cascade Control, Feed forward Control, Feed forward- Feedback control configuration, Ratio Controller, PID control, Controller Tuning

Unit-IV	Sequence Control: Introduction, Basic parts of a PLC, Operation of a PLC, Basic symbols used in PLC, realization, Difference between PLC and Hardwired systems, Difference between PLC and computer, Relay logic to ladder logic, Ladder commands, Examples of PLC ladder diagram realization, PLC timers, PLC counters and examples, Classification of PLCs.
Unit-V	DCS and SCADA system: History of DCS, DCS concepts, DCS hardware & software, DCS structure, Advantages and disadvantages of DCS, Representative DCS, SCADA, SCADA hardware & software, DDC, Components and Working of DDC, Benefits of DDC, Digital controller realization, discrete domain analysis, Networking of sensors, Actuators, controllers, CANBUS, PROFIBUS AND MODBUS.

Text books:

1. Dobrivojic Popovic, Vijay P. Bhatkar, “Distributed Computer Control for Industrial Automation”, Dekker Publications.
2. Webb and Reis,” Programmable Logic Controllers: Principles and Applications”, PHI.
3. S.K. Singh, “Computer Aided Process Control”, PHI
4. Garry Dunning, “Introduction to Programmable Logic Controllers”, Thomson Learning.
5. N. E. Battikha, “The Management of Control System: Justification and Technical Auditing”, ISA
6. Krishna Kant, “Computer Based Process Control”, PHI
7. Fu, Lee, Gonzalez, “Robotic Control, sensing and Intelligence”, Tata McGraw-Hill

2. ISE III Assessment: The teacher’s assessment should be done based on any one or combination of any two of the following schemes.

1. Assignments
2. Objective type test
3. Modeling of electrical machines using any electrical software
4. Technical/Industrial visit report / Quiz

3. Assessment table:

Assessment Pattern Level No.	Knowledge Level	ISE 1	ISE III Assignment	End Semester Examination
K3	Apply	10		20
K4	Analyze	10	10	20
K5	Evaluate		10	20
Total Marks 100		20	20	60

3. Sample Assessment table:

Assessment Tool	K2+K3	K2+K3	k2+k3	K2+K3	K2+K3
	C01	C02	C03	CO4	CO5
ISE I test (20 Marks)	10	10			
ISEI III (20 Marks)			10	10	
ESE Assessment (60 Marks)	12	12	12	12	12

Designed by Dr. S. S. Kulkarni

EEPEC6102 Embedded Systems			
Teaching Scheme		Examination Scheme	
Lectures	: 3 Hrs/Week	ISE I	: 20 Marks
Tutorial	: 0 Hr/Week	ISE III	: 20 Marks
Total Credits	: 03	End -Semester Exam	: 60 Marks

Course Description:

The course focuses on the concepts of Embedded platform, understand related programming, PIC architecture and peripheral interfacing, develop the applications.

Course Objectives: The objectives of the course are to

1. Introduce to the architecture of embedded system
2. Explain various devices and communication system in network
3. Explain programming concept in C++
4. Explain real time operating concept
5. Explain the case studies in RTOS

Unit wise Course Outcomes expected:

After completion of course students will be able to

CO1	Explain the embedded system concepts and architecture of embedded systems
CO2	Apply various signal conditioning devices for various applications using microcontroller
CO3	Test and debug peripherals and related applications in embedded platforms.
CO4	Write assembly language program for PIC microcontroller to interface peripherals
CO5	Debug and write the I/O and timers/counter programming

Detailed Syllabus:

Unit-I	Introduction: Embedded system introduction: Introduction to embedded system, embedded system architecture, classifications of embedded systems, challenges and design issues in embedded systems, fundamentals of embedded processor and microcontrollers, CISC vs. RISC, fundamentals of Vonneuman/Harvard architectures, types of microcontrollers, selection of microcontrollers.
Unit-II	Signal Conditioning: Signal Conditioning & Various Signal Chain Elements, Critical Specifications, How to smartly choose elements from wide choice available in market. Various elements include OPAMPs, Comparators, Instrumentation OP AMPs, ADCs, DACs, DC-DC Converters, Isolators, Level Shifters, ESD Protection Devices.
Unit-III	Memory Systems: On Chip, Memory Subsystem, Bus Structure, Interfacing Protocol, Peripheral interfacing, Testing & Debugging, Power Management, Software for Embedded Systems, Design of Analog Signal Chain from Sensor to Processor with noise, power, signal bandwidth, Accuracy Considerations. Concurrent Programming. Real Time Scheduling, I/O Management, Embedded Operating Systems. RTOS, Developing Embedded Systems, Building Dependable Embedded Systems.

Unit-IV	PIC Architecture: Introduction to PIC microcontrollers, PIC architecture, comparison of PIC with other CISC and RISC based systems and microprocessors, memory mapping, assembly language programming, addressing modes, instruction set.
Unit-V	I/O Programming PIC I/O ports, I/O bit manipulation programming, timers/counters, programming to generate delay and waveform generation, I/O programming, LEDs, 7 segment LEDs, LCD and Keypad interfacing.

Text/References:

1. Rajkamal, “*Embedded Systems Architecture, Programming and Design*”, TMH, 2003
2. WyneWoff “*Principles of Embedded computing System Design*”, Morgan Koffman publication 2000
3. Steve Heath, “*Embedded Systems Design*”, Second Edition-2003, Butterworth-Heinemann.
4. David E.Simon, “*An Embedded Software Primer*”, Pearson Education Asia, First Indian Reprint 2000
5. Wayne Wolf, “*Computers as Components; Principles of Embedded Computing System Design*”, Harcourt India, Morgan Kaufman Publishers
6. Chuck Helebuyck “*Programming PIC microcontrollers with PIC basic*”
7. Qing Li, “*Real Time Concepts for Embedded Systems*”, Elsevier, 2011.
8. Shibu K.V, “*Introduction to Embedded Systems*”, Mc Graw Hill.
9. Frank Vahid, Tony Givargis, “*Embedded System Design*”, John W
10. Milan Verle “*PIC Microcontrollers-programming in Basic*”

ISE III Assessments:

Teacher’s Assessment based on one of the /or combinations of the few of the following.

1. Multiple choice question
2. PPT presentation
3. Assignments

Sample Assessment table:

Assessment Tool	K2+K3	K2+K3	k2+k3	K2+K3	K2+K3
	C01	C02	C03	CO4	CO5
ISE I test (20 Marks)	10	10			
ISEI III (20 Marks)			10	10	
ESE Assessment (60 Marks)	12	12	12	12	12

Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE 1	ISE III Assignment	End Semester Examination
K3	Apply	10		20
K4	Analyze	10	10	20
K5	Evaluate		10	20
Total Marks 100		20	20	60

Designed by:
Dr. S. S. Kulkarni

EEPEC6103: Electromagnetic Interference	
Teaching Scheme Lectures: 3 Hrs/Week Tutorial: 0 Hr/Week Credits : 03	Examination Scheme ISE I Test : 20 Marks ISE III Assessment : 20 Marks End Semester Exam : 60 Marks

The students will be able to

CO1	Recognize the sources of Conducted and radiated EMI in Power Electronic Converters and consumer appliances and suggest remedial measures to mitigate the problems
CO2	Assess the insertion loss and design EMI filters to reduce the loss
CO3	Design EMI filters, common-mode chokes and RC-snubber circuits measures to keep the interference within tolerable limits
CO4	Develop suitable techniques to mitigate EMI/EMC issues in power converters

Detailed Syllabus

Unit I	Introduction: Sources of conducted and radiated EMI, EMC standardization and description, measuring instruments, conducted EMI references, EMI in power electronic equipment: EMI from power semiconductor circuits.
Unit II	Noise suppression in relay systems: AC switching relays, shielded transformers, capacitor filters, EMI generation and reduction at source, influence of layout and control of parasites
Unit III	EMI filter elements: Capacitors, choke coils, resistors, EMI filter circuits. Ferrite beads, feed through filters, bifilar wound choke filter, EMI filters at source, EMI filter at output EMI filter design for insertion loss: Worst case insertion loss, design method for mismatched impedance condition and EMI filters with common mode choke-coils, IEC standards on EMI
Unit IV	EMI in Switch Mode Power Supplies: EMI propagation modes, power line conducted-mode interference, safety regulations (ground return currents), Power line filters, suppressing EMI at sources, Line impedance stabilization network (LISN), line filter design, common-mode line filter inductors- design & example, series –mode inductors and problems, EMI measurements.
Unit V	Faraday Screens for EMI prevention: As applied to switching devices, transformers faraday screen and safety screens, faraday screens on output components, reducing radiated EMI on gapped transformer cores, metal screens, electrostatic screens in transformers

Text Books & Reference Books:

1. Electromagnetic Compatibility in Power Electronics, Laszlo Tihanyi, IEEE Press, 1995, 1st Edition.
2. Practical Design for Electromagnetic Compatibility, Ficchi, Rocco F., Hayden Book Co., 1981.
3. Handbook on Switch-Mode power supplies, Keith H Billings, Taylor Morey, McGraw-Hill, Publisher, 2011, 3rd Edition.
4. Switching Power Supply Design, Abraham I. Pressman, Keith Billings, Taylor Morey, McGraw Hill International, 2009, 3rd Edition.

Online Resources:

5. <https://nptel.ac.in/courses/108/106/108106138/>

ISE III: Assessment: It is based on one of the /or combinations of the few of the following.

1. Multiple choice question, 2. PPT presentation, 3. Assignments

Sample Assessment table:

Assessment Tool	K2+K3	K2+K3	k2+k3	K2+K3	K2+K3
	C01	C02	C03	CO4	CO5
ISE I test (20 Marks)	10	10			
ISEI III (20 Marks)			10	10	
ESE Assessment (60 Marks)	12	12	12	12	12

Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE 1	ISE III Assignment	End Semester Examination
K3	Apply	10		20
K4	Analyze	10	10	20
K5	Evaluate		10	20
Total Marks 100		20	20	60

**Designed by:
Dr. S. S. Kulkarni**

Mechanical Department MERMC5001: Research Methodology	
Teaching Scheme Lectures: 2 Hrs/Week Tutorial: 0 Hr/Week Credits : 02	Examination Scheme ISE I Test : 10 Marks ISE II : 10 marks ESE : 30 Marks Total : 50 Marks

After completing the course students will able to

CO1	Create well-structured research proposals that include clear research objectives, methods, and expected outcomes.
CO2	Proficient in using data analysis techniques relevant to their chosen research methods, such as statistical analysis for quantitative research or thematic analysis for qualitative research.
CO3	Create comprehensive research reports in diverse formats, such as academic papers, presentations, and technical reports.

Detailed Syllabus:

Unit 1	Foundations and Methods of Research Meaning, objectives, significance of research; research approaches; research methods vs. methodology; scientific method; research process; criteria of good research; identifying and defining the research problem; selecting a research problem; research design; research plan; literature review; qualitative and quantitative research methods; historical, case study, ethnography, ex post facto, documentary and content analysis; survey methods (descriptive, normative, evaluative); field and laboratory experimental studies; characteristics, advantages, limitations, and implications of various research methods.
Unit 2	Data Collection and Data Analysis Concept of sampling; probability and non-probability sampling; sampling techniques and implications; tools of data collection—questionnaire, opinionnaire, observation, interviews, scales, and tests; designing and standardizing research tools; qualitative data analysis; quantitative data analysis; tabulation, graphs and charts; measures of central tendency and dispersion; hypothesis testing; parametric and non-parametric tests; validity, reliability, and delimitations of research findings.
Unit 3	Research Proposal, Interpretation and Report Writing Research proposal and its elements; formulation and definition of research problems; sources and criteria for selecting research problems; development of objectives; characteristics of objectives; formulation and application of hypotheses; interpretation of research findings; techniques of interpretation; research report writing; layout and types of research reports; technical paper writing; oral presentation of research findings; mechanics of report writing; plagiarism and research ethics.

Text and Reference Books

1. Garg B.L., Karadia R., Agarwal F. and Agarwal U.K., An introduction to Research Methodology, RBSA Publishers, 2002
2. Kothari C.R., Research Methodology: Methods and Techniques. New Age International, 1990.
3. Merriam S.B., Tisdell E.J., Qualitative Research: A Guide to Design and Implementation, 4th edition, John Wiley & Sons, 2016.
4. Creswell J.W., Research Design: Qualitative, Quantitative and Mixed Methods Approaches, 4th edition, SAGE Publications, Inc, 2014.
5. Olsen C., Devore J., Peck R., Introduction to Statistics and Data Analysis, 5th edition, Brooks/Cole, 2015.
6. Panneerselvam R., Research Methodology, 2nd edition, PHI Learning, 2014

Assessment: ISEI (Class Test), ISEII (TA) & ESE

TA: Students will perform one or more of the following activities

1. Surprise Test
2. Assignment
3. Quiz
4. Any other activity suggested by course coordinator

Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	05	02	06
K2	Understand	10	08	24
K3	Apply	00	03	09
K4	Analyze	05	04	12
K5	Evaluate	00	03	09
K6	Create	00	00	00
Total		10	10	30

INCCC5101: Stress Management Through Yoga		
Teaching Scheme	Examination Scheme	
Practicals: 02 Hrs. / Week	Audit Course	
Credits: 0		

Course Objectives:

This course aims at enabling students:

1. To get awareness of Physical, Mental, Social and Spiritual health
2. To learn to manage the Stress through art of Yoga.
3. Understand and perform skill of Yoga Asanas
4. Gain knowledge and benefits of Pranayam and Dhyan
5. Importance of diet, food and nutrition.

	Course Outcomes
	The students will able to -
CO1	Aware regarding healthy and peaceful living
CO2	Understand the cause of stress and its relief
CO3	Perform skill of Yoga Asanas and Meditation
CO4	Bring peace and harmony in the society at large
CO5	Aware of yogic diet, food and nutrition.

Detailed Syllabus:

Unit1	Introduction, meaning and definition of health, various dimensions of health, like, Physical, Mental, Social and Spiritual health
Unit2	Concept of stress according to yoga, causes and consequences of stress, stress management through Yoga.
Unit3	Introduction and definition of yoga, Fundamental concept of yoga, relationship of yoga and health.
Unit4	Yogic sukshnavyayam, Maharshi Patanjali Ashtang Yog sutra, different types and benefits of asanas (min. five in each pose), Suryanamaskar, different types and benefits of Pranayam(min. Five), Meaning and importance of dhyan .
Unit5	Importance of yogic diet, food and nutrition.
List of Practice Sessions	1. Practice of Yogic Sukshma Vyayam 2. Practice of different Asanas 3. Practice of different Pranayam 4. Practice of Dhyan

Text and Reference books:

1. K, N, Udupa, Stress and its Management by Yoga, Motilal Banaridas Publishers
2. Acharya Yetendra, Yoga and Stress Management, Finger print Publications
3. B. K. S. Iyengar, Light on Yoga, Harper Collins Publisher, New Delhi, 2005
4. Swami Vivekanand, Patanjali Yog Sutra, Geeta Press, Gorakhpur
5. Swami Ramdev, Pranayam Rahasya, Divya Prakashan, 2009.

Semester II

EEPCC6111: Advanced Control Systems

Teaching Scheme	Examination Scheme
Lectures: 03 Hrs/Week	ISE I : 20 Marks
Tutorial: 0Hrs/Week	ISE III : 20 Marks
Credits: 03	End Semester Exam : 60 Marks

Course Description:

The course introduces the various state feedback, nonlinear and digital control systems which will be helpful for understanding its applications in drives and power systems.

Course Objectives:

The objectives of the course are to-

1. Explain the system representation in state space and design of state feedback
2. Explain the basics for design of robust control system
3. Explain the stability analysis of nonlinear control systems
4. Explain the representation of optimal control systems
5. Explain the applications industrial controllers
6. Explain the multi-loop control systems

Course Outcomes: After completing the course, students will able to:

CO1	Explain systems in state space model
CO2	Design control system state feedback
CO3	Analyze the stability of nonlinear control systems
CO4	Formulate and represent the systems in standard form of optimal control
CO5	Apply industrial control for system and realize multi-loop control system

Detailed Syllabus

Unit-1	Compensator design in frequency domain: Compensator design in frequency domain to improve steady state and transient response. Feedback and Feed forward compensator design using bode diagram. Lead, Lag and Lead Lag compensator design.
Unit-2	State feedback control system: Concepts of state, state variable, state model, state models for linear continuous time functions & physical systems. Diagonalization of transfer function, solution of state equations, concept of controllability & observability effect of pole zero cancellation, pole placement design through state feedback. Ackerman's Formula for feedback gain design. Design of Observer, Reduced order observer
Unit-3	Control Design: Design of PI/PID controller Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback- Feed forward control. Introduction to process control, various control configurations such as: feed-forward, cascaded etc. PID controller and implementation Digital Control System: Discrete time systems, discretization, sampling, aliasing, choice of sampling frequency, ZOH equivalent, Jury stability, bilinear transformation

Unit-4	Nonlinear Control system: Introduction to nonlinear systems, phase plane and describing function methods for analysis of linear systems and linearization using Describing function analysis, phase plane analysis, bang-bang control system, Lyapunov's stability analysis
Unit-5	Optimal Control System: Introduction to optimal control system, problems, Quadratic performance index, Formulation of optimal control problem, linear quadratic regulator (LQR), Introduction to Adaptive control

Text and reference books:

1. S. Sastry and M. Bodson, "Adaptive Control: Stability, Convergence, and Robustness", Prentice-Hall, 1989.
2. Gopal. M., "Control Systems: Principles and Design", Tata McGraw-Hill, 1997.
3. Kuo, B.C., "Automatic Control System", Prentice Hall, sixth edition, 1993.
4. Ogata, K., "Modern Control Engineering", Prentice Hall, second edition, 1991.
5. Nagrath Gopal, "Modern Control Engineering", New Age International

ISE III Assessments:

Assessments will be based on following:

- | | |
|---------------|----------|
| 1. Assignment | 10Marks |
| 2. MCQ | 10 Marks |

Sample Assessment Pattern:

Assessment Tool	K2+K3	K2+K3	K2+K3	K2+K3	K2+K3+K4
	C01	C02	C03	CO4	CO5
ISE I Test (20 Marks)	10	10	-	-	-
ISE III Assessment (20 Marks)	0	0	0	10	10
ESE Assessment (60 Marks)	12	12	12	12	12

4. Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE 1	ISE III Assignment	End Semester Examination
K3	Apply	10		20
K4	Analyze	10	10	20
K5	Evaluate		10	20
Total Marks 100		20	20	60

Designed by Dr. S. S. Kulkarni

EEPCC 6112 Control of Electrical Drives			
Teaching Scheme		Examination Scheme	
Lectures	: 4 Hrs/Week	ISE I	: 20 Marks
Tutorial	: 0 Hr/Week	ISE III	: 20 Marks
Total Credits	: 4	End -Semester Exam	: 60 Marks

Course Description: The objective of this course is to give exposure to the students of fundamentals, operations, control and analysis of DC motor and AC motor electrical drives. It also covers the industrial application of it.

Course Objective:

The objective of this course is to give exposure to the students of

1. Fundamentals of an electrical drives
2. Basics, Control and analysis of DC motor drives
3. Basics, Control and analysis of Induction motor drives
4. Vector control of Induction motor drives
5. Basics, Control and analysis of PM Synchronous and Brushless DC motor drives

Course Outcomes

After completing the course, students will able to:

CO1	Describe fundamentals of an electrical drives
CO2	Explain the operations and analysis of Phase controlled and Chopper controlled DC Motor drives
CO3	Explain the operations and analysis of Phase controlled and Frequency Controlled Induction Motor Drives
CO4	Discuss the principle and analysis of Vector controlled Induction Motor Drives
CO5	Discuss the principle of operation, analysis of P.M. Synchronous and Brushless DC Motor Drives

Detailed Syllabus:

Unit 1	Phase Controlled and Chopper Controlled DC Motor Drives: Phase Controlled- Introduction, Principle of DC motor speed control, Phase controlled converters, Steady state analysis of three phase converter controlled DC Motor drives, Applications. Chopper Controlled- Introduction, Principle of the chopper, Four quadrant Chopper circuit, Chopper for inversion, Steady state analysis of chopper controlled DC motor drives, Applications.
Unit 2	Voltage Fed and Current Fed Converters: Voltage Fed Converters- Introduction, Single phase inverters, Three phase bridge inverters, multi stepped inverters, PWM techniques, Three level inverters, hard switching effects, resonant inverters, soft- switched inverters, dynamic and regenerative drive braking, PWM rectifiers, Static VAR compensators. Current Fed Converters- Introduction, General operation of six stepped thyristor inverter, Load commutated inverters, Force commutated inverters, harmonic heating and torque pulsation, multi stepped inverters, inverter with self commutated devices.

Unit 3	Induction Motor Slip-Power Recovery Drives: Introduction, Doubly fed machine speed control by rotor rheostat, static Kramer drives, Static Scherbius drive, modified static Scherbius drive. Principle of vector control of IM, Indirect vector control with feedback, Indirect vector control with feed-forward, Indirect vector control in various frames of reference, Decoupling of vector control with feed forward compensation, Direct Torque Control of IM, control of wound rotor induction machine, introduction to five-phase induction motor drives
Unit 4	Control and Estimation of Induction Motor Drives: Introduction, Induction Motor control with small signal model, Scalar Control, Vector or Field oriented control, Sensorless vector control, direct torque and flux control, Adaptive control, Self commissioning drive.
Unit 5	Control and Estimation of Synchronous Motor Drives: Permanent Magnet Drives: Expression for torque, Model of PMSM, Implementation of vector control for PMSM, BLDC drives Switched Reluctance Motor Drives: Torque expression, converters for SRM drives, Sinusoidal SPM machine drives, Synchronous reluctance machine drive, sinusoidal IPM machine drive, trapezoidal SPM machine drive, Wound Field synchronous machine drive, switched reluctance motor drives.

Textbooks/References:

1. B. K. Bose, "Modern Power Electronics and AC drives", Pearson Education, Asia, 2003
2. R. Krishan, "Electric Motor Drives-Modeling Analysis and Control", Pearson Prentice Hall.
3. G.K. Dubey, "Fundamentals of Electrical Drives", Narosa Publication
4. N.K. De and P.K.Sen "Electric Drives", Prentice Hall India
5. B.K. Bose, "Power Electronics and Variable Frequency Drive", IEEE Press, 2000
6. Vedam Subramanyam, "Electric Drives Concepts and Applications", Tata McGraw-Hill

ISE III Assessments:

Assessments will be based on any one or two of the following:

- | | |
|------------------|----------|
| 1. Assignment | 10 Marks |
| 2. MCQ | 10Marks |
| 3. PPT | 10Marks |
| 4. Surprise Test | 10Marks |

Sample Assessment Pattern:

Assessment Tool	K2+K3	K2+K3	K2+K3	K2+K3	K2+K3+K4
	C01	C02	C03	CO4	CO5
ISE I Test (20 Marks)	10	10	-	-	-
ISE III Assessment (20 Marks)	0	0	0	10	10
ESE Assessment (60 Marks)	12	12	12	12	12

4. Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE 1	ISE III Assignment	End Semester Examination
K3	Apply	10		20
K4	Analyze	10	10	20
K5	Evaluate		10	20
Total Marks 100		20	20	60

Designed by Dr. N.R. Bhasme

EEPCC6113: Lab Control of Electrical Drives			
Teaching Scheme		Examination Scheme	
Practical	: 2 Hrs/Week	ISE III Term work	: 25 Marks
Total Credits	: 1	Total Marks	: 25 Marks

Course Objectives

The objectives of the course are to-

1. To expose the students to a variety of electric drives.
2. To provide hand-on experience in ac and dc drives.

Course Outcomes: After completion of this course students will be able to

CO1	Write a code for the selected DSP/microcontroller to control the dc motor drives
CO2	Write a code for the selected DSP/microcontroller to control the ac motor drives
CO3	Develop technical writing skills important for effective communication
CO4	Acquire teamwork skills for working effectively in groups

List of the Experiments:

1. Three experiments based on study and / or simulation of voltage fed , current fed converters and electric drives (mentioned in the syllabus) using MATLAB/SIMULINK/PSPICE
2. Three experiments based on study and / or experimentation on following electrical drives
 - a. DC motor drive
 - b. V/F induction motor control drive
 - c. Vector control of induction motor drive
 - d. Synchronous motor drive
 - e. Special machines

Term work:

The term work shall consist of submitting a file for minimum six experiments performed with neatly written records of the study, circuit diagrams, observations, and graphs with results.

The term work will be assessed by the course coordinator

Practical Examination:

The Practical Examination shall comprise of performing the experiment and viva voce on the syllabus. The practical will be assessed by two examiners, one will be internal examiner and other will be external examiner appointed by DFB.

Sample Assessment Pattern:

Assessment Pattern Level No.	Skill Level	Term Work	Practical Examination & viva voce
S1	Imitation	05	05
S2	Manipulation	10	10
S3	Precision	10	10
S4	Articulation	00	00
S5	Naturalization	00	00
Total		25	25

Details	Term Work	Practical Examination & viva voce
Preparation (S1)	05	05
Conduct of Experiment (S2)	05	05
Observation and Analysis of Results (S3)	05	05
Record (S2)	05	05
Presentation/ Viva-Voce (S3)	05	05
Total	25	25

Sample Assessment Table

Assessment Tool	S1,S2,S3	S1,S2,S3	S1,S2,S3	S1,S2,S3
	C01	C02	C03	C04
Term Work (25 Marks)	08	07	05	05
Practical Examination & Viva Voce (25 Marks)	08	07	05	05

Designed by Dr. N. R. Bhasme

EEAEC5110: Lab Software skills	
Teaching Scheme Practical: 04 Hrs/Week Credits: 02	Examination Scheme ISE III : 50 Marks Total : 50 Marks

This set can be organized as **(14–16 experiments) laboratory** for M Tech Electrical Engineering students. Here are some additional **advanced and industry-oriented Software Laboratory experiments.**

Suggested Software Tools

- Python
- MATLAB
- GNU Octave
- Jupyter Notebook
- Power World Simulator ,ETAP

1. Programming for Electrical Engineering

Introduction to Python/MATLAB

- Basic arithmetic and matrix operations.
- Plotting electrical signals.

Analysis of AC Waveforms

- Generate sine, square, and triangular waves.
- Calculate RMS, average, and peak values.

Power Factor Calculation

- Program to calculate real, reactive, and apparent power.
- Determine power factor and compensation requirements.

Load Flow Data Handling

- Read bus and line data from files.
- Create bus admittance matrix (Y-bus).

2. Power Grid and Interconnected Power Systems

Formation of Y-Bus Matrix

Develop software for Y-bus formation using inspection method.

Load Flow Analysis

Implement Gauss-Seidel load flow algorithm.

Newton-Raphson Load Flow

Develop and compare with Gauss-Seidel results.

Economic Load Dispatch

Determine optimal generation scheduling among interconnected stations.

Frequency Control Simulation

Simulate single-area and two-area load frequency control.

Tie-Line Power Flow Analysis

Study power exchange between interconnected power stations.

Transmission Line Performance

Calculate voltage regulation and efficiency.

Power System Fault Analysis

Symmetrical fault current calculation using software.

3. Smart Meter Data Analysis

Read and visualize smart meter datasets.

Load Forecasting

Short-term electrical load prediction using historical data.

Demand Response Analysis

Study consumer load shifting and peak reduction.

Renewable Energy Integration

Analyze solar/wind generation variability.

4Data Science Applications in Electrical Engineering

Electrical Data Visualization

Plot voltage, current, frequency, and power trends.

Power Consumption Pattern Analysis

Statistical analysis of energy consumption data.

Transformer Condition Monitoring

Analyze temperature and loading datasets.

Anomaly Detection in Power Systems

Detect abnormal voltage or current measurements.

Machine Learning for Load Prediction

Apply linear regression for demand forecasting.

Fault Classification Using Machine Learning

Classify fault types from simulated data.

Power Quality Analysis

Identify voltage sags, swells, and harmonics from datasets.

Mini Project

Develop a complete software solution for a grid, substation, or smart energy system using programming and data analytics.

Grid and Power System Applications

DC Load Flow Analysis

Develop a program for DC load flow and compare with AC load flow results.

Contingency Analysis

Study the effect of line or generator outages on system performance.

Optimal Power Flow (OPF)

Minimize generation cost while satisfying system constraints.

State Estimation in Power Systems

Estimate bus voltages using measured data.

Voltage Stability Analysis

Determine voltage stability margins under increasing load conditions.

Unit Commitment Problem

Schedule generating units for minimum operating cost.

Relay Coordination Study

Simulate overcurrent relay settings and coordination.

Transmission Network Expansion Planning

Analyze the need for additional transmission lines.

Renewable Energy and Smart Grid

Solar PV Performance Analysis

Analyze solar irradiation and power output datasets.

Wind Power Forecasting

Predict wind generation using historical data.

Battery Energy Storage Management

Develop algorithms for charging/discharging optimization.

Microgrid Energy Management

Optimize operation of distributed energy resources.

Electric Vehicle Charging Load Analysis

Study impact of EV charging on distribution networks.

Virtual Power Plant Simulation

Aggregate renewable sources and storage for grid support.

5. Data Science and Artificial Intelligence Applications

Time Series Analysis of Load Data

Use moving averages and trend analysis.

Energy Consumption Clustering

Group consumers based on usage patterns.

Predictive Maintenance of Transformers

Analyze condition monitoring data for failure prediction.

Machine Learning-Based Fault Detection

Train models using fault datasets.

Classification of Power Quality Disturbances

Identify harmonics, sags, swells, and interruptions.

Electricity Price Forecasting

Predict market prices using historical data.

Energy Theft Detection

Detect abnormal consumption patterns using analytics.

Neural Network-Based Load Forecasting

Compare results with conventional forecasting methods.

6. Signal Processing Applications

FFT Analysis of Electrical Signals

Determine harmonic content in waveforms.

Digital Filter Design

Design low-pass, high-pass, and band-pass filters.

Power Quality Monitoring System

Develop software for monitoring voltage and current quality.

Wavelet-Based Disturbance Detection

Detect transient events in power systems.

7. Visualization and Digital Twin Applications

SCADA Data Visualization Dashboard

Create real-time monitoring dashboards.

Substation Monitoring System

Develop graphical interfaces for equipment monitoring.

Digital Twin of a Distribution Feeder

Simulate feeder behavior under varying load conditions.

Geographical Information System (GIS) for Power Networks

Visualize transmission and distribution networks on maps.

PMU (Phasor Measurement Unit) Data Analysis

Analyze synchrophasor measurements for grid monitoring.

List of Program Electives in Semester II

EEPEC6110: Reliability and Condition Monitoring			
Teaching Scheme		Examination Scheme	
Lectures	: 03 Hrs/Week	ISE I	: 20 Marks
Tutorial	: 0 Hr/Week	ISE III	: 20 Marks
Total Credits	: 03	End -Semester Exam	: 60 Marks

Course Objective:

The objectives of the course are to

1. Know engineering system monitoring and fault diagnosis and explains the basic concepts of condition monitoring.
2. Know how modern technology, quality control and environmental issues have affected current thinking.
3. Protect themselves and others in the workplace and focus on the safety measures needed when Carrying out monitoring activities, especially those for isolating equipment.
4. Know how to use a range of condition monitoring equipment and will develop the skills and knowledge required for the location and identification of faults in engineering systems.
5. Learners will be required to select the appropriate monitoring technique and equipment based on the type of plant or equipment being monitored and the conditions checked.

Course Outcomes: After completing the course, students will be able to:

CO1	Know the health and safety requirements relevant to monitoring and fault diagnosis of engineering Systems.
CO2	Know about system monitoring and reliability.
CO3	Use monitoring and test equipment
CO4	Carry out fault diagnosis on electrical engineering equipment
CO5	Develop model for improvement in life of electrical equipment.

Detailed Syllabus:

Unit 1	Introduction to the field of machine condition monitoring: methods, tools used to monitor a machine, diagnostics and prognostics, reliability, maintenance practices, health usage monitoring, Frequency of monitoring, infrared thermography, Ultrasounds
Unit 2	Failure analysis: Failure mode-effect and criticality analysis, fault tree analysis. Breakdown mechanisms in gasses, liquids, vacuum, solids. maintenance strategies (breakdown, preventive, planned, scheduled, diagnostic, total productive maintenance, reliability centered maintenance) organization for maintenance, maintenance requirements, maintenance planning and work control, maintenance records, frequency of maintenance, cost of maintenance, maintenance effectiveness
Unit 3	Condition Monitoring of Transformer: Type of faults, duration and the impacts Interpretation of gasses generated in Oil-Immersed Transformer, Transformer winding and core deformation detection utilizing SFRA technique, Methods of Dissolved Gas Analysis (DGA), partial discharge

Unit 4	Diagnosis of electrical equipment: Motors, generators, Configuration, problems, diagnosis and solutions, Causes of motor failure, remedies. Signature analysis, condition monitoring of induction motor, power cables
Unit 5	Substation Maintenance: Types – Routine, Preventive, Planned, Predictive, Break-down, Emergency maintenance, on-line maintenance of different equipments, Condition monitoring of power apparatus, New advanced techniques in diagnosis and monitoring of electrical equipment.

Text and Reference Books:

1. Advances in high voltage engineering, edited by A. Haddad and D. Warne, IEEE Power and Energy Series, 2004.
2. Electrical Insulation in Power Systems, N. H. Malik, A. A. Al-Arainy and M. I. Qureshi, Marcel Dekker, 1997.
3. Insulation of High Voltage Equipment, V.Y. Ushakov, Springer-Verlag, 2004.
4. High Voltage Engineering Fundamentals, Kuffel/Zaengel/Kuffel, Newnes
5. K. B. Raina, S. K. Bhattacharya, Electrical Design, Estimation and costing, Wiley Eastern Limited New Delhi 1991.
6. S. L. Uppal- Electrical Power- Khanna Publishers Delhi.
7. Condition Monitoring and Assessment of Power Transformers Using Computational Intelligence, W.H. Tang, Q.H. Wu, ISBN: 978-0-85729-051-9
8. Handbook of Condition Monitoring: Techniques and Methodology Edited by A. Davies

ISE III Assessment: Teachers Assessment of 20 marks is based on attendance of the student and one of the / or combination of few of following. However, the course coordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. Problems based on GATE questions
3. Simulations problems
4. Quiz

Sample Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE III Assessment	End Semester Examination
K2	Understand			10
K3	Apply	10	10	20
K4	Analyze	10	10	20
K5	Evaluate			10
K6	Create			
Total		20	20	60

Sample Assessment Table:

Assessment Tool	K2+K3	K2+K3	K2+K3	K2+k 3	K2+K3
	C01	C02	C03	CO4	CO5
ISE I Test (20 Marks)	10	05	05		
ISE III Assessment (20 Marks)			05	10	05
ESE Assessment (60 Marks)	12	12	12	12	12

**Designed by
Dr. N. J. Phadkule**

EEPEC6111: Digital Control Systems			
Teaching Scheme		Examination Scheme	
Lectures	: 03Hrs/Week	ISE I	:20 Marks
Tutorial	: 0	ISE III	: 20 Marks
Total Credits	: 3	End -Semester Exam	: 60 Marks

Course description: The purpose of this course is to teach students the fundamentals of Digital Control Systems.

Course objectives: -The objectives of the course are to

1. Explain sampling and reconstruction
2. Illustrate transform analysis of sampled data system
3. Explain the design of digital controls
4. Describe self-tuning
5. Illustrate the control applications of microprocessor based control system

Unit wise Course Outcomes expected:

After completion of this course students will be able to

CO1	Obtain discrete representation of LTI systems
CO2	Analyze Z transform of sample data control
CO3	Evaluate the stability of system in discrete form
CO4	Analyze state space model of discrete systems
CO5	Apply digital PID systems

Detailed syllabus:

Unit-I	Discrete Representation of Continuous Systems: Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modeling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent.
Unit-II	Discrete System Analysis: Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time response of discrete time system.
Unit-III	Stability of Discrete Time System: Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response design.
Unit-IV	State Space Approach for discrete time systems: State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability
Unit-V	Design of Digital Control System: Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator.

Text Books:

1. K. Ogata, "Digital Control Engineering", Prentice Hall, Englewood Cliffs, 1995.
2. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
3. G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic Systems", Addison-Wesley, 1998.
4. B.C. Kuo, "Digital Control System", Holt, Rinehart and Winston, 1980.
5. Digital Control Engineering, M. Gopal, New Age International Publications, Second Edition

Teaching Strategies:

The teaching strategy is planned through the lectures, tutorials and team based home works. Exercises are assigned to stimulate the students to actively use and revise the learned concepts which also help the students to express their way of solving the problems fluently in written form. Most critical concepts and mistakes are emphasized.

ISE III Assessment: Teacher's Assessment based on one of the /or combination of the few of the following.

- 1) Assignment
- 2) Multiple choice question

Sample Assessment Table:

Assessment Tool	K2+K3	K2+K3	K2+K3	K2+K3	K2+K3
Course outcomes	CO1	CO2	CO3	CO4	CO5
ISE I Test 20 Marks	10	05	05		
ISE III Assessment 20 Marks				10	10
ESE Assessment 60 Marks	12	12	12	12	12

Sample Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE III Assessment	End Semester Examination
K2	Understand			10
K3	Apply	10	10	20
K4	Analyze	10	10	20
K5	Evaluate			10
K6	Create			
Total		20	20	60

**Designed by
Dr. S. S. Kulkarni**

EEPEC6112 : Energy Storage Systems			
Teaching Scheme		Examination Scheme	
Lectures	: 03 Hrs/Week	ISE I	: 20 Marks
Tutorial	: 00	ISE III	: 20 Marks
Total Credits	: 3	End-Semester Exam	: 60 Marks

Course Description: The course covers energy storage techniques involving electrochemical, mechanical and emerging options. Integration of the energy storage media, its effects on the bulk power system, and design tradeoffs to understand environmental impacts, cost, reliabilities, and efficiencies for commercialization of bulk energy storage.

Course Objectives: The objectives of the course are to

1. Understand energy storage needs
2. Study and compare different methods of Electro-chemical energy storages
3. Understand superconducting magnetic energy storage systems
4. Get knowledge of mechanical and thermal energy storage systems
5. Study various energy storage applications and management of storage systems

Course Outcomes: After completing the course, students will able to

CO1.	Describe the need of energy storage systems - present and future
CO2	Demonstrate working/ operational principles of various Electrochemical Energy Storage systems
CO3	Explain superconducting magnetic energy storage systems
CO4	Explain mechanical energy storage and Thermal energy storage systems
CO5	Select appropriate energy storage systems for various applications and demonstrate management of energy storage systems

Detailed Syllabus:

Unit-I	Necessity of Energy Storage: Storage Needs - Variations in Energy Demand - Variations in Energy Supply - Interruptions in Energy Supply - Transmission Congestion - Demand for Portable Energy - Demand and scale requirements - Environmental and sustainability issues, future prospect of storage
Unit-II	Electrochemical Energy Storage: Electrochemical storage system (11 Hours) (a) Batteries-Working principle of battery, primary and secondary (flow) batteries, battery performance evaluation methods, major battery chemistries and their voltages- Li-ion battery & Metal hydride battery vs lead-acid battery. (b) Super capacitors- Working principle of super-capacitor, types of super-capacitors, cycling and performance characteristics, difference between battery and super-capacitors, Introduction to Hybrid electrochemical super-capacitors (c) Fuel cell: Operational principle of a fuel cell, types of fuel cells, hybrid fuel cell-battery systems, hybrid fuel cell-super-capacitor systems

Unit-III	Superconducting Magnetic Energy Storage: Introduction to Superconducting Magnetic Energy Storage (SMES) operation, theory of usage and emergent research. Focus will primarily be on large utility scale energy storage facilities
Unit-IV	Mechanical Energy Storage and Thermal Energy Storage: Flywheel, Pumped hydro storage, compressed gas storage technologies, models for compressed gas capacity, efficiency and availability Thermal Energy Storage- Phase Change Materials (PCMs); Selection criteria of PCMs; Stefan problem; Solar thermal LHTES systems; Energy conservation through LHTES systems; LHTES systems in refrigeration and air-conditioning systems
Unit-V	Applications: Present status of applications, Utility use (Conventional power generation, Grid operation & Service), Consumer use (Uninterruptible power supply for large consumers), New trends in application, Renewable energy generation, Smart grid, Electric vehicles, Management and control hierarchy of storage systems, Internal configuration of battery storage systems, External connection of EES systems

Text and Reference Books:

1. Ter-Gazarian, A.G. (2011) *Energy Storage for Power Systems*, 2nd Edition, IET Publications (ISBN: 978-1849192194)
2. P. Deshpande, "Ultracapacitors", McGraw Hill Education Publication.
3. R.A. (2010) *Energy Storage*, Springer, (ISBN: ISBN 978-1441910240)
4. Robert A. Huggins, "Energy Storage", Springer Publication.
5. Fransisco Diaz, "Energy storage in power systems", published by Wiley.

Sample Assessment Table:

Assessment Tool	K1+K2+K3	K1+K2+K3	K2+K3	K1 to K6	K1 to K6
Course outcomes	CO1	CO2	CO3	CO4	CO5
ISE I 20 Marks	10	10			
ISE III Assessment 20 Marks			10	10	
ESE Assessment 60 Marks	12	12	12	12	12

ISE III Assessment: It is based on one or combination of the following.

1. Assignments, 2. Models/ Presentations, 3. multiple choice questions test, 4. Quiz

Sample Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE III Assessment	End Semester Examination
K2	Understand	10	10	20
K3	Apply	10	05	20
K4	Analyze		05	20
Total		20	20	60

Designed by
Dr. Sunanda Ghanegaonkar

EEPEC5112: Machine Learning and Applications			
Teaching Scheme		Examination Scheme	
Lectures	: 03 Hrs/Week	ISE I	: 20 Marks
Tutorial	: 00	ISE III	: 20 Marks
Total Credits	: 03	End -Semester Exam	: 60 Marks

Course Outcomes (COs):

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

CO1	Understand basic concepts of Machine Learning Techniques
CO2	Distinguish between supervised learning, unsupervised learning and reinforced learning
CO3	Develop the skills in using machine learning software for solving practical problems
CO4	Apply Machine Learning Algorithms for Electrical Engineering problems

Detailed Syllabus:

Unit I	Neural Networks: Introduction to Neural Networks, Models of Neuron Network, Architectures – Knowledge representation, Artificial Intelligence and Neural Networks – Learning Process, Error Correction Learning, Multi-layer perceptron using Back Propagation Algorithm (BPA) Learning Theory: Introduction to Machine Learning, Learning Objectives, Data needed, Bayesian inference and Learning, Bayes theorem, inference -naïve Bayes, Regularization, Bias-Variance Decomposition and Trade-off, Concentration Inequalities, Generalization and Uniform Convergence, VC dimension. Types of Learning, Supervised Learning, Unsupervised Learning and Reinforcement Learning
Unit II	Supervised Learning: Simple linear Regression, Multiple Linear Regression- Logistic Regression, Exponential Family and Generalized Linear Models Generative Models: Gaussian Discriminant Analysis, Naïve Bayes Kernel Method: Support Vector Machine (SVM), Kernel function, Kernel SVM, Gaussian Process Tree Ensembles: Decision Trees- Random Forests, Boosting and Gradient Boosting
Unit III	Un-Supervised Learning: (CLUSTERING): K means Clustering Algorithm, Gaussian Mixture Model (GMM), Expectation Maximization (EM), Variational AutoEncoder (VAE) Factor Analysis, Principle Components Analysis (PCA) Independent Component Analysis (ICA)
Unit IV	Reinforcement Learning: Markov Decision Processes (MDP)-Bellman's Equations- Value Iteration and Policy Iteration - Value Function Approximation - Q-Learning
Unit V	Applications of ML: Load Forecasting, Energy Market forecasting, Fault identification and localization, Renewable Uncertainty estimation

Text and reference books:

1. Christopher Bishop, “ Pattern Recognition and Machine Learning” , Springer, 2011
2. E. Alpaydin, “ Machine Learning”, , MIT Press, 2010 Reference Books:
3. Tom M. Mitchell, “ Machine Learning” , McGraw Hill International Edition, 1997
4. Online Resources: <https://www.learndatasci.com/best-machine-learning-courses/>

Sample Assessment Table:

Assessment Tool	K1+K2+K3	K1+K2+K3	K2+K3	K1 to K6	K1 to K6
Course outcomes	CO1	CO2	CO3	CO4	CO5
ISE I 20 Marks	10	10			
ISE III Assessment 20 Marks			10	10	
ESE Assessment 60 Marks	12	12	12	12	12

ISE III Assessment: It is based on one or combination of the following.

1. Assignments, 2. Models/ Presentations, 3. multiple choice questions test, 4. Quiz

Sample Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE III Assessment	End Semester Examination
K2	Understand	10	10	20
K3	Apply	10	05	20
K4	Analyze		05	20
Total		20	20	60

Designed by

Dr. N. J. Phadkule

EEPEC5113 : Optimization Techniques	
Teaching Scheme Lectures: 03 Hrs/Week Tutorial : 0 Hrs/Week Credits : 3	Examination Scheme ISE I : 20 Marks ISE III : 20 Marks End Semester Exam : 60 Marks

Course Description: Electrical Power Systems is growing at a faster pace. An Electrical Engineer should be able to solve the optimization problems in electrical engineering. This course is aimed to cover the fundamentals of LPP and NLPP optimization techniques for solving engineering problems.

Course Objectives: The objectives of the course are to

1. Introduce the fundamental concepts of Optimization Techniques;
2. Make the learners aware of the importance of optimizations in real scenarios;
3. Provide the concepts of various classical and modern methods for constrained and unconstrained problems in both single and multivariable.

Course Outcomes: After completing the course, students will able to:

CO1	formulate optimization problems
CO2	understand and apply the concept of optimality criteria for various type of optimization problems
CO3	solve various constrained and unconstrained problems in single variable as well as multivariable;
CO4	apply the methods of optimization genetic algorithm for real life situation
CO5	apply the methods of optimization techniques for the application in power system engineering

Detailed Syllabus:

Unit 1	Introduction: Concept of optimization and classification of optimization techniques, formation of optimization problems Linear Programming : Standard form of LPP Simplex Method of solving LPP, duality in LP, transportation problem
Unit 2	Non-Linear Problem (NLP): One dimensional methods: Elimination methods, Interpolation methods, Unconstrained optimization techniques:-Direct search and gradient based methods, Constrained optimization techniques:-Lagrange multiplier method, Kuhn-Tucker Conditions, Cutting plane Method, penalty function Methods
Unit 3	Dynamic Programming: Multistage decision processes, concept of sub-optimization and principle of optimality, conversion of final value problem into an initial value problem.
Unit 4	Advanced Optimization Techniques: Introduction to Multi objective Optimization, Swarm intelligences, Genetic Algorithm, Teaching Learning Based Optimization, and other Non-traditional Optimization Algorithms applications.

Unit 5	Applications to Power system: Economic Load Dispatch in thermal and Hydro-thermal system Unit commitment problem, reactive power optimization. Optimal power flow, LPP and NLP techniques to Optimal flow problems.
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Text and Reference Books

1. S.S.Rao, "Optimization - Theory and Applications", Wiley-Eastern Limited.
2. David G. Luenberger, "Introduction of Linear and Nonlinear Programming ", Wesley a. Publishing Company
3. Polak, "Computational methods in Optimization", Academic Press. Pierre D.A, "Optimization Theory with Applications", Wiley Publications.
4. Kalyanmoy deb, "Optimization for Engineering Design: Algorithms and Examples", Kalyanmoy deb, PHI Publication.
5. D.E. Goldberg & Addison, "Genetic Algorithm in Search Optimization and Machine Learning ", Wesley Publication, 1989
6. L.P. Singh, "Advanced Power System Analysis and Dynamics", Wiley Eastern Limited.
7. Hadi Saadat "Power System Analysis ", TMH Publication.
8. Olle I. Elgerd " Electrical Energy System : An Introduction", TMH Publication, NewDelhi

ISE III Assessment: Assessment of 20 marks is based on one or combination of following. However, the course coordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. Problems based on GATE questions, Simulations problems, Quiz

Sample Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	Test	ISE III Assessment	End Semester Examination
K2	Understand	10	10	20
K3	Apply	10	10	20
K4	Analyze			20
K5	Evaluate			
K6	Create			
Total Marks 100		20	20	60

3. Sample Assessment table:

Assessment Tool	K2+ K3	K2+ K3	K2+ K3	K2+ K3	K2+K3
	CO1	CO2	CO3	CO4	CO5
ISE I Test (20 Marks)	10	5	5		
ISE III Assessment (20 Marks)				10	10
ESE Assessment (60 Marks)	10	20	10	10	10

Designed by Dr. S. P. Ghanegaonkar

PEC5114: Power Quality and Mitigation			
Teaching Scheme		Examination Scheme	
Lectures	: 03 Hrs/Week	ISE I	: 20 Marks
Tutorial	: 00	ISE III	: 20 Marks
Total Credits	: 03	End -Semester Exam	: 60 Marks

Pre-requisites: Power Electronics, Electrical Machines, Power System

Course Description:

This course gives an introduction on power quality causes and effects, requirement of power quality improvements and mitigation aspects of power quality problems

Course Objectives: The objectives of the course are to

1. Understand power quality problem and classify power quality events
2. Understand different methods of monitoring power quality and standards for power quality
3. Outline concept of Passive shunt and series compensators
4. Understand Active Shunt And Series Compensators
5. Understand Unified Power Quality Compensators

Course Outcomes: After completing the course, students will able to

CO1.	Identify and describe Power quality problems and classify power quality events.
CO2	Evaluate power quality indices in distribution system
CO3	Develop mitigation techniques for compensating devices to improve power quality in distribution systems
CO4	Suggest compensating devices to improve power quality in distribution system
CO5	Analyze Unified Power Quality Compensators

Detailed syllabus:

Unit-I	Power Quality: Significance of power quality, Power quality terms: Transients, Long-duration voltage variations, Short-duration voltage variations, Voltage imbalance, Waveform distortion, Voltage fluctuation, CBEMA and ITI curves. Devices for Overvoltage Protection: Surge arresters and transient voltage surge suppressors, Isolation transformers and Low-impedance power conditioners. Waveform Distortion: Introduction, Voltage versus current distortion, Harmonics versus transients, Harmonics indices: Total Harmonics Distortion (THD) and Total Demand distortion (TDD); Harmonic standards; Harmonic analysis; Harmonic phase sequence; Triplen harmonics; Inter harmonics.
Unit-II	Harmonic Sources: Harmonics generated from electrical machines such as transformers and rotating machines; Arcing devices; Static power conversion: Phase controlled and uncontrolled rectifiers, AC voltage regulators, Cyclo-converters, Pulse width modulated inverters; Converter fed ac and dc drives

Unit-III	Effects of Harmonic Distortion: Resonances; Effects of harmonics on rotating machines; Effect of harmonics on static power plant; Power assessment with distorted waveforms; Effect of harmonics on measuring instruments; Harmonic interference with ripple control systems; Harmonic interference with power system protection; Effect of harmonics on consumer equipment; Interference with communication systems
Unit-IV	Harmonic Elimination: Passive power filters: Design, A Shunt active power filters: Configurations, State of the art, Design and control strategies. Three-phase four-wire shunt active power filters
Unit-V	Voltage Quality: Sources of Sags, Swell, Unbalance and Flicker; Voltage quality standards; Effects of sags, Swell, Unbalance and Flicker; Voltage sag magnitude due to fault; Voltage sag magnitude calculation based on influence of cross section of conductor, transformer and fault levels; Critical distance for a voltage sag magnitude; Causes of phase- angle jumps in voltage; Classification of voltage sags, voltage sag transformation due to transformers.

Sample Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	Test	ISE III Assessment	End Semester Examination
K2	Understand	10		20
K3	Apply	10	10	20
K4	Analyze		10	20
K5	Evaluate			
K6	Create			
Total Marks 100		20	20	60

Sample Assessment table:

Assessment Tool	K2+ K3	K2+ K3	K2+ K3	K2+ K3	K2+K3
	CO1	CO2	CO3	CO4	CO5
ISE I Test (20 Marks)	10	5	5		
ISE III Assessment (20 Marks)				10	10
ESE Assessment (60 Marks)	10	20	10	10	10

Designed by
Prof. B. T. Deshmukh

EEDIS6120 : DISSERTATION PHASE – I	
Teaching Scheme Practical: 4 Hrs/Week Credits :2	Examination Scheme ISE III : 50 Marks ESE :50 Marks Total : 100 Marks

Students will present seminars on the dissertation work carried out as a part of term work. The department will constitute a committee of three members to evaluate the presentation. The committee will have the following structure.

1. Head Of the department
2. Guide- Member
3. Subject expert from institute/industry-member

The committee will monitor the quality of the dissertation work.

Semester III

EEM course EEEEM5101: Energy Audit and Management	
Teaching Scheme Lectures: 2 Hrs/Week Tutorial: 0 Hrs/Week Credits : 02	Examination Scheme ISE I : 10 Marks ISE II : 10 Marks End-Semester Examination : 30 Marks Total :50 Marks

Course Objectives:

After completing the course, students will able to:

CO1	describe the concept of energy management and various regulations related to energy conservation
CO2	demonstrate the significance of energy audit
CO3	apply the different methods used for the economic analysis of energy projects
CO4	appraise the significance of energy efficient & demand- side management of electricity

Detailed Syllabus:

Unit 1	Energy Scenario and Management: An overview of Indian Energy Scenario, Sector Wise Energy Consumption in India, Energy needs of Growing Economy, Long Term Energy Scenario for India. Reasons to save energy (both financial and environmental), Energy Conservation and its importance, Energy Conservation Act and related policies, Bureau of Energy Efficiency(BEE)Regulations. Need to Manage Energy, Definition and objectives of Energy Management, Components of Energy Management program and their explanation.
Unit 2	Energy Audit: Energy audit concepts, Scope of energy audit, types of energy audit, general procedure for a detailed energy audit, various energy audit methodologies, instruments and metering for energy audit, general procedure for a detailed energy audit, preparation of detailed energy audit report, benefits of energy audit. Case study of energy audit in different industrial organizations / electrical utilities.
Unit 3	Utility Rate Structures and Financial Analysis: Understanding Energy Costs, Innovative rates, Real Time Pricing Rates, Financial incentive rates, Energy Purchase Rates. Basic concept of Economic Analysis–Interest Rate, Inflation rate, Single Payment, Uniform–Series Payment. Economic Evaluation Methods – Net Present Worth, Rate of Return, Benefit – Cost Ratio, Payback period. Comparison of Various Economic Evaluation Methods.

Unit 4	Energy Efficiency & Demand Side Management: Introduction, Energy Efficient Motor, Adjustable Speed Drives, Energy Saving Calculations, Energy Efficient Lighting Systems, High Efficiency Fluorescent Lamps, Compact Fluorescent Lamps, Cost Effectiveness of Efficient Lighting Technologies, Automatic Power factor Controllers, HVAC system, Role of New Equipment and Technology in Industrial Energy Efficiency. Introduction to Demand Side Management, Integrated Resource Planning Concepts, Relation between Demand Side Management and Integrated Resource Planning, Demand Side Management Programs, Cost Benefit Analysis of Demand Side Management
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Text and Reference Books

1. Smith C.B. Energy Management Principles, Pergamon Press, New York.
2. Wayne C. Turner, Steve Doty, Energy Management Handbook, Taylor and Francis Ltd., CRC Press.
3. Frank Kreith, Goswami. Yogi, Energy Management and Conservation Handbook, Taylor and Francis Ltd., CRC Press.
4. Albert Thumann, Terry Niehus, William J. Younger, Handbook of Energy Audits, Taylor and Francis Ltd., CRC Press.
5. Rajive Shanker, Energy Auditing in Electrical Utilities, Viva Book Pvt. Limited, New Delhi.
6. Bureau of Energy Efficiency, General Aspects of Energy Management and Energy Audit. New Delhi.

ISE III Assessment: Teachers Assessment of 20 marks is based on **attendance** of the student and one of the / or combination of few of following.

1. Presentation on latest topics/Real life problems related with the subject
2. Simulations problems
3. Quiz
4. MCQ

Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II Assignment	End Semester Examination
K2	Understand	0		10
K3	Apply	10	0	10
K4	Analyze		10	10
K5	Evaluate			
K6	Create			
Total Marks 100		10	10	30

IKS course EEIKS5101: Vedic Approach to Mathematics

Teaching Scheme	Examination Scheme
Lectures: 2 Hrs/Week	ISE I : 10 Marks
Tutorial: 0 Hrs/Week	ISE II : 10 Marks
Credits : 02	End-Semester Examination : 30 Marks
	Total :50 Marks

Understand traditional Indian approaches to energy generation, utilization, and conservation.

- Examine sustainable practices embedded in Indian knowledge traditions.
- Analyze indigenous technologies from the perspective of modern energy engineering.
- Explore integration of traditional wisdom with contemporary sustainable energy systems.

Course description: This course is planned as Ability enhancement course. It is an exposure to the Engineering students about Vedic Mathematics. Vedic Mathematics is a collection of Techniques/Sutras to solve mathematical arithmetics in easy and faster way. It consists of 16 Sutras (Formulae) and 13 sub-sutras (Sub Formulae) which can be used for problems involved in arithmetic, algebra, geometry, calculus, conics. By using Vedic maths, the problems are solved mentally with the use of few or some of steps which increase accuracy and reduce mistakes. Through the application of the sutras, it ensures both speed and accuracy and enhances computational skills. In this course some of the topics from Vedic Mathematics are introduced which are use full to Engineering Students.

Course Objectives:

The main objectives of the course are:

1. Multiply and division of two or three digits numbers.
2. Factorise the quadratic expressions of single variable.
3. Find the Solution of Linear Simultaneous Equations

Course Outcomes

After completing the course, students will be able:

CO1	Do multiplication and division of two and three digit numbers by applying Sutras in Vedic Mathematics
CO2	To factorize and find LCM/HCF of numbers by applying Sutras in Vedic Mathematics
CO3	To solve Simultaneous Linear Equations by applying Sutras in Vedic Mathematics

Detailed Syllabus:

Unit 1	Multiplication : 1. Ekadhikenpurven method (multiplication of two numbers of two digits) 2. Eknunenpurven method (multiplication of two numbers of three digits) 3. Urdhvatiragbhyam method (multiplication of two numbers of three digits) 4. Nikhilam Navtashchramam Dashtaha (multiplication of two numbers of three digits) Division and Divisibility : Part A: Division 1. Nikhilam Navtashchramam Dashtaha (two digits divisor) 2. Paravartya Yojyet method (three digits divisor) Part B: Divisibility 1. Ekadhikenpurven method (two digits divisor) 2. Eknunenpurven method (two digits divisor) Factorisation /LCM/HCF
Unit 2	Solution of Linear Simultaneous Equations : Simple equations, Simultaneous Simple Equations, Quadratic Equations, Cubic Equations, Simultaneous Quadratic Equations.
Unit 3	Power and Root Power : (i) Square (two digit numbers), (ii) Cube (two digit numbers). (iii) Square root (four digit number) (iv) Cube root (six digit numbers) [Self Study and assignments]

Text and Reference Books

1. Vedic Mathematics, Jagadguru Swami Sri BHARATI KRSNA TIRTHAJI MAHARAJA, Motilal Banarsi Das Publishing House, New Delhi.
2. Vedic Ganita: Vihangama Drishti-1, Siksha Sanskriti Uthana Nyasa, New Delhi.
3. Vedic Ganita Praneta, Siksha Sanskriti Uthana Nyasa, New Delhi.
4. Vedic Mathematics: Past, Present and Future, Siksha Sanskriti Uthana Nyasa, New Delhi.
5. Leelavati, Chokhambba Vidya Bhavan, Varanasi.
6. Bharatiya Mathematicians, Sharda Sanskrit Sansthan, Varanasi

Assessment:

ISEI:	Shall be based on Class Tests/ Assignments/Quizzes/Presentations/ Course Projects
ISEII:	Shall be based on class test.

Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE1	ISEII	ESE
K2	Understand	05	05	10
K3	Apply	05	05	10
K4	Analyze	-	-	10
KS	Evaluate	-	-	-
K6	Create	-	-	-
Total Mars 50		10	10	30

Assessment table

Assessment Tool	K2	K2	K2
	CO1	CO2	CO3
ISE I (10Marks)	10	-	-
ISE II (10Marks)	-	10	-
ESE (30Marks)	10	10	10

Mapping of Course

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1I	POI 2	PSO 1	PSO 2	PSO 3
COI															
CO2															

Prof. S.P. Attipamalu

EEDIS6121: DISSERTATION PHASE – II	
Teaching Scheme Practical : 16 Hrs Credits :08	Examination Scheme ISE III : 50 Marks ESE e : 50 Marks Total : 100 Marks

Students will present seminars on the dissertation work carried out as a part of term work. The department will constitute a committee of three members to evaluate the presentation. The committee will have the following structure.

1. Head Of the department
2. Guide- Member
3. Subject expert from institute/industry-member

The committee will monitor the quality of the dissertation work.

Semester IV

INT : EEINT6101 Internship/ Industrial Training	
Teaching Scheme Theory : 0Hrs/Week Credits : 10 Hrs/ week	Examination Scheme ISE III :50 Marks ESE :50 Marks Total :100 Marks

As per institute policy

Course Description: Industrial training(In-Plant Training/Internship) refers to work experience done during the program of study that is relevant to professional development prior to graduation. The training will provide an industrial exposure to the students and opportunity to develop as per the expectations and requirement of industry giving a good start of the career.

The students shall study the technology, processes, practices and work culture in the industry during the training. They shall also work on the project, if allotted. A faculty from the institute and one mentor from the industry will guide the students. The training period will be of minimum 90 working days.

ISE I, II and III: The evaluation is done through reviews. The student has to present his work during the internship. Every candidate has to give a presentation in presence of faculty members and students. The Head of the department will appoint two internal examiners to assess the term work; guide shall be one of the examiners. The student has to prepare typed report of about 25 pages or more, on the work carried out in the respective industry.

Course Outcomes:

CO1	Observe & experience the practices, processes and work culture of the industry
CO2	Apply engineering concepts to solve the problems
CO3	Develop employability skills and attitude

Mapping of Course outcome with Program Outcomes:

Program Outcome	1	2	3	4	5	6	7	8	9	10	11	PSO1	2	3
CO1						1	1	1	2	2	2	1	1	1
CO2	3	3	3	3								3	3	3
CO3						1	1	1	3	2	2			

1 – Low 2 – Medium 3 -High

Assessment Table:

Assessment Tool	K2	K2	A3
	CO1	CO2	CO3
ISE III (50 Marks)	20	20	10
ESE (50 Marks)	40	40	20