AR-26

COURSE STRUCTURE
AND
DETAILED SYLLABUS

For

M.Tech

Power Systems and Power Electronics

(DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING)

(Applicable for the batches admitted from 2026-2027)

ADITYA INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AUTONOMOUS)
Approved by AICTE, Accredited by NBA&NAAC,
Recognised under 2(f)12(b) of UGC
Permanently Affiliated to JNTUGV,Vizianagaram
K.Kotturu,Tekkali,Srikakulam-532201,AndhraPradesh.

VISION OF THE INSTITUTE

To evolve into a premier engineering institute in the country by continuously enhancing the range of our competencies, expanding the gamut of our activities and extending the frontiers of our operations.

MISSION OF THE INSTITUTE

Synergizing knowledge, technology and human resource, we impart the best quality education in Technology and Management. In the process, we make education more objective so that efficiency for employability increases on a continued basis.

VISION OF THE DEPARTMENT

The department of Electrical and Electronics Engineering is committed to innovation and excellence in teaching, research, service and provide programs of the high quality, collaborative efforts with industry to produce world class engineering professionals.

MISSION OF THE DEPARTMENT

M1. To inculcate value based, socially committed professionalism to the cause of overall development of students and society.

M2. Cultivate the spirit of entrepreneurship and the connection between engineering and business that encourages technology commercialization.

M3. Improve continuously the engineering pedagogical methods employed in delivering its academic programs.

M4. Evolve thoughtfully in response to the needs of industry, society and the changing world.

Aditya Institute of Technology and Management, Tekkali
M.Tech. – (Power Systems and Power Electronics)
(AR26 Regulations)

COURSESTRUCTURE

Semester	Subject Code	Theory/Lab	L	T	P	C
I	26MPS1001	Programmable Logic Controllers & Applications	4	0	0	4
	26MPS1002	Electrical Drives	4	0	0	4
	26MPS1003	Flexible AC Transmission Systems	4	0	0	4
	26MXX1E1X	Program Elective–1	3	0	0	3
	26MXX1E2X	Program Elective–2	3	0	0	3
	26MPS1101	Programmable Logic Controllers Lab	0	0	4	2
	26MPS1102	Electrical Drives Lab	0	0	4	2
	26MAC1001 26MAC1002 26MAC1003	Audit Course: English for Research Paper Writing Disaster Management Constitution of India	2	0	0	0
Total			**20**	**0**	**8**	**22**

Semester	Subject Code	Theory/Lab	L	T	P	C
II	26MPS1004	Power System Dynamics and Stability	4	0	0	4
	26MPS1005	Energy Storage Technologies	4	0	0	4
	26MPS1006	Analysis of Dynamic Systems	4	0	0	4
	26MXX1E3X	Program Elective–3	3	0	0	3
	26MXX1E4X	Program Elective–4	3	0	0	3
	26MPS1103	Power Electronic Circuits Simulation Lab	0	0	4	2
	26MCC1001	Research Methodology and IPR/Swayam 12 Week MOOC course–RM&IPR	2	0	0	2
Total			**20**	**0**	**4**	**22**

Semester	Subject Code	Theory/Lab	L	T	P	C
III	26MPS2I01	Internship/Industrial Training(8 weeks)	-	-	-	3
	26MPS2201	Technical Seminar	-	-	4	2
	26MPS2202	Comprehensive Viva	-	-	-	2
	26MPS2203	Dissertation Phase–1	0	0	20	10
Total			**0**	**0**	**24**	**17**

Semester	Subject Code	Theory/Lab	L	T	P	C
IV	26MPS2204	Dissertation Phase–2	0	0	32	16
Total			**0**	**0**	**32**	**16**

Program Elective – I

Code	Subject
26MPS1E11	Advanced Power System Protection
26MPS1E12	Reactive Power Compensation and Management
26MPS1E13	HVDC Transmission

Program Elective – II

Code	Subject
26MPS1E21	Advanced Power Electronic Converters
26MPS1E22	Electric and Hybrid Vehicles
26MPS1E23	Machine Modelling and Analysis

Program Elective – III

Code	Subject
26MPS1E31	Smart Grid
26MPS1E32	AI Techniques in Power Systems
26MPS1E33	Energy Auditing and Management

Program Elective – IV

Code	Subject
26MPS1E41	Switched Mode Power Converters
26MPS1E42	Power Electronics for Renewable Energy Systems
26MPS1E43	IoT Applications to Electrical Engineering

PROGAMMABLE LOGIC CONTROLLERS & APPLICATIONS

Subject Code: 26MPS1001

L	T	P	C
4	0	0	4

Course Objectives:
The main objective of the course is to:
Introduces basic concepts in PLC programming, operational procedure, different types of PLC registers, PLC functions, data handling functions, which are useful in practical PLC applications in Industries.

Course Outcomes:
CO1: Able to learn the basic PLC system construction and programming.
CO2: Able to learn programming examples using contacts and coils, Drill press operation.
CO3: Able to learn ladder diagrams for different process control.
CO4: Able to learn the Characteristics of PLC Registers.
CO5: Able to learn PLC Functions with application and able to learn data handling functions with application.

UNIT -I
PLC Basics: Introduction, Advantages and Disadvantages of PLC, PLC system, PLC as a Computer , CPU processor, I/O Modules (Interfaces), programming formats, construction of PLC ladder diagrams, process scanning considerations.

UNIT-II
PLC Programming-I: Types of PLC Programming, PLC Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation. Digital logic gates.

UNIT -III
PLC Programming-II: Boolean algebra PLC programming, conversion examples, Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.

UNIT-IV
PLC Registers: Characteristics of Registers, module addressing, holding registers, input registers, output registers.

UNIT -V
PLC Functions: PLC Timer functions and Industrial applications, PLC counters, counter function industrial applications, Arithmetic functions (Addition and Subtraction, Multiplication, Division).
Data Handling functions: PLC SKIP function and Applications, Master control Relay function and Applications, Jump function with non-return and with return, PLC Move function with application.

TEXT BOOKS:

1. Programmable Logic Controllers – Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI
2. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth and F.D Hackworth Jr. – Pearson, 2004.

REFERENCE BOOKS:

1. Introduction to Programmable Logic Controllers- Gary Dunning Cengage Learning.
2. Programmable Logic Controllers –W.Bolton-Elsevier publisher

ELECTRICAL DRIVES

Subject Code: 26MPS1002

L	T	P	C
4	0	0	4

Course Objectives:

- To understand principle of operation of scalar control of AC motor and corresponding speed torque Characteristics.
- To comprehend the vector control for AC motor drive(IM and SM)
- To explain the static resistance control
- To understand the Slip power recovery schemes
- Toexplainsynchronousmotordrivecharacteristicsanditscontrolstrategies and to comprehend the principle of operation of brushless DC motor.

Course Outcomes:

After completion of the course, students will be able to:

CO1: Understand Closed loop control of DC Drive.

CO2: Summarize Chopper Controlled DC Motor Drives.

CO3: Understand control of Induction Motor.

CO4: Explains Rotor Side Control of Induction Motor Drives.

CO5: Develop Vector Control of Induction Motor Drives and demonstrate control of permanent magnet synchronous motor drives**.**

UNIT–I:

Rectifier controlled DC motor

Separately excited DC motors and DC series motors with single phase semi converter and single phase full converter, Three-phase controlled converter, control circuit, control modeling of three phase converter, Steady state analysis of three phase converter control DC motor drive, Two quadrant, Three phase converter controlled DC motor drive, DC motor, load and converter.

Closed loop control of DC drive

Current and speed controllers, Current and speed feedback, Design of controllers, Current and speed controllers, Motor equations, Filter in the speed feedback loop speed controller, Current reference generator, Current controller and flowchart for simulation, Harmonics and associated problems, Sixth harmonics torque.

UNIT–II:

Chopper Controlled DC Motor Drives

Principle of operation of the chopper, Chopper with other power devices, Model of the chopper, Input to, Steady state analysis of chopper-controlled DC motor drives.

Closed loop operation:

Speed controlled drive system, Current control loop, Pulse width modulated current controller, Hysteresis current controller, Modeling and Design of current controller.

UNIT–III:

Control of Induction Motor

Introduction to motor drive, Torque production, Analysis of equivalent circuit, Toque – Speed characteristics with Variable voltage, Variable frequency, Constant v/f, Variable stator current operation, Induction motor characteristics in constant torque and field weakening regions.

Stator Side Control

Scalar control, Voltage fed inverter control, Open loop v/f control, Speed control slip regulation, Speed control with torque and flux control, Current controlled voltage fed inverter drive.

UNIT-IV

Rotor Side Control of Induction Motor Drives

Slip power recovery schemes, Static Kramer Drive, Phasor diagram, Torque expression, Speed control of Kramer Drive, Static Scheribus Drive, and Modes of operation.

UNIT–V:

Vector Control of Induction Motor Drives

Principles of Vector control, Direct and Indirect methods of vector control, Adaptive control principles, Self tuning regulator Model referencing control, Direct torque control of AC motors.

Control of Permanent Magnet Synchronous Motor Drives

Synchronous motor and its characteristic, Control strategies, Constant torque angle control, Unity power factor control, Constant mutual flux linkage control, Closed loop operation.

TEXTBOOKS:

1. R.Krishnan, “Electric Motor Drives Pearson Modeling, Analysis and control”,1st Edition,2002.
2. B KBose, “Modern Power Electronics and AC Drives”, Pearson Publications,1st Edition.

REFERENCES:

1. MD Murthy and FG Turn, “Power Electronics and Control of AC Motors”, Pergman Press 1st Edition.
2. MH Rashid, “Power Electronic circuits Deices and Applications”,PHI,1995.
3. G.K.Dubey, “Fundamentals of Electrical Drives”, Narosa publications,1995.

FLEXIBLE AC TRANSMISSION SYSTEMS

Subject Code: 26MPS1003

L	T	P	C
4	0	0	4

Course Objectives:

- To develop the understanding of uncompensated lines and their behavior under heavyloading conditions.
- To understand the concept and importance controllable parameters of FACTS controllers.
- To emphasize the objectives of Shunt compensation, and basic operation of SVC and STATCOM.
- To analyze the functioning of series controllers like GCSC, TSSC and TCSC

Course Outcomes: Upon the completion of this course, the student will be able to

CO1: Choose proper controller for the specific application based on system requirements
CO2: Understand various systems thoroughly and their requirements
CO3: Able to understand Static Shunt Compensation
CO4: Interpret the control circuits of Shunt Controllers SVC & STATCOM for various CO5: functions viz. Transient stability Enhancement, voltage instability prevention and power oscillation damping
CO5: Detect the Power and control circuits of Series Controllers GCSC, TSSC and TCSC and able to familiar with Self And Line Commutated Current Source Converter

UNIT-I: FACTS Concepts

Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters basic types of FACTS controllers, benefits from FACTS controllers.

UNIT-II: Voltage Source Converters

Single phase three phase full wave bridge converters transformer connections for 12 pulse 24 and48 pulse operation. Three level voltage source converter, pulse width modulation converter, basic concept of voltage source Converters, and comparison of current source converters with voltage source converters.

UNIT-III: Static Shunt Compensation

Objectives of shunt compensation, mid-point voltage regulation voltage instability prevention, improvement of transient stability, Power oscillation damping, Methods of controllable VAR generation, variable impedance type static VAR generators switching converter type VAR generators hybrid VAR generators.

UNIT-IV: SVC and STATCOM

The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation damping operating point control and summary of compensator control.

UNIT-V: Static Series Compensators

Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, and functional requirements of GTO thyristor controlled series capacitor (GSC),thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC) Control schemes for GSC TSSC and TCSC.

Self and Line Commutated Current Source Converter

Basic concepts, 3 phase full wave rectifier, thyristor based converter, basic concept of current source Converters , current sourced converter with turnoff devices, current sourced versus voltage source converter.

TEXT BOOKS:

1. Hingorani H G and Gyugyi. L " Understanding FACTS-Concepts and Technology of FlexibleAC Transmission Systems" New York, IEEE Press, 2000.
2. Padiyar.K.R, " FACTS Controllers in Power Transmission and Distribution" New Age Int. Publishers, 2007.

REFERENCES:

1. Zhang, Xiao-Ping, Rehtanz, Christian, Pal, Bikash "Flexible AC Transmission Systems: Modeling and Control", Springer, 2012.
2. Yong-Hua Song, Allan Johns, "Flexible AC Transmission Systems", IET, 1999

ADVANCED POWER SYSTEM PROTECTION

(Professional Elective – I)

Subject Code: 26MPS1E11

L	T	P	C
3	0	0	3

Course Objectives: To make the student

- To study the basic concepts and classification of relay operation.
- To understand the protection of transmission lines using distance and over current
- relays
- To understand the protection of transmission lines using Pilot Wire and Carrier
- Schemes
- To know the operation of relays for transformer protection.
- To know the operation of relays for generator protection. and to understand the protection of large motors and bus bars

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

CO1: Describe the concepts and operation of protective relays

CO2: Describe the protection of transmission lines using distance and over current Relays

CO3: Describe the protection of transmission lines using Pilot Wire and Carrier Schemes

CO4: Explore the operation of relays for transformer protection

CO5: Analyze the operation of relays for generator protection and to explain the protection of large motors and bus bars

UNIT – I

Protective Relays

Basic requirement; classification on the applications; principles of operation; over current relay, directional relay- characteristics and connections; distance relays - impedance, reactance and mho types; differential relays and percentage differential relays- voltage and current balance types; negative sequence relay.

UNIT – II

Protection of transmission lines – I (Over Current and Distance Protection)

Unit and non-unit types; time and current graded systems; setting of relays for coordination; distance protection- impedance, reactance and mho types; three zone distance protection.

UNIT – III

Protection of transmission lines – II (Pilot Wire and Carrier Scheme Protection)

Pilot wire protection using current and voltage balance; Translay system; carrier current protection.

UNIT –IV

Protection of transformers

Types of faults- faults in auxiliary equipments, winding faults, overloads and external short circuits; gas actuated devices- pressure relief device, rate of rise pressure relay, gas accumulator relay; biased differential protection for different transformer connections; earth fault protection; over current protection.

UNIT – V

Protection of generators

Types of faults- stator faults, rotor faults, abnormal running conditions; biased differential protection for different stator connections; protection against earth fault, turn to turn fault, rotor earth fault, loss of field excitation; negative phase sequence protection.

Protection of large Motors and Bus bars

Large motors protection

Earth fault Protection, thermal overload protection, differential protection, protection against Stalling, negative phase Sequence protection.

Bus bars protection

Circulating current differential protection and biased percentage differential protection.

Text Books

1. T.S. Madhava Rao, Power system Protection static relay, Tata McGrawHill Publishing Company limited, 2nd Edition, 2004.

2. Badri Ram and D.N. Vishwakarma, Power system Protection and Switchgear, Tata McGraw Hill Publication Company limited, 2nd Edition, 2013.

Reference Books

1. Bhavesh Bhalja, R. P. Maheshwari, N. G. Chothani, Protection and Switchgear, Oxford University Press, 2nd Edition, New Delhi, India, 2018.

2. Oza, B. A., N. C. Nair, R. P. Mehta, et al., Power System Protection & Switchgear, Tata McGraw Hill, New Delhi, 1st Edition, 2011.

REACTIVE POWER COMPENSATION AND MANAGEMENT

(Professional Elective – I)

Subject Code: 26MPS1E12

L	T	P	C
3	0	0	3

Course Objectives:

- To identify the necessity of reactive power compensation
- To describe load compensation
- To select various types of reactive power compensation in transmission systems
- To illustrate reactive power coordination system
- To characterize distribution side and utility side reactive power management and to identify the methods of reactive power management in traction & furnace.

Course Outcomes: After completion of the course, students will be able to:
CO1: Distinguish the importance of load compensation in symmetrical as Well as unsymmetrical loads
CO2: To understand various compensation methods in transmission lines
CO3: Student can able to construct models for reactive power coordination
CO4: Distinguish demand side reactive power management & capacitor placement
CO5: To understand the user side reactive power management techniques and to understand the methods of reactive power management in electric traction and arc furnace

UNIT-I:

Load Compensation

Objectives and specifications, Reactive power characteristics, Inductive and capacitive approximate biasing, Load compensator as a voltage regulator, Phase balancing and power factor correction of unsymmetrical loads.

UNIT-II:

Steady–State Reactive Power Compensation In transmission Systems

Uncompensated line, Types of compensation, Passive shunt and series and dynamic shunt compensation, Examples.

Transient State Reactive Power Compensation in TransmissionSystems

Characteristic time periods, Passive shunt compensation, Static compensation, Series capacitor compensation, Compensation using synchronous condenser.

UNIT-III:

Reactive Power Coordination

Objective, Mathematical modeling, Operation planning, Transmission benefits, Basic conceptsof quality of power supply, Disturbances, Steady–state variations, Effect of under-voltages, Frequency, Harmonics, Radio frequency and electromagnetic interference.

UNIT-IV:

Demand Side Management

Load patterns, Basic methods load shaping, Power tariffs, KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels.

Distribution Side Reactive Power Management

System losses, Loss reduction methods, Examples, Reactive power planning, Objectives, Economics planning capacitor placement.

UNIT-V:

User Side Reactive Power Management

KVAR requirements for domestic appliances, Purpose of using capacitors, Selection of capacitors, Types of available capacitor, Characteristics and Limitations.

Reactive Power Management in Electric Traction Systems andArc Furnaces

Typical layout of traction systems, Reactive power control requirements, Distributiontransformers, Electric arc furnaces, Basic operation, Furnaces transformer, Filter requirements, Remedial measures, Power factor of an arc furnace.

TEXT BOOKS:

1. T.J.E.Miller, “Reactive power control in Electric power systems”, John Wiley and sons, 1982.
2. D.M. Tagare,” Reactive power Management”, Tata McGraw Hill, 2004.

REFERENCES:

1. Wolfgang Hofmann, Jurgen Schlabbach, Wolfgang Just, “Reactive Power Compensation: A Practical Guide”, Wiley Publication, April2012.

HVDC TRANSMISSION

(Professional Elective – I)

Subject Code: 26MPS1E13

L	T	P	C
3	0	0	3

Course objectives:

- To understand the concept, planning of DC power transmission and comparison with AC Power transmission.
- To analyze HVDC converters.
- To study about the HVDC system control.
- To analyze harmonics and design of filters.
- To model and analysis the DC system under study state.

Course outcomes:

CO1: Understand the basics of HVDC Transmission systems, learning about advantages and disadvantages of DC with AC Transmission.
CO2: Analyze HVDC converters and characteristics of 6 and 12 pulse converters with and without overlapping.
CO3: Understand the converter control characteristics, Various controlling methods of converters
CO4: Illustrate generation of harmonics, its adverse effects and also the design of filters for harmonic elimination. Learn about Multi terminal DC systems.
CO5: Design of AC filters and to Understand Power flow analysis in AC/DC systems

UNIT-I

Introduction

DC Power transmission technology – Comparison of AC and DC transmission – Application of DC transmission – Description of DC transmission system – Planning for HVDC transmission – Modern trends in HVDC technology – DC breakers – Operating problems – HVDC transmission based on VSC – Types and applications of MTDC systems.

UNIT-II

Analysis of HVDC converters

Line commutated converter – Analysis of Graetz circuit with and without overlap – Pulse number –Choice of converter configuration – Converter bridge characteristics – Analysis ofa 12 pulse converters – Analysis of VSC topologies and firing schemes.

UNIT-III

Converter and HVDC system control

Principles of DC link control– Converter control characteristics – System control hierarchy– Firing angle control – Current and extinction angle control – Starting and stopping of DC link – Power control –Higher level controllers – Control of VSC based HVDC link.

UNIT-IV

Converter fault & protection

Converter Fault & Protection: Converter faults - protection against over current and over Voltage in converter station - surge arresters - smoothing reactors - DC breakers - Audible noise space charge field- corona effects on DC lines-Radio interference.

UNIT-V

Harmonics & filters

Harmonics & Filters: Generation of Harmonics-Characteristics harmonics, calculation of AC Harmonics, Non- Characteristics harmonics, adverse effects of harmonics - Calculation of voltage& Current harmonics - Effect of Pulse number on harmonics

Types of AC filters, Design of Single and double tuned filters–Design of High pass filters

Power flow analysis in AC/DC systems

Per unit system for DC quantities – DC system model – Inclusion of constraints – Power flow analysis – case study.

TEXTBOOKS:

1. Padiyar,K.R.,"HVDCpowertransmissionsystem",NewAgeInternational(P)Ltd.,NewDelhi, Second Edition, 2010.
2. EdwardWilsonKimbark,"DirectCurrentTransmission",Vol.I,Wileyinterscience,NewYork, London, Sydney, 1971.
3. RakoshDasBegamudre,"ExtraHighVoltageACTransmissionEngineering",NewAgeInternational (P)Ltd.,NewDelhi, 1990.

REFERENCEBOOKS:

1. KundurP.,"Power System Stability and Control",McGraw-Hill,1993.
2. Colin Adamson and HingoraniNG,"High Voltage Direct Current Power Transmission",Garraway Limited, London, 1960.
3. Arrillaga,J.,"HighVoltageDirect CurrentTransmission",PeterPregrinus,London, 1983.
4. S. Kamakshaiah,V. Kamaraju,'HVDC Transmission',Tata McGraw Hill Education Private Limited, 2011.

ADVANCED POWER ELECTRONIC CONVERTERS

(Professional Elective – II)

Subject Code: 26MPS1E21

L	T	P	C
3	0	0	3

Course Objectives:

- To understand various advanced power electronics devices.
- To describe the operation of multi level inverters with switching strategies for high power applications.
- To comprehend the design of resonant converters and switched mode power supplies.

Course Outcomes: After completion of the course, students will able to:
CO1: Identify the application various modern power semiconductor devices
CO2: Analyze and design Series resonant inverters.
CO3: Analyze and design Series resonant inverters
CO4: Develop and analyze resonant converters.
CO5: Identify different levels of multilevel inverters and related topology and to design AC or DC switched mode power supplies.

UNIT-I:

Modern Power Semiconductor Devices

Modern power semiconductor devices – Insulated Gate Bipolar Transistor (IGBT) –MOSFET-MOSTurnoffThyristor(MTO)–EmitterTurnOffThyristor(ETO)–IntegratedGate-Commutated Thyristors (IGCTs) – MOS controlled thyristors (MCTs)– Power integrated circuits(PICs)–symbol, structure and equivalent circuit–their driver circuits.

.

UNIT-II:

Series resonant inverters

Series resonant inverters–series resonant inverters with unidirectional switches – series resonant inverters with bidirectional switches – analysis of half bridge resonant inverter – evaluation of currents and voltages of a simple resonant inverter – analysis of half bridge and full bridge resonant inverter with bidirectional switches – Frequency response of series resonant inverters – for series loaded inverter – for parallel loaded inverter – For series and parallel loaded inverters –numerical problems.

UNIT-III:

Parallel Resonant Inverters

Parallel resonant inverters – Voltage control of resonant inverters –class E resonant inverter – class E resonant rectifier – evaluation of values of C's and L's for class E inverter and Class E rectifier– numerical problems.

UNIT-IV:

Resonant Converters

Resonantconverters–zerocurrentswitchingresonantconverters–LtypeZCSresonantconverter –

M type ZCS resonant converter – zero voltage switching resonant converters –comparison between ZCS and ZVS resonant converters–Two quadrant ZVS resonant converters– resonant dc-link inverters – evaluation of L and C for a zero current switching inverter –Numerical problems.

UNIT-V:

Multilevel Inverters

Multilevel concept – Classification of multilevel inverters – Diode clamped multilevel inverter – principle of operation–main features–improved diode Clamped inverter–principle of operation flying capacitors multilevel inverter-principle of operation–main features–cascaded multilevel inverter–principle of operation–main features.

D.C&A.C Power Supplies

DC power supplies – classification - switched mode dc power supplies – fly back Converter –forward converter–push-pull converter–half bridge converter–Full bridge converter–Resonant dc power supplies–bidirectional power supplies–Applications.

AC power supplies – classification – switched mode ac power supplies – Resonant AC power supplies–bidirectional ac power supplies–multistage conversions–control circuits–applications.

TEXTBOOKS:

1. MohammedH.Rashid–"PowerElectronics"–PearsonEducation-ThirdEdition–firstIndianreprint-2004.
2. NedMohan,ToreM.UndelandandWilliamP.Robbins-"PowerElectronics"–JohnWiley&Sons–SecondEdition.

REFERENCES:

1. MillimanShepherdandLizang–"Powerconverterscircuits"–Chapter14(Matrixconverter)PP-415-444,
2. M.H.Rashid-Power electronics handbook–
3. MarianP.Kaźmierkowski,RamuKrishnan,FredeBlabjergEdition:"Controlinpowerelectronics"illustratedPublishedbyAcademicPress,2002.
4. NPTELonlinecourse,"PulsewidthModulationforPowerElectronicConverters"Dr.,G.Narayanan.

ELECTRIC AND HYBRID VEHICLES

(Professional Elective – II)

Subject Code: 26MPS1E22

L	T	P	C
3	0	0	3

Course Objectives: To make the student

- Analyze the components of an EV and identify the importance of EVs in recent issues related to air pollution and Electric mobility policies in India coupled with energy costs.
- Differentiate the characteristics of series and parallel HEV.
- Develop a model of an Electric Vehicle.
- Analyze the characteristics of various electric motor drive systems for HEVs and identify a suitable motor drive system for HEVs.
- Analyze the characteristics of various energy storage systems and identify a suitable energy storage system for a Hybrid Electric Vehicle.

Course Outcomes (CO): Student will be able to

CO1: Identify the importance of EVs in present days

CO2: Analyze the performance of EVs

CO3: Identify the difficulties in modeling of an EV

CO4: Develop model of an EV by considering Tractive Effort

CO5: Develop model of an EV with its range and acceleration and to analyze the configuration and characteristics of DC motor Drives

UNIT I Electric Vehicles

Introduction, Components, vehicle mechanics – Roadway fundamentals, vehicle kinetics, Dynamics of vehicle motion - Propulsion System Design.

UNIT II Battery

Basics – Types, Parameters – Capacity, Discharge rate, State of charge, state of Discharge, Depth of Discharge, Technical characteristics, Battery pack Design, Properties of Batteries.

UNIT III DC & AC Electrical Machines

Motor and Engine rating, Requirements, DC machines, Three phase A/c machines, Induction machines, permanent magnet machines, switched reluctance machines.

UNIT IV Electric Vehicle Drive Train

Transmission configuration, Components – gears, differential, clutch, brakes regenerative braking, motor sizing.

UNIT V Hybrid Electric Vehicles

Types – series, parallel and series, parallel configuration – Design – Drive train, sizing of components.

Energy Storage

Energy Storage: 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, Hybridization of different energy storage devices.

TEXT BOOKS:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRCPress,2003.
2. Mehrdad Ehsani,Yimi Gao,Sebastian E.Gay,Ali Emadi,Modern Electric, Hybrid Electric and Fuel Cell Vehicles:Fundamentals,Theory and Design,CRC Press,2004.JamesLarminie,John Lowry, Electric Vehicle Technology Explained,Wiley,2003.

REFERENCE BOOKS:

1. Fundamentals of Hybrid and Electric Vehicles by Prof. K.C.Jain (Author), Dr.Amit R.Patil (Author), Dr. Arvind J. Bhosale (Author).
2. Solar Photo voltaic: Fundamentals, Technologies And Applications 3rd Edition, PHI Edition
by CHETAN SINGH SOLANKI

NPTEL:

https://archive.nptel.ac.in/courses/108/103/108103009/

\

MACHINE MODELLING AND ANALYSIS

(Professional Elective – II)

Subject Code: 26MPS1E23

L	T	P	C
3	0	0	3

Course Objectives:
The main objective of the course is to provide an in-depth knowledge about various fundamentals, modelling and analysis of AC & DC machines using generalized machine theory

Course Outcomes:
At the end of the course, the students will be able to:

CO1: Able to understand Principles of electromagnetic energy conversion.
CO2: Able to develop torque equation in Kron's primitive Machine and determine the dynamic model of a DC machine.
CO3: Able to understand Real time model of a two-phase induction machine
CO4: Able to Determine the dynamic model & Small signal model of three phase induction machine based on the dq_0 Transformation and which leads to understand advanced control strategies such as vector control and direct torque control of three phase induction machine.
CO5: Analyze and model the Symmetrical and Unsymmetrical Two-phase induction machine and to analyze and model the three-phase synchronous machine and special electrical machines.

UNIT I:
Principles of electromagnetic energy conversion: Magnetic circuits, permanent magnet, General expression of stored magnetic energy, co-energy– force and torque in single and doubly excited system.

UNIT II:
Basic Concepts of Modeling: Basic Two-pole Machine representation of Commutator machines, 3-phase synchronous machine with and without damper bars and 3-phase induction machine. Kron's primitive Machine-voltage, current and Torque equations.

DC Machine Modeling: Mathematical model of separately excited D.C motor – Steady State analysis-Transient State analysis- Sudden application of Inertia Load-Transfer function of Separately excited D.C Motor- Mathematical model of D.C Series motor, Shunt motor

UNIT III:
Reference Frame Theory: Real time model of a two-phase induction machine-Transformation to obtain constant matrices-Linear transformation-three phase to two phase transformation-Power equivalence.

UNIT IV:
Dynamic & Small Signal Modeling of Three phase Induction Machine:
Generalized model in arbitrary reference frame-Electromagnetic torque-Derivation of commonly used Induction machine models- Stator reference frame model-Rotor reference frame model-Synchronously rotating reference frame model-Equations in flux linkages-per unit model -Small signal equations of Induction machine.

UNIT V:
Symmetrical and Unsymmetrical Two phase Induction Machine:
Analysis of symmetrical 2 phase induction machine-voltage and torque equations for unsymmetrical 2 phase induction machine-voltage and torque equations in stationary reference

frame variables for unsymmetrical 2 phase induction machine-analysis of steady state operation of unsymmetrical 2 phase induction machine.

Modeling of Synchronous Machine:
Voltage and torque equations in machine variables, voltage equations in arbitrary reference frame, voltage equations in rotor reference frame (park's equations), Torque equation in Substitute Variables.
Modeling of Special Machines: Modeling of PM Synchronous motor, Modeling of BLDC motor, Modeling of Switched Reluctance motor.

TEXT BOOKS:
1.Electric Motor Drives - Modeling, Analysis& control -R.Krishnan- Pearson Publications-1st edition -2002
2. Generalized Theory of Electrical Machines – P.S.Bimbra-Khanna publications-5thEdition-1995
3.Electric Machinery-Charles Kingsle,Jr.,A.E. Fitzgerald, Stephen D.Umans-Tata Mcgraw Hill

REFERENCE BOOKS:

1. Analysis of Electrical Machinery and Drive systems – P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff – Second Edition-IEEE Press
2. Brushless Permanent Magnet and Reluctance Motor Drives-Miller, T.J.E.- Clarendon Press
3. Dynamic simulation of Electric machinery using Matlab / Simulink –CheeMunOng- Prentice Hall

PROGRAMMABLE LOGIC CONTROLLERS LAB

Subject Code: 26MPS1101

L	T	P	C
0	0	4	2

Course objective:
To enable the students to gain sufficient knowledge on the programmable logic controller & SCADA and their applications.

Course outcomes: Student will be able to

CO1: Develop the ladder logic diagram for Boolean logic gates.
CO2: Develop the ladder logic diagram for Boolean logic expressions.
CO3: Develop the ladder logic diagrams for timers, counters and their combinations.
CO4: Develop the ladder latching logic diagram for counters and timers.
CO5: Develop ladder logic for various practical applications using timers and to development of ladder logic for various practical applications using timers and counters.

1. Switch on light/off light for logic gates - AND, OR, NOT, NOR, NAND, XOR, XNOR by using Ladder Logic with PLC and SCADA monitoring.
2. Switch on light/off light for logic gates HALF ADDER, FULL ADDER by using Ladder Logic with PLC and SCADA monitoring.
3. Develop the ladder logic for the given Boolean logic function before and after simplification with PLC and SCADA monitoring.
4. Switch on light/off light with timers (on Delay and Off Delay) , counters (up & Down) and their combination by using Ladder logic with PLC and SCADA monitoring.
5. Switch on light/ off light with timers and switch on light/off light with counter by using Ladder latching logic with PLC and SCADA monitoring.
6. Develop small ladder logic programs for traffic signal control with PLC and SCADA monitoring.
7. Develop a ladder logic program that will flash a light once every one second with PLC and SCADA monitoring
8. Develop ladder logic with for the motor which is controlled by two switches PLC and SCADA monitoring. (using Counters only)
9. Develop ladder logic for the motor which is controlled by two switches with PLC and Scada monitoring.(using Timers and counters)
10. Develop ladder logic for microwave oven operation using PLC and SCADA monitoring.
11. Develop ladder logic for conveyor run by switching on or off a motor with PLC and SCADA monitoring.
12. To study the variable frequency drive based 3phase induction motor operation by key pad.

ELECTRICAL DRIVES LAB

Subject Code: 26MPS1102

L	T	P	C
0	0	4	2

Course Objectives:
The main objective of the course is to:
To develop, analyze fully controlled converters, choppers and their functions of all types of power electronic converter drives.

Course Outcomes:
CO1: Experiment with speed control of 3-Phase induction motor with static rotor resistance control, ac voltage controller and DSP based v/f control
CO2: Experiment with speed control DC motor with 3-Phase fully controlled converter and four quadrant chopper.
CO3: Analyze power factor correction boost converter.
CO4: Study the operation of forward and fly back converter.
CO5: Able to understand the operation of 3phase slip ring Induction motor by Static Rotor Resistance controller and able to understand the DSP based V/F Control of 3 phase Induction motor

LISTOF EXPERIMENTS:

1. Operationof3-phaseFull-Converter on R &R-L load.
2. Performance&speedcontrolofD.C.driveusing3-phasefullConverter.
3. Performance &Operation of a four quadrant Chopper on D.C. Drive.
4. Performance&Operationofa3-phase A.C. Voltage controller on motor load.
5. Single Phase IGBT based PWM Inverter on R&R-L load.
6. Operation of 3-phase IGBT based PWM Inverter on R&R-L load.
7. Performance &speed control of 3phase slip ring Induction motor by Static Rotor Resistance controller.
8. Three phase PWM Pulse generation using PIC Microcontroller.
9. PIC Microcontroller based speed control of three phase Induction Motor.
10. DSP based V/F Control of 3phase Induction motor.

ENGLISH FOR RESEARCH PAPER WRITING

Subject Code: 26MAC1001

L	T	P	C
2	0	0	0

COURSE OBJECTIVES

1. **To develop students' ability to plan and organize academic writing** by mastering word order, sentence structure, paragraph development, conciseness, and techniques for avoiding ambiguity and redundancy.
2. **To enable learners to present ideas clearly and responsibly** through skills such as clarifying agency (who did what), highlighting findings, using hedging and criticism appropriately, and avoiding plagiarism through effective paraphrasing.
3. **To train students in the structure and components of a research paper** by understanding and producing well-organized abstracts, introductions, literature reviews, methods, results, discussions, and conclusions.
4. **To enhance students' competence in writing key academic sections**—including titles, abstracts, introductions, and literature reviews—using appropriate academic style, coherence, and logical progression.
5. **To equip learners with practical skills for drafting, revising, and finalizing research papers** by applying section-specific writing strategies and conducting a thorough final check for clarity, accuracy, and academic integrity.

COURSE OUTCOMES

1. **Students will be able to plan and organize academic texts effectively** by applying correct word order, clear sentence and paragraph structure, and techniques for conciseness while avoiding ambiguity and redundancy.
2. **Students will be able to present information clearly and ethically** by clarifying agency (who did what), highlighting key findings, using appropriate hedging and criticism, and avoiding plagiarism through accurate paraphrasing.
3. **Students will be able to write and evaluate major sections of a research paper** such as literature reviews, methods, results, discussions, conclusions, and perform a final check for coherence and accuracy.
4. **Students will be able to construct effective titles, abstracts, and introductions** and develop logically organized reviews of literature using accepted academic writing conventions.
5. **Students will be able to apply section-specific writing skills** to produce well-structured methods, results, discussion, and conclusion sections that meet academic and research communication standards.

UNIT-I

Planning and preparation, Word order, Breaking up long sentences, Structuring paragraphs and sentences. Being concise and removing redundancy, Avoiding ambiguity and vagueness

UNIT-II

Clarifying who did what, Highlighting findings. Hedging and criticizing. Paraphrasing and plagiarism, Sections of a paper, Abstracts, Introduction

UNIT-III

Review of the Literature. Methods, Results, Discussion, Conclusions, Final check

UNIT-IV

Key skills needed when writing a title. An abstract, An introduction and a review of the Literature

UNIT-V

Skills needed when writing methods, Results, Discussions and Conclusion.

.

TEXT BOOKS

1. Goldbort R (2006). Writing for Science. Yale University Press.
2. Day R (2006). How to Write and Publish a Scientific Paper. Cambridge University Press.
3. Highman N (1998). Handbook of Writing for the Mathematical Sciences. SIAM. Highman's book.

DISASTER MANAGEMENT

Subject Code: 26MAC1002

L	T	P	C
2	0	0	0

Course Objectives:

The primary objectives of this course are:

1. To provide basic concepts and terminologies related to hazards and disasters.
2. To highlight the critical importance and role of disaster management in the contemporary world.
3. To enhance awareness of institutional processes, policies, and management strategies used to mitigate disaster impacts.
4. To analyze the various dimensions of vulnerability and their contribution to disasterrisk.
5. To equip knowledge regarding emergency management for manmade and technological threats.

Course Outcomes:

Upon successful completion of this course,students will be able to:

1. Define and classify different types of disasters and distinguish them from hazards.
2. Evaluate the nature of vulnerability and assess the impacts of disasters on different communities.
3. Explain the components of the Disaster Management Cycle,including mitigation, preparedness, response, and recovery.
4. Discuss the institutional frame works and legislations available for disaster risk management at national and international level.
5. Identify specific threats related to industriala ccidents and security,and understand the necessary emergency response mechanisms.

Unit 1: Introduction and Basic Concepts: Understanding Fundamental Concepts: Definitions of Hazards and Disasters. Classification: Disaster types and causes including Geophysical, Hydrological, Meteorological, Biological, Atmospheric, and Human-made. Distinguishing between natural hazards and manmade disasters

Unit 2: Dimensions of Disasters and Vulnerability: Global Trends: Analysis of global trendsindisasters.Impactanalysis:Physical,Social,Economic,Political,Environmental,and Psychosocial impacts of disasters. Understanding Vulnerability: Defining and analyzing Physical Vulnerability, Economic Vulnerability, and Social Vulnerability

Unit 3: The Disaster Management Cycle and Risk Reduction: Detailed study of the components of DM Cycle: Response and recovery, Risk assessment, Mitigation and prevention, Preparedness planning, Prediction and warning. Disaster Risk Reduction (DRR): Concepts of DRR and Community based disaster risk reduction strategies.

Unit 4: Institutional Frameworks and Initiatives: National Context: Disaster Risk ManagementinIndia;relatedpolicies,plans,programs,andlegislation.GlobalContext:

International strategies for disaster reduction and other global initiatives. Agencies: Role of agencies NIDM, NDRF.

Unit 5: Emergency Management and Emerging Threats: Technological and Industrial Disasters: Explosions, Industrial accidents, Nuclear, Transport, and Mining accidents. Environmental Emergencies: Spills (Oil and Hazardous material). Security Threats: Bomb threats, terrorist attacks, stampedes, and conflict situations.

Textbooks:

1. Sharma,S.C.,DisasterManagement,KhannaBookPublishing. Latest Edition
2. Singh,R.B.(ed.),NaturalHazardsandDisasterManagement:Vulnerability and Mitigation, Rawat Publications, New Delhi. Latest Edition
3. Modh,S.,ManagingNaturalDisaster:Hydrological,MarineandGeological Disasters, Macmillan, Delhi. Latest Edition

ReferenceBooks:

1. **Carter, N.**, Disaster Management: A Disaster Management Handbook, Asian Development Bank, Manila. Latest Edition
2. **Clements,B.W.**,DisastersandPublicHealth:PlanningandResponse,ElsevierInc. LatestEdition
3. **Dunkan, K., and Brebbia, C. A. (Eds.)**, Disaster Management and Human Health Risk: Reducing Risk, Improving Outcomes, WIT Press, UK. Latest Edition
4. **Ramkumar, Mu**,GeologicalHazards:Causes,Consequences andMethodsof Containment, New India Publishing Agency, New Delhi. Latest Edition

CONSTITUTION OF INDIA

Subject Code: 26MAC1003

L	T	P	C
2	0	0	0

COURSE OBJECTIVES

1. To provide students with a comprehensive understanding of the historical background and salient features of the Indian Constitution, including Fundamental Rights, Duties, and Directive Principles of State Policy.
2. To familiarize learners with the structure and functioning of local self-government institutions and the importance of grassroots democracy in India.
3. To develop awareness of the parliamentary system of government in India, including the roles and powers of the President, Prime Minister, Cabinet, and Judiciary.
4. To explain the nature of Indian federalism and the legislative procedures and privileges of Union and State legislatures.
5. To enable students to understand the role and functioning of constitutional and statutory bodies such as parliamentary committees, Election Commission, CAG, Finance Commission, NITI Aayog, and political parties.

COURSE OUTCOMES

1. Students will be able to **explain the origin, structure, and key features of the Indian Constitution,** including Fundamental Rights, Fundamental Duties, and Directive Principles.
2. Students will be able to **describe the organization and functions of local administration,** including Panchayati Raj Institutions and municipal bodies, and appreciate the value of participatory democracy.
3. Students will be able to **analyze the working of the parliamentary system** and the emergency provisions, and understand the relationship between the executive, legislature, and judiciary.
4. Students will be able to **interpret the principles of Indian federalism** and explain Union–State relations and the legislative process in Parliament and State Legislatures.
5. Students will be able to **evaluate the role of constitutional and non-constitutional bodies** and recognize their contribution to democratic governance and accountability in India.

UNIT-I

Introduction: Historical perspective of the constitution of India -Salient features of The Indian Constitution-Features: Fundamental Rights (Article 12 to 35), Duties (31 A-1976 emergency) and Directive principles (Article 30 to 51) of State Policy - Articles 14 to 18 Articles 19-Article 21- Amendment Procedure of The Indian Constitution: 42nd amendment (Mini Constitution)-44th amendment (1978-Janatha Govt.)

UNIT-II

Local Administration: District's administration head: Role and Importance, Municipalities Introduction, Mayer and role of elected representative, CEO of municipal corporation, Pachayati raj: Introduction, PRI: ZilaPachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of elected and appointed officials, Importance of grass root democracy.

UNIT-III

Parliamentary form of Govt. In India: President of India- Emergency provisions- National Emergency Article 352 President Rules- Article 356 Financial Emergency- Article 360 Prime Minister and Cabinet-Supreme Court of India (Indian Judiciar)

UNIT-IV

Indian Federalism: Union State relations, Legislative, Administrative and Financial relations. Lok Sabha, Rajya Sabha, Vidhan Sabha & Vidhan Parishad-Composition, Speaker, Chairman, Privileges, Legislative procedure.

UNIT-V

Parliamentary Committees: Public Accounts Committee- Estimates Committee- Committee on Public Undertakings- Election commission of India (Article -324) -Comptroller and Auditor General (CAG) of India (Article 148 to 150) Finance Commission (Article-280)-Neethi Aayog (Planning Commission) and Political Parties.

TEXT BOOKS

DD Basu-Indian Constitution
Dr. D. Surannaida - Indian Politica ISystem.
Madhav Khosla- The Indian Constitution

REFERENCES BOOKS

The Constitution of India. 1950 (Bare Act), Government Publication
M. P. Jain, Indian Constitution Law, 7th Edn, Lexis Nexis, 2014

POWER SYSTEM DYNAMICS AND STABILITY

Subject Code: 26MPS1004

L	T	P	C
4	0	0	4

Course Objectives:

- To study the model of synchronous machines.
- To study the stability studies of synchronous machines.
- To study the solution method of transient stability.
- To study the effect of different excitation systems.

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

CO1: Determine the model of synchronous machines.
CO2: Know the stability studies of synchronous machines.
CO3: Get the knowledge of solution methods of transient stability.
CO4: Get the knowledge about governor and excite action
CO5: Know the effect of different excitation systems in power systems & familiar with different excitation methods.

UNIT-I

System Dynamics: Synchronous machine model in state space from computer representation forexcitation and governor system –modeling of loads and induction machines.

UNIT-II

Steady state stability – steady state stability limit – Dynamics Stability limit – Dynamic stability analysis – State space representation of synchronous machine connected to infinite bus-time response – Stability by eigen value approach.

UNIT-III

Digital Simulation of Transient Stability: Swing equation machine equations – Representation of loads – Alternate cycle solution method – Direct method of solution – Solution Techniques: Modified Euler method – Runge Kutta method – Concept of multi machine stability.

UNIT-IV

Stability: Effect of governor action and excite on power system stability, effect of saturation, saliency & automatic voltage regulators on stability.

UNIT-V

Excitation Systems I : Rotating Self-excited Exciter with direct acting Rheostatic type voltage regulator – Rotating main and Pilot Exciters with Indirect Acting Rheostatic Type Voltage Regulator

Excitation Systems II :

Rotating Main Exciter, Rotating Amplifier and Static Voltage Regulator – Static excitation scheme – Brushless excitation system.

TEXT BOOKS :

1. Power System Stability by Kimbark Vol. I&II, III
2. Power System control and stability by Anderson and Fund

REFERENCE BOOKS :

1.Power systems stability and control by PRABHA KUNDUR
2. Computer Applications to Power Systems–Glenn.W.Stagg &Ahmed.H.El.Abiad
3.Computer Applications to Power Systems – M.A.Pai
4.Power Systems Analysis & Stability – S.S.Vadhera Khanna Publishers

ENERGY STORAGE TECHNOLOGIES

Subject Code: 26MPS1005

L	T	P	C
4	0	0	4

Course Objectives:

The objectives of this course is to acquire knowledge on

- Need of energy storage and different types of energy storage.
- Thermal, magnetic, electrical and electrochemical energy storage systems.
- Emerging needs for EES pertaining to Renewable energy
- Types of electrical energy storage systems
- Types of Batteries & Fuel cells and their applications and applications of Electrical Energy Storage

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

CO1: Identify the need of energy storage& different types of energy storage in the power systems
CO2: Classify Thermal, magnetic, electrical and electrochemical energy storage systems.
CO3: Illustrates standards of electrical energy storage systems & technical comparison of EES.
CO4: Standards of electrical energy storage systems & technical comparison of EES.
CO5: Identify the types of Batteries & Fuel cells and their applications & Illustrates the applications of Electrical Energy Storage

UNIT - I: Introduction:
Necessity of energy storage, different types of energy storage, mechanical, chemical, electrical, Electrochemical, biological, magnetic, electromagnetic, thermal, comparison of energy storage Technologies

UNIT - II: Energy Storage Systems:
Thermal Energy storage-sensible and latent heat, phase change materials, Energy and exergy analysis of thermal energy storage, Electrical Energy storage-super-capacitors, Magnetic Energy storage Superconducting systems, Mechanical-Pumped hydro, flywheels and pressurized air energy storage, Chemical-Hydrogen production and storage.

UNIT - III Needs for Electrical Energy Storage:
Emerging needs for EES, more renewable energy-less fossil fuel, Smart Grid uses - the roles of electrical energy storage technologies-the roles from the viewpoint of a utility-the roles from the viewpoint of consumers-the roles from the viewpoint of generators of renewable energy.

UNIT - IV: Types of Electrical Energy Storage systems:
Electrical storage systems, Double-layer capacitors (DLC), Superconducting magnetic energy storage (SMES), super charging stations, Thermal storage systems, Standards for EES, Technical comparison of EES technologies.

UNIT-V: Batteries & Fuel cells

Batteries-classification of batteries-difference between primary and secondary batteries- lead acid batteries - nickel cadmium batteries- lithium ion batteries- applications of batteries.

Concept of fuel cell - classification of fuel cells- working of alkaline fuel cell, phosphoric acid fuel cell, polymer electrolyte membrane fuel cell ,molten carbonate fuel cell and solid oxide fuel cell - advantages ,disadvantages and applications of fuel cells.

Design and Applications of Electrical Energy Storage:
Renewable energy storage-Battery sizing and stand-alone applications, stationary (Power Grid application), Small scale application-Portable storage systems and medical devices, Mobile storage Applications- Electric vehicles (EVs), types of EVs, future technologies, hybrid systems for energy storage.

TEXT BOOKS:

1. Energy Storage - Technologies and Applications by Ahmed FaheemZobaa, InTech
2. Fundamentals of Energy Storage by J. Jensen and B. Sorenson, Wiley-Interscalene, NewYork,
3. Energy Storage: Fundamentals, Materials and Applications, by Huggins R. A., Springer.

REFERENCE BOOKS:

1. Thermal energy storage: Systems and Applications by Dincer I. and Rosen M. A., Wileypub.
2. Energy Storage: Fundamentals, Materials and Applications, by Huggins R. A., Springer.
3. Electric & Hybrid Vehicles by G. Pistoia, Elsevier B. V.
4. Fuel cell Fundamentals by R. O' Hayre, S. Cha, W. Colella and F. B. Prinz, Wiley Pub.

ANALYSIS OF DYNAMIC SYSTEMS

Subject Code: 26MPS1006

L	T	P	C
4	0	0	4

Course Objectives:

The main objective of the course is to:

- To explain the nature of lumped parameters for dynamic system models and their impact on system transient response.
- To manipulate block diagrams and derive various transfer functions of feedback loops.
- To design simple PID controllers based of given control specifications.
- To understand data acquisition and the various parameters chosen in sampling dynamic signals.

Course Outcomes:

CO1: Ability to model electrical systems.
CO2: Ability to select operating points and computer system variables at steady-state conditions using nonlinear models.
CO3: Ability to find stability of a discrete time systems.
CO4: Ability to design controllers by different classical methods.
CO5: Ability to represent the discrete time in state space representation in advance methods & Ability to Understand Advanced state space methods

UNIT-I:

Sampling & Reconstruction: Introduction, Sampling theorem, Examples of data control systems, Digital to analog conversion and Analog to Digital conversion, sample and hold operations, spectrum analysis of sampling process, shifting and scaling operator, periodic and non periodic signals, Linear time invariant systems.

UNIT-II:

Z - Transforms: Z- transform, properties of z-transform, Inverse z-transforms, solving difference equations, pulse transfer function for linear discrete systems, block diagram and analysis of sampled-data systems, z and s–domain relationship, Jury's stability test, bilinear transformation.

UNIT-III:

Design of discrete data systems: Introduction, digital implementation of analog controllers, PID controllers, lag and lead controllers, phase lead and phase lag controllers in w-domain, design with dead- beat response.

UNITI-V:

State feedback controllers and observers: state feedback and pole placement, tracking problems, observer design, full and reduced order observer design.

UNIT-V:

State Space analysis: State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and it's properties, Methods for Computation of State Transition Matrix. Discretization of continuous time state – space equations.

Advanced state space methods: Introduction, Linear Quadratic Problem, Properties of LQR design, Kalman filter, Linear Quadratic Gaussian (LQG) problem, control.

TEXTBOOKS:

1. ControlSystemEngineering,I.J.NagrathandM.Gopal,NewAgeInternational Publishers, (3rdEdition).
2. DesignofFeedbackControlSystems,Stefane,Shahian,Savant,Hostetter,Oxford University Press, (4thEdition).

REFERENCEBOOKS:

1. Automatic Control Systems, BenjaminC.Kuo, (7thEdition).
2. Modern Control Engineering, Ogata,PrenticeHall,(3rdEdition).
3. NonlinearControlSystemAnalysisbyM.Vidyasagar,2ndedition,PH Inc,1991.

SMART GRID
(Professional Elective III)

Subject Code: 26MPS1E31

L	T	P	C
3	0	0	3

Course Objective:

To provide students with a working knowledge of fundamentals and development of Smart Grid, from the basic concepts of power systems.

Course outcomes:

After completion of course students will be able to

CO1: Understand the concept of smart grid, its need ,opportunities ,challenges.

CO2: Explain about various types of meters used in smart grid such as real time pricing, outage management system, smart sensor etc.

CO3: Explain different types substations, their automation, smart storage systems and phase measurement units.

CO4: Apply the concept of micro grid, address the issues such as interconnection, protection and control of micro grid, the different energy sources feeding the micro grid.

CO5: Analyze different types of power quality issues, power quality conditioners and power quality monitoring & to apply information and communication technology to smart grid.

UNIT-I

Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & challenges of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self- healing Grid, Present development& International policies on Smart Grid.

UNIT-II

Smart Grid Technologies: Part 1: Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading (AMR), Outage Management System (OMS), Plug-in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensor.

UNIT-III

Smart Grid Technologies: Part2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System (GIS), Intelligent Electronic Devices (IED), Smart storage like Battery, SMES, Wide Area Measurement System (WAMS), Phase Measurement Unit(PMU).

UNIT-IV

Micro grids and Distributed Energy Resources: Concept of micro grid, need & applications of micro grid, formation of micro grid, Issues of interconnection, protection & control of micro grid. Thin film solar cells, Variable speed wind generators, fuel cells, micro turbines, Integration of renewable energy sources.

UNIT-V

Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN).

TEXTBOOKS:

1. AliKeyhani,MohammadN.Marwali,MinDai"Integration of Green and Renewable Energy in Electric Power Systems", Wiley Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRCPress
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, JianzhongWu, Akihiko Yokoyama,"Smart Grid:Technology and Applications",Wiley

REFERENCEBOOKS:

1. Smart Grid, An Indian Adaptation: Fundamentals, Design, Technology, Applications, Communication and Security Kindle Editionby Uma Rao (Author), Prema V (Author), Wiley.
2. Smart Grid: Technology and Applications 1st Edition Wiley, by Janaka Ekanayake (Author), Nick Jenkins (Author), Kithsiri M. Liyanage (Author)

AI TECHNIQUES IN POWER SYSTEMS
(Professional Elective III)

Subject Code: 26MPS1E32

L	T	P	C
3	0	0	3

Course Objectives:

- To provide insight into fundamentals of Artificial Intelligence Techniques to the students
- To understand fuzzy logic, Artificial Neural Networks, Genetic Algorithms & Evolutionary Programming
- To convey application of Artificial Intelligence techniques in power system.

Course Outcomes:

After completion of the course, students will be able to:
CO1: Understand the concepts of artificial intelligence techniques.
CO2: Categorize feed forward and feedback neural networks.
CO3: Realize the concepts of Fuzzy Logic
CO4: Identify fuzzy and neural network Control Principles
CO5: Examine the concept of genetic algorithm **&** apply ANN, fuzzy logic control and GA to Electrical engineering problems

UNIT-I: Artificial Neural Networks:
Biological foundations to intelligent Systems, Artificial Neural Networks, Single layer and Multilayer Feed Forward NN, LMS and Back Propagation Algorithm, Feedback networks and Radial Basis Function Networks.

UNIT-II: ANN Paradigms:
Perceptron, Limitations of the Perceptron Model, Back propagation Algorithm with example problem, Radial Basis Function Network, Hopfield Network.

UNIT-III: Fuzzy Logic Principles:
Fuzzy Logic, Membership Functions, Operations on Fuzzy Sets, Fuzzy System, Knowledge Representation and Inference Mechanism, Defuzzification Methods. Fuzzy Neural Networks and their learning methods.

UNIT-IV: Fuzzy and Neural network Control:
Concept of Fuzzy Control, Historical Perspective, Control Principle, -Radial Basis Function Network, Kohonen's Self-Organizing Feature Map Network, System Identification using Fuzzy and Neural Network.

UNIT-V:

Genetic Algorithms:

Introduction, Fitness Function, Reproduction operators, Genetic operators, Reproduction cross over, Mutation, Introduction to evolutionary program.

Applications of AI Techniques:

Applications of above mentioned techniques to practical problems, Load flow studies, Economic load dispatch, Load frequency control, Single area system and two area system.

TEXTBOOKS:

1. J M Zurada , "An Introduction to ANN", Jaico Publishing House.
2. Simon Haykins, "Neural Networks", Prentice Hall.

REFERENCES:

1. Timothy Ross, "Fuzzy Logic with Engg.Applications", McGraw Hill.
2. Driankov, Dimitra, "An Introduction to Fuzzy Control", Narosa Publication.
3. Golding, "Genetic Algorithms", Addison-Wesley Publishing Com.

ENERGYAUDITING AND MANAGEMENT
(Professional Elective III)

Subject Code: 26MPS1E33

L	T	P	C
3	0	0	3

Course Objectives: To make the student

- To understand the current energy scenario and importance of energy conservation
- To Analyze the operating principle of energy efficient motors and power factor improvement methods.
- To acquire the knowledge about different energy efficient devices
- To measure thermal efficiency and other renewable resources.
- To design suitable energy monitoring system to analyze and optimize the energyconsumption in an electrical system.

Course Outcomes (CO): Student will be able to

CO1: Understand the current energy scenario, Role of Energy Managers and Energy Audit

CO2: Understand the operating principle of energy efficient motors and power factor improvement methods.

CO3: Acquire the knowledge about different case studies and potential energy savings

CO4: Measure efficiency and performance in various devices.

CO5: Identify the equipment and areas of a system where energy conservation andAudit is necessary & to understand Economic evaluation of energy conservation measures.

UNIT – I: ENERGY AUDIT AND DEMAND SIDE MANAGEMENT (DSM) IN POWER UTILITIES

Energy Scenario & Conservation -Demand Forecasting Techniques- Integrated Optimal Strategy for Reduction of T&D Losses - DSM Techniques and Methodologies- Loss Reduction in Primary and Secondary Distribution system and Role of Energy Managers – Energy Audit-Metering.

UNIT–II: ENERGY EFFICIENT MOTORS AND POWER FACTOR IMPROVEMENT

Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics – variable speed , variable duty cycle systems.

Power factor – Need of power factor -methods of improvement of power factor, location of capacitors.

UNIT – III: ENERGY AUDIT

Energy audit concepts - Basic elements and measurements - Mass and energy balances - Scope of energy auditing in industries - Evaluation of energy conserving opportunities and environmental management - Preparation and presentation of energy audit reports - case studies and potential energy savings.

UNIT – IV: INSTRUMENTATION

General Audit Instrumentation –Measuring building losses – Applications of IR thermo graphy – Measurement of electrical system performance – Measurement of heating, ventilation, air conditioning system performance.

UNIT – V: ENERGY CONSERVATION

Energy conservation in thermal power plants, Solar systems, Fan and Lighting Systems - Different light sources and luminous efficiency.

ECONOMIC EVALUATION OF ENERGY CONSERVATION

Energy conservation in electrical devices and systems - Economic evaluation of energy conservation measures - Electric motors and transformers - Inverters and UPS - Voltage stabilizers.

TEXTBOOKS:

1. Frank kreith and D. Yogi goswamy/ Editors, "Energy Management and conservation handbook". NewYork,2008.
2. WC Turner: Energy Management Handbook, Seventh Edition, (Fairmont Press Inc., 2007)
3. YP Abbi and Shashank Jain: Handbook on Energy Audit and Environment Management,(TERIPress, 2006)

REFERENCE BOOKS:

1. Albert Thumann, and William J. Younger, "Handbook of Energy Audits", Marcel Dekker,Inc., Newyork, 6th edition, 2003.
2. D.A.Reay, Industrial Energy Conservation-Pergamon Press, 1980.
3. T.L.Boten, LiptakB.G.,(Ed)Instrument Engineers Handbook, Chinton Book Company, 2004.
4. Hodge B.K, Analysis and Design of Energy Systems, Prentice Hall, 2002.
5. Larry C.Witte, Schmidt & Brown, Industrial energy management and utilization. Hemispherepublishing, Co.NewYork,1988.

SWITCHED MODE POWER CONVERTERS
(Professional Elective IV)

Subject Code: 26MPS1E41

L	T	P	C
3	0	0	3

Course Objectives: To make the student
- Remember and understand the concept of advanced converter topologies.
- Apply the concept of topologies for various switching regulators.
- Analyze the working and waveforms of the converters designed.
- Evaluate the operation of converters in continuous and discontinuous modes.

Course Outcomes (CO): Student will be able to

CO1: Remember and understand the concept of Buck and Boost switching regulator topologies push pull & forward converter ,voltage& current fed topologies.

CO2: Apply the concept of topologies for various switching regulators.

CO3: Analyze the concepts of half &full bridge converter topologies

CO4: Evaluate the operation of continuous and dis-continuous Fly back converter topologies

CO5: Familiar with Voltage-Fed and Current-Fed Topologies and to understands Resonant Converters

UNIT–I: FUNDAMENTAL SWITCHING REGULATORS–BUCK AND BOOST TOPOLOGIES

Buck Switching Regulator Topology: Basic Operation - Significant Current waveforms -Buck regulator efficiency-Design relations of output filter inductor and capacitor. Boost Switching Regulator Topology: Basic Operation – Quantitative relations –Discontinuous and Continuous modes-Design relations.

UNIT–II: PUSH-PULL AND FORWARD CONVERTER TOPOLOGIES

Push-PullTopology:BasicOperation–Master/slaveoutputs-Fluximbalance-Powertransformer design relations - Primary, secondary peak and RMS currents - output power and input voltage limitations - output filter design relations. Forward Converter Topology: Basic operation -Design relations - Slave output voltages -secondary load -freewheeling diode andinductorcurrents.Forwardconverterwithunequalpowerandresetwindingturns-powertransformerdesignandoutputfilterdesign.

UNIT–III: HALF AND FULL BRIDGE CONVERTER TOPOLOGIES

Half Bridge Converter Topology: Basic operation-Half bridge magnetic output filter calculations, blocking capacitor to avoid fluxed balance-Half bridge leakage inductance problems. Full Bridge Converter Topology: Basic operation-Full Bridge magnetic–output filter calculations–transformer primary blocking capacitor.

UNIT–IV: FLYBACK CONVERTER TOPOLOGIES

Discontinuous-Mode Fly backs: Basic operation - relation between output voltage versus input voltage on time output load - design relations and sequential decision requirements –fly back converter, disadvantages. Continuous Mode Fly backs: Basic operation - Discontinuous mode tocontinuousmodetransition-designrelations–continuousmodeflybacks.

UNIT–V: VOLTAGE-FED AND CURRENT-FED TOPOLOGIES

Definitions-deficiencies of voltage fed pulse width modulated full wave bridge-buck voltage fedfullwavebridgetopology–basicoperationbuckvoltagefedfullwavebridge–advantages-

Drawbacks in buck voltage fed full wave bridge-buck current fed full wave bridge topology–basic operation–fly back current fed push pull topology.

RESONANT CONVERTERS

Resonant Converters: Classification of Resonant converters-Basic resonant circuits- Series resonant circuit-parallel resonant circuits- Resonant switches. Concept of Zero voltage switching, principle of operation, analysis of M-type and L-type Buck or boost Converters. Concept of Zero current switching, principle of operation, analysis of M-type and L-type Buck or boost Converters.

TEXTBOOKS:

1. PressmanA. I,Switching Power Supply Design, McGraw-Hill, 3rdedition,2009.
2. MitchellD.M,DC-DCSwitching Regulator Analysis,McGrawHill,1stedition,1988

REFERENCEBOOKS:

1. Ned Mohan, Power Electronics,JohnWiley,3rdedition,2011.
2. Otmar Kingenstein, Switched Mode Power Supplies in Practice,JohnWiley,1st edition,1991.
3. BillingsK.H., Hand book of Switched Mode Power Supplies,McGrawHill,3rdedition,2010.
4. Nave M.J,PowerLine Filter Design for Switched-Mode Power Supplies, Mark Nave Consultants, 2ndedition,2010

POWER ELECTRONICS FOR RENEWABLE ENERGYSYSTEMS
(Professional Elective IV)

Subject Code: 26MPS1E42

L	T	P	C
3	0	0	3

Course Objectives:

- To impart knowledge on different types of renewable energy systems.
- To analyze the operation of electrical generators used for the wind energy conversionSystems.
- To know the operation of AC-DC, DC-DC and AC-AC power converters used inrenewable energy systems.
- To know the principles of standalone, grid connected and hybrid operation in renewable energy systems.
- To know the issues related to the grid and network integration of systems.

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

CO1: Demonstrate the various types of renewable energy technologies that are used toharness electrical power.

CO2: Demonstrate the operating principle and analysis of various types of Windgenerators and PV systems.

CO3: Identify a suitable converter such as AC-DC, DC-DC and AC-AC converters forrenewable energy systems.

CO4: Demonstrate and analyze the various types of wind and PV systems.

CO5: Interpret the stand alone, grid connected and hybrid renewable energy systems & Understand the issues related to the grid and network integration of systems

UNIT-I: Solar Photovoltaic Systems and MPPT Techniques

Solar cell characteristics and their measurement, PV Module, PV array, Partial shading of a solar cell and a module, The diode, Power conditioning unit, maximum power point tracker, Implementation of Perturb and Observe Method, Incremental Conductance Method.

UNIT-II: Solar PV Inverter Technologies and Applications

Centralized Inverters, String Inverters, Multi-string Inverters, Module Integrated Inverter/Micro-inverters, Inverter Topology, Model of Inverter.

Types of PV Systems: Grid-Connected Solar PV System, Stand-Alone Solar PV System.

UNIT-III: Wind Energy Conversion Systems

Introduction to wind: Characteristics, Wind Turbine, Fixed and Variable-Speed Wind Turbines, Components of WECS, Description of Components, Types of Wind Turbine Generators, Power Converter Topologies for Wind Turbine Generators.

UNIT-IV: Modeling and Control of Wind Turbine Generators

Modeling of Permanent Magnet Synchronous Generators, Doubly Fed Induction Generators, Squirrel cage Induction Generators wind turbine, Control of Power converters for WECS.

UNIT-V: Hybrid Renewable Energy Systems

Hybrid Energy Systems, Need for Hybrid Energy Systems, Range and types of Hybrid systems, Hybrid Solar PV/Wind Energy System, Architecture of Solar-Wind Hybrid System.

Network Integration Issues

Overview of grid code technical requirements. LVRT and Fault ride-through capability for wind farms - real and reactive power regulation, voltage and frequency operating limits. Power quality issues.

TEXTBOOKS:

1. "Solar Photovoltaic: "Fundamentals, Technologies and Application" Chetan Singh Solanki.,
2. PHI Learning Pvt., Ltd., 1st Edition, 2009. S. N. Bhadra, D.Kastha, S.Banerjee, "Wind Electrical Systems", Oxford University Press,2005.

REFERENCE BOOKS:

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press,2009.
2. Rashid .M. H, "Power Electronics Hand book", Academic Press, 2001.
3. Rai. G.D, "Non-conventional energy sources", Khanna Publishers, 1993.
4. Rai. G.D," Solar energy utilization", Khanna Publishes, 1993.
5. Gray, L. Johnson, "Wind energy system", Prentice Hall of India, 1995.
6. B.H.Khan "Non-conventional Energy sources", Mc Graw-hill, 2nd Edition, 2009
7. "Grid integration of wind energy conversion systems", H. Siegfried and R. Waddington, John Wiley and Sons Ltd., 2nd Edition, 2006.

IoT APPLICATIONS TO ELECTRICAL ENGINEERING
(Professional Elective IV)

Subject Code: 26MPS1E43

L	T	P	C
3	0	0	3

Course Objectives: On completion of the course the learner will be able to;

- Understand IoT and its design requirements
- Select appropriate Sensors and Actuators for desired application
- Compare various technologies and protocols
- Understand IoT applications in different domains
- Actuators, Microcontrollers and Cloud

Course Outcomes:
CO1. EXPLAIN the Applications/Devices, Protocols and Communication Models of IoT
CO2. DEMONSTARTE small Mechanical Engineering IoT oriented applications using Sensors, Actuators, Microcontrollers and Cloud
CO3. SELECT commonly used IoT Simulation Hardware platforms
CO4. APPLICATION of Interfacing and Communication Technologies for IoT
CO5. ILLUSTRATE IoT Application Development and Security of IoT Ecosystem & EVALUATE Present and Future Domain specific Applications of IoT Ecosystem

Unit I: Introduction to Internet of Things: IoT: Definition and importance, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Three-layer and Five-layermodel of IoT.

Unit II : Sensors-I: Introduction, Sensors, Sensor Characteristics, Sensorial Deviations, Sensing Types, Scalar sensing, Multimedia sensing, Hybrid sensing, Virtual sensing, Sensing Considerations. Actuators, Actuator Types, Hydraulic actuators, Pneumatic actuators, Electric actuators, Thermal or magnetic actuators, Mechanical actuators, Soft actuators, Actuator Characteristics.

Unit III: Sensors-II: Sensor Technology, Mobile Phone Based Sensors, Medical Sensors, Neural Sensors, Environmental and Chemical Sensors, Radiofrequency Identification, Actuators, IoT Challenges: Design challenges, Development challenges, Privacy and Security challenges, Data Management and Other challenges

Unit IV: IoT Communication network: Architecture of IoT, Communication network: Home Area Network (HAN), Neighborhood Area Network (NAN), Field Area Network (FAN), Wide Area Network (WAN), Wireless Sensor Networks (WSNs)

Unit V: IoT Protocols: IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRa WAN,

Application of IoT: Smart Homes: Smart Appliances, Security and Safety. Smart Energy: Smart Meters, Automatic Meter Reading (AMR), Advanced Metering Infrastructure (AMI), Real-time Pricing, Smart grid, Smart Cities: Smart Vehicles, Smart Lighting, Smart Parking etc.

TEXTBOOKS:

1. Internet of Things by Rajkamal, Tata McGraw Hill publication
2. Internet of things (A-Hand-on-Approach) By Vijay Madisetti and ArshdeepBahga1st Edition,Universal Press

REFERENCE BOOKS:

1. The Internet of Things: Connecting Objects by HakimaChaouchi Wiley publication
2. The Internet of Things – Key applications and Protocols By Olivier Hersent, David Boswarthick, Omar Elloumi,, Wiley, 2012

POWER ELECTRONIC CIRCUITS SIMULATION LAB

Subject Code: 26MPS1103

L	T	P	C
0	0	4	2

Course Objectives:

The main objective of the course is to:

- To develop, analyze and experience with principle and working of thyristors, functions of all types of power electronic converter drives.

Course Outcomes:

CO1. Demonstrateproficiencyintheuseofhigh-performanceengineeringmodelingand analysis software(MATLAB and SIMULINK)for control system analysis and design in this course and for subsequent engineering practice.

CO2: Identify the application of various power semiconductor devices in electrical engineering.

CO3: Developthesimulationofpowerelectronicscircuitswithdifferentloads.

CO4: Develop the simulation of different converters with PWM techniques.

CO5: Develop the simulation of different inverters with PWM techniques.& Observe several concepts and procedures learned in electrical system modeling and analysis and also electrical machines.

LISTOFEXPERIMENTS:

Any 10 of the following experiments are to be conducted

1. Switching characteristics of Thyristors, MOSFET and IGBT.
2. Simulation of Single phase full converter using RL load with and without LC Filter.
3. Simulation of Single phase full converter using RL&E load with and without freewheeling diode.
4. Simulation of Three phase full converter using RL&E Loads.
5. Simulation of single phase AC Voltage controller with PWM control for RL load.
6. Simulation of three phase AC Voltage controller using RL load.
7. Simulation of single phase inverter with sinusoidal PWM control for R-load
8. Simulation of Three phase inverter with Sinusoidal PWM control for R-Load.
9. Study of performance of 3-phase to 5-phase induction motor using matrix converter.
10. Simulation of dc-dc Boost converter.
11. DC motor with controlled ac rectification
12. Volts/Hz closed-loop speed control of an induction motor drive.
13. Open-loop Volts/Hz control of asynchronous motor drive.
14. Speed control of a permanent magnet synchronous motor.
15. Single phase IGBT based fully controlled rectifier with PWM control.
16. Three phase IGBT based ac voltage controller with PWM control.
17. Study on the design of PI controllers and stability analysis for a DC-DC buck Converter.
18. Study of performance of 3-phase to 6-phase induction motor using matrix converter

RESEARCH METHODOLOGY AND IPR

Subject Code: 26MCC1001

L	T	P	C
2	0	0	2

COURSE OBJECTIVES

1. Formulateresearchproblemswithclarityanddevelopstronganalyticalskills.
2. Applystructured research methodology, literature review techniques, and ethical practices to academic work.
3. Interpretresearchdataeffectivelyandmasterthemechanicsoftechnicalreport writing.
4. Gaina comprehensive understanding of Intellectual Property Rights (IPR) and the legalities of the patenting process.
5. Understandthe global landscape of patent rights, technologytransfer, and emergingtrends in IP.

COURSE OUTCOMES

CO 1 Summarizethefundamentalconcepts,types,andsystematicprocessesofscientific research.

CO 2 Formulateawell-definedresearchproblembyapplyingsystematicselection techniques

CO 3 Constructacomprehensiveliteraturereviewandtheoreticalframeworkwhile maintaininghighethicalstandards.

CO 4 Executedatainterpretationandproducehigh-qualitytechnicalreportsandoral presentations.

CO 5 NavigatethelegalitiesofIntellectualPropertyRights,includingpatentfiling, licensing,and emergingIPtrends.

UNIT-I:IntroductiontoResearch Methodology

Meaning, objectives, and motivation in research. **Research Taxonomy:** Types of research (Descriptive vs. Analytical, Applied vs. Fundamental, and Quantitative vs. Qualitative).

Methodology: Researchapproaches,significanceofresearch,andthedistinctionbetweenResearchMethodsvs. Methodology.**ScientificRigor:** Researchandthescientific method;Importanceofunderstandingtheresearch processfrominceptiontocompletion.

UNIT-II:DefiningtheResearchProblem

Quality Standards: Criteria of good research; Common problems encountered byresearchers in India. **Problem Formulation:**The art of defining the research problem; Necessityandimportanceofawell-definedproblem.**Techniques:**Step-by-stepprocessof

identifyingandselectingaresearchproblem.**Application:**Practicalillustrationsandthe logic of narrowing down a broad area into a researchable topic.

UNIT-III:LiteratureReviewandResearch Ethics
Strategic Review: Place of literature review in research; Bringing clarity and focus to the problem; improving methodology and broadening knowledge base. **Execution:**Searching existingliterature,reviewingselectedliterature,andcontextualizingfindings.

Frameworks: Developingtheoreticalandconceptualframeworksforthe study.**Integrity:**Writingaboutheliteraturereviewed; **AnalysisofPlagiarism** and adherence to **Research Ethics**.

UNIT-IV:InterpretationandReport Writing
Data Synthesis: Meaning and techniques of interpretation; Precautions to take during data interpretation. **Technical Communication:**Significance of report writing; Different stepsand layout of a formal research report.

Formatting & Mechanics: Types of reports, oral presentation skills, and the mechanics of writing a research report. **QualityControl:**Precautions for writing effective and accurate research reports.

UNIT-V:NatureofIntellectualPropertyandPatenting
IP Fundamentals: Nature of Intellectual Property: Patents, Designs, Trademarks, and Copyrights. **The Patent Lifecycle:** From technological research and innovation to development; Procedure for grant of patents.
Global Framework: International cooperation on IP; Patenting under the**Patent Cooperation Treaty (PCT)**. **Rights & Trends:**Scope of patent rights; Licensing and transfer of technology; Patent databases. **Emerging Areas:** Geographical Indications (GI), Traditional knowledge case studies.

TEXT BOOKS

1. Kothari,C.R(1990).Researchmethodology,2nd edition,NewAgeInternationalPublishers.
2. Kothari,C.R.,&Garg,G.(2024).Researchmethodology:Methodsandtechniques(5thed.). New Age International Publishers.
3. Ramappa,T.(2021).IntellectualpropertyrightsunderWTO(3rded.).S.Chand Publishing.

REFERENCE BOOKS

1. Chawla, D., &Sondhi,N. (2016). *Researchmethodology:Conceptsand cases*(2nded.). VikasPublishing House.
2. Cornish, W., Llewelyn, D., & Aplin, J. (2025). *Intellectual property: Patents, copyright, trademarksandalliedrights*(10thSouthAsianed.).Sweet&Maxwell.AvailableatBharatLaw House.
3. ControllerGeneralofPatents,DesignsandTradeMarks.(2024).*Manualofpatentpractice and procedure*. IP India Official Website.
4. WorldIntellectualPropertyOrganization.(2024).PCT–TheInternationalPatent System. WIPO..