Semester I

Sr No	Course Code	Course Title	TOTAL Hours			Credits	Maximum Marks		Total	Minimum Passing Marks	No. of Hrs. for ESE
			L	T	P		Continual Assessment	End Sem Examination			
1	25PE101T	E-Drive System, Design and Control Strategy for Electric Vehicles	4	-	0	4	40	60	100	50	3
2	25PE102T	Industrial Power System Analysis with AI Applications	4	-	0	4	40	60	100	50	3
3	25PE102P	Industrial Power System Analysis with AI Applications Lab	0	-	2	1	25	25	50	25	-
4	25PE103T	Program Elective–I	4	-	0	4	40	60	100	50	3
5	25PE104T	Program Elective-II	4	-	0	4	40	60	100	50	3
6	25PE105P	Technical Seminar-I & Research Paper Writing	-	-	6	3	100	-	100	50	-
7	25PE106P	Mini Project	-	-	6	3	100	-	100	50	-
Total			16	-	14	23	385	265	650	-	-

Program Elective-I	
25PE103T (i)	Microcontroller-Based Embedded Systems for Electric Vehicles
25PE103T (ii)	Power Quality
Program Elective-II	
25PE104T (i)	Substation Engineering - Design & Digital Concepts
25PE104T (ii)	Energy Storage Technologies

FIRST SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25PE101T	E-Drive System, Design and Control Strategy for Electric Vehicles	4	-	-	4	40	60	100

Course Objectives	Course Outcomes
1. This course aims to provide participants with the technical knowledge and practical skills needed to design and control e-drive systems for electric vehicles. 2. The goal is to enable learners to implement and optimize advanced control strategies for efficient EV performance.	**Students will be able to** 1. **Analyze** and Design traction motors and power converters for electric vehicles, understanding their performance characteristics and applications through simulation and real-world case studies. 2. **Implement** Space Vector Pulse Width Modulation (SVPWM) techniques in motor control systems, comparing its performance with traditional PWM methods through practical simulation exercises and case studies. 3. **Apply** advanced control strategies such as Field Oriented Control (FOC) and Direct Torque Control (DTC) to enhance EV performance, developing and testing simulation models for both strategies. 4. **Optimize** electric vehicle systems focusing on efficiency, performance, cost, and reliability, utilizing energy management and thermal management strategies through simulation-based optimization exercises. 5. **Integrate** hardware and software components for efficient EV operation, addressing challenges in systems integration, embedded systems, and charging infrastructure, supported by hands-on integration projects and exploration of future trends in EV technology.

Unit I **[12 Hrs]**

Traction Motors and Power Converters

Introduction to Traction Motors - Types of traction motors: AC induction, Permanent Magnet Synchronous Motors (PMSM), Brushless DC Motors (BLDC), Performance characteristics and applications in EVs - Power Converters for EVs - DC-DC converters, DC-AC inverters, and AC-DC rectifiers, Design considerations and efficiency optimization - Motor Control Techniques - Basics of motor control for traction applications, Integration of power converters with traction motors - Simulation and Modeling.

Unit II **[12 Hrs]**

Space Vector Pulse Width Modulation (SVPWM)

Fundamentals of SVPWM - Basic principles and mathematical background, Benefits of SVPWM over traditional PWM techniques - SVPWM Implementation - Analyzing the impact on motor performance and efficiency - Simulation Exercises - Hands-on projects to simulate SVPWM in traction motor control, Using MATLAB/Simulink and other tools for implementation - Case Studies.

Unit III **[12 Hrs]**

Field Oriented Control (FOC) and Direct Torque Control (DTC)

Introduction to Advanced Control Strategies - Overview of FOC and DTC, Importance in enhancing EV performance - Field Oriented Control (FOC) - Principles and mathematical foundations, Implementation techniques for high-performance motor control - Direct Torque Control (DTC) - Developing simulation models for FOC and DTC, Hands-on exercises to test and compare both strategies - Case Studies.

Unit IV **[12 Hrs]**

System Optimization Techniques

Optimization in EV Systems - Key areas for optimization: efficiency, performance, cost, and reliability, multi-objective optimization approaches - Energy Management Systems (EMS) - Tools and methodologies for system-level optimization, Practical exercises using simulation software - Case Studies.

Unit V **[12 Hrs]**

Integration of Hardware and Software for EV Operation

Systems Integration in EVs - Challenges and solutions for integrating hardware and software, Importance of communication protocols (CAN, LIN, FlexRay) - Embedded Systems for EVs - Role of embedded controllers and ECUs- Practical Integration Projects - Hands-on projects to integrate various EV systems, Testing and validation of integrated systems - Future Trends and Innovations - Emerging technologies in EV integration-The role of AI and machine learning in EV systems

Text Books

S. N.	Title	Authors	Edition	Publisher
1	Electric Vehicle Technology Explained	James Larminie, John Lowry		Wiley, 2003
2	Electric and Hybrid Vehicles: Design Fundamentals	Iqbal Hussein		CRC Press, 2003
3	"Electric Vehicle Systems Architecture and Standardization Needs"	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi		CRC Press, 2004
4	"Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional Hybrids"	Jia-Sheng Zhang and David Xu		CRC Press, 2004
5	"Advanced Electric Drive Vehicles"	Ali Emadi		CRC Press, 2004

FIRST SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25PE102T	Industrial Power System Analysis with AI Applications	4	-	-	4	40	60	100

Course Objectives	Course Outcomes
This course is intended	**Students will be able to**
1. To facilitate students to learn the advantages, challenges, history and evolution of power system, types of electrical grids and its control Hierarchy.	1. Explain the structure, components, and modelling of modern power systems, including the application of per-unit system and AI/ML techniques for system analysis.
2. To learn about various power system components and single line representation of power system and to model power system networks based on per unit calculations.	2. Apply numerical and computational methods for load flow analysis using Gauss-Seidel, Fast Decoupled, and DC load flow methods, and demonstrate AI-based approaches for high-dimensional power networks.
3. To perform and analyze load flow iterative techniques for load flow solutions, study the behavior of the power systems under steady state and transient conditions.	3. Analyse symmetrical and unsymmetrical faults in power systems using sequence networks, short circuit studies, and software tools (ETAP), along with AI-based fault detection and diagnosis techniques.
4. To learn modelling, analysis of rotor angle stability and Voltage stability studies on single & multimachine infinite bus system. Study the types of stability enhancement methods in power systems.	**4.** Model synchronous machines and evaluate rotor angle stability, steady-state, transient, and voltage stability using analytical, numerical, and simulation methods (PSCAD/ETAP), including AI-based stability assessment.
5. To introduce learners to AI-driven approaches for solving power system challenges, including load flow analysis, fault detection, and stability assessment, enhancing grid efficiency and reliability.	5. Evaluate and apply methods of stability enhancement in single and multi-machine power systems, incorporating advanced modelling, simulation, and AI-based decision-making techniques.

Unit	Hours
Unit I :- Power System Structure and Modeling	**[12 Hrs]**
Structure and Nature of power system: Major areas of Power System Analysis, History, Evolution and Challenges faced by Indian Power sector, Electrical Grid System, Advantages, problems, Hierarchy of Grid operations and Total Installed Capacity of Indian Power Sector, Types of electrical grid interconnections, Basic components of power system or Constituents of a present-day power system, Structure of electric power system, Analogy of Real power, Reactive power, and Apparent power. Per unit system and Modelling of Power System: Merits and Demerits of per unit calculation, Single phase System, Three Phase System-Balanced star & delta connected load, Equivalent Circuits of components of power systems -Generator, synchronous motor, and Induction Motor, Two and Three Winding Transformer, transmission line, steps for constructing per unit impedance & reactance diagram with numerical examples. Introduction to Artificial Intelligence (AI) and Machine Learning (ML) techniques	
Unit II :- Load flow solution for power system network	**[12 Hrs]**
Formation of Bus Admittance and Bus Impedance: Network Models -Transmission lines & Transformer on nominal ration, Network off nominal transformer tap settings, Primitive impedance and admittance networks equations & numerical problems, Formation of impedance& admittance Bus by inspection matrix method & numerical problems, Sparsity in admittance bus Matrix, ETAP program for admittance bus and impedance bus Matrix, Formation of Bus using Graph Theory & numerical example Load flow solution for power system network: Variables and classification of buses, Formulation of load flow equations, Iterative procedure for Gauss seidel method -Derivation-Algorithm & numerical problems, Significance of acceleration factor and its value, Bus mismatches and convergence criteria, Development of Algorithm using Fast decoupled load flow, Flow Chart for Fast Decoupled Load flow & numerical solutions with simulation, Development of Direct current load flow solution for reference system, Power flow modelling of wind generation, Formulation of Three Phase Alternating Current- Direct Current Load Flow problem. AI Applications: AI Based Load Flow Analysis for High Dimensional Power Networks.	
Unit III :- Symmetrical& Unsymmetrical load /Balanced fault analysis/Short Circuit Studies	**[10 Hrs]**
Symmetrical/Balanced fault analysis/Short Circuit Studies: Analysis of three phase faults in power system - unloaded synchronous machine, Reactor control of short circuit currents, Three phase sequence impedances and sequence networks (Synchronous Machines), Computations of Short circuit capacity, Computations of short circuit ratio of a circuit breaker and fuse selection. Unsymmetrical faults/Asymmetrical fault Analysis: Three phase sequence impedances and sequence networks for transformers and loads, Analysis of Single line to ground fault Conditions, Line-to-line fault Conditions, Double line to ground Conditions, Fault Analysis for realistic Power System Model &numerical problems with industrial software ETAP simulation, Series Faults or open circuit faults &numerical problems. AI Applications: Fault Detection and Fault Diagnosis in Power System using AI techniques	
Unit IV :- Power System component modelling and stability analysis	**[16 Hrs]**
Synchronous machine modelling: Three damper winding model, Transformations and scaling, Single machine magnetic Circuit, Constant flux linkage model - Classical model, Classical modelling –including the effects of sub transients' circuits, Terminal constraints. Rotor angle power system stability analysis: Time frame for basic power system dynamic phenomena, Dynamics of synchronous machine rotor, Swing equation and analysis of first order differential equation for Single machine infinite bus system - (Simple system), Power angle equation, Power angle curve, Steady state stability of Synchronous machine, Transient Stability on single machine infinite bus system Simulation with PSCAD, Equal area criterion - transient stability-two machine system, Transient. Stability analysis for a sudden change in mechanical input to generator, Calculation of critical clearing time and angle for transient stability and its limitations, Equal area criterion for sudden increase in power input, Sudden decrease in power output due to three phase faults, Equal area criterion application of Sudden short circuit on one parallel lines a) one end of line b) middle of the line, Direct methods based on Lyapunov's theory both linear and non-linear method, Integration methods for transient stability Assessment, Techniques for improving steady state Stability limit, Techniques for improving Transient Stability, Problem solving using PSCAD.AI Applications: AI Based Quick Assessment of Rotor Angle Stability for Multimachine Power Systems. Voltage stability Analysis: Basic concepts related to voltage stability, Types of voltage stability, effects of instability, Voltage collapse, Short & Long-term voltage stability, Time frame-based voltage stability analysis, Effect of load on voltage stability with ETAP simulation, Analysis of voltage stability for simple Systems, Modelling requirements, Simplified Voltage Stability Criterion, Static & Sensitivity Analysis, Dynamic Analysis-Load build up, Network outages, Dynamic Analysis of asynchronous operation, phenomena inside the composite load, Transient Voltage stability Assessment using Real power - Voltage curve and Voltage-reactive power load Curves, Prevention of voltage collapse-system design measures, Prevention of voltage collapse-system operating measures, Simulation with ETAP	
Unit V :- Methods of stability enhancement	**[10 Hrs]**
Definition of Multi machine infinite bus system and representation, Differential Algebraic Equations, synchronously rotating reference frame, Network and Resistance and inductance load Constraints, Elimination of stator / Network Transients, Multi machine two axis model, Multi machine flux decay model, Multi Machine Classical Model, Short comings of classical model, Power System Representation for multi machine for Transient Stability Analysis.	

Text Books

S. N.	Title	Authors	Edition	Publisher
1	Modern Power System Analysis	I. J. Nagrath and Kothari	Fourth	Tata McGraw Hill
2	Electrical Power System	C. L. Wadhwa	Eighth	New Age International
3	Power System Analysis	John J Grainger & William D Stevenson	Third	Tata McGraw Hill

FIRST SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25PE102P	Industrial Power System Analysis with AI Applications	0	-	2	1	25	25	50

Course Objectives	Course Outcomes
This course is intended 1. To introduce learners to AI-driven approaches for solving power system challenges such as load flow analysis, fault detection, and stability assessment 2. To apply programming and simulation knowledge to solve and design programs for applications related to electrical engineering	**Students will be able to** 1. To analyse MATLAB, PSIM and LABVIEW Software toolboxes for applications in Power System 2. To develop and design programs in MATLAB Simulink 3. To evaluate power system models in MATLAB, PSIM and LABVIEW Software

Expt. No. (Any 08)	Title of the experiment (Any 08)
1	To design and develop power system protection using Artificial Intelligence in MATLAB Simulink
2	To design load frequency control in MATLAB Simulink
3	To design three phase full wave control rectifier using PSIM Software
4	To design Buck Boost Converter using PSIM Software
5	To design a fault detection model using optimization in MATLAB Simulink
6	To design renewable energy generation system in MATLAB Simulink
7	To study fault scenario simulation in feeder using Virtual Lab IIT Bombay
8	To develop power system protection using LABVIEW Software
9	To perform MATLAB simulation for analyzing Electrical Power System

Text Books

S. N.	Title	Authors	Edition	Publisher
1	Getting started with MATLAB	Rudra Pratap	2	Oxford
2	MATLAB and Simulink	Agam Tyagi	1	Oxford

Reference Books

S. N.	Title	Authors	Edition	Publisher
1	MATLAB for Engineers	William J Palm	1	Tata Mcgraw Hill

FIRST SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
25PE103T (i)	PE-I Microcontroller-Based Embedded Systems for Electric Vehicles	4	-	0	4	CA	ESE	Total
						40	60	100

Course Objectives	Course Outcomes
The course aims to: 1. Provide a comprehensive understanding of embedded systems, microcontrollers, and their applications in electric vehicle (EV) technology. 2. Develop programming proficiency in Embedded C and MicroPython for sensor integration and control applications. 3. Enable students to design and analyze embedded control systems for EV powertrain and Battery Management Systems (BMS). 4. Introduce automotive communication protocols such as CAN, LIN, FlexRay, and Ethernet used in EVs. 5. Expose learners to advanced embedded applications in ADAS, AUTOSAR, and Software Defined Vehicles (SDV) for next-generation automotive systems.	**This course aims to** 1. Provide a foundational understanding of embedded systems and their role in electric vehicles 2. Equip learners with practical skills in sensor integration using Embedded C and Micro Python. 3. Explore embedded system control for powertrain, BMS, charging infrastructure, and ADAS. 4. Understand automotive networking protocols, AUTOSAR architecture, and software-defined vehicle ecosystems.

Unit I: Foundations of Embedded Systems & Cyber-Physical Systems in EVs **[12 Hrs]**

Cyber-Physical Systems: Overview and Architecture, Evolution of Embedded Processors; From Sand to Chip, Structural Units and Embedded Memory Systems, Sensors and Actuators, Serial and Wireless Communication in CPS, Cybersecurity and Cloud-Edge Computing in CPS, Basics of Mechatronics and Automotive Embedded System Architecture, Embedded ECUs, Sensor Integration, and Control Fundamentals

Unit II: Sensor Integration and Programming with Embedded C & Micro Python **[12 Hrs]**

STM32F103 Architecture, STM Cube IDE Setup, Sensor Integration using Embedded C, Humidity, Temperature, Ultrasonic, Hall Effect, Sound, Current, Voltage, Tilt, Touch Sensors. Raspberry Pi Pico and Thonny IDE, Micro Python-based Interfacing: LED, Traffic Light, PIR, LCD (I2C), ADC-OLED, Dot Matrix (SPI), Bluetooth-Relay, Project: Real-time Data Acquisition using Microcontrollers

Unit III:Embedded Applications in Powertrain and BMS **[12 Hrs]**

Embedded Systems in Electric Powertrain, BLDC, PMSM, ACIM, SRM Motor Control, Motor Inverter Control and Vector Control Techniques, Embedded BMS Applications, Battery Chemistry, BMS Functions, SOC/SOH Estimation, Wired and Wireless BMS Design, MATLAB Simulation of BMS, Mini EV Prototype: Motor Control using Arduino Nano.

Unit IV:Automotive Communication and Charging System Integration **[12 Hrs]**

Introduction to Automotive Networking, Protocols: CAN, LIN, Flex Ray, Automotive Ethernet, V2X Communication and Security in Automotive Networks, Demo: CAN Protocol Interface using STM32F407, Embedded Systems in Charging Infrastructure, DC, Wireless Charging Systems, Charging Standards: CHAdeMO, CCS, EVSE Level 2, DC Fast Charger, Wireless Charging, MATLAB Simulation of EV Charging.

Unit V:Advanced Embedded Applications in ADAS, AUTOSAR & SDV **[12 Hrs]**

ADAS Overview: Sensors, Architectures, ML/DL-based Processing, Embedded Hardware and Software in ADAS. AUTOSAR Fundamentals: Layered Architecture, BSW, ASW, Ports, RTE, Methodology, Software Defined Vehicles (SDV), SDV OS, Enabling Technologies, E/E Architecture, Digital Twins, Software-defined Networking and Automotive Computer Hierarchies.

Text Books

S. N.	Title	Authors	Edition	Publisher
1	Electric Vehicle Technology Explained	James Larminie and John Lowry	2	Wiley / John Wiley & Sons
2	Electric and Hybrid Vehicles: Design Fundamentals	Iqbal Husain	3	CRC Press
3	Electric Vehicle Systems Architecture and Standardization Needs	Muhammad Ehsani, Mehrdad Ehsani, and Ali Emadi	1	Springer
4	Advanced Electric Drive Vehicles	Ali Emadi	1	CRC Press / Taylor & Francis

Reference Books

S. N.	Title	Authors	Edition	Publisher
1	Embedded Systems: Real-Time Interfacing to Arm Cortex-M Microcontrollers"	Jonathan W. Valvano	4	Self-published / via author's site
2	Electric and Hybrid Vehicles: Technologies, Modeling and Control - A Mechatronic Approach"	Amir Khajepour, M. Saber Fallah, and Avesta Goodarzi	1	John Wiley & Sons
3	Automotive Embedded Systems Handbook	Nicolas Navet and Francoise Simonot-Lion	1	CRC Press / Taylor & Francis (via Routledge)

FIRST SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25PE103T(ii)	PE-I Power Quality	4	--	--	4	40	60	100

Course Objectives	Course Outcomes
This course is intended to 1. To introduce various power quality events. 2. To introduce indices used for the analysis of power quality events. 3. To introduce mitigation techniques for the improvement of power quality. 4. To introduce the application of switching controller for power quality improvement.	A student who successfully fulfil the course requirements will be able to 1. Identify the various power quality events like short and long duration variations, Waveform distortion, Unbalance, Transients, Power factor etc. 2. Analyze the power quality issues using the power quality indices. 3. Suggest suitable mitigation strategies for some of the power quality issues. 4. Provide solution for the mitigation of power quality issues like waveform distortion, unbalance and poor power factor.

Unit I	[12 Hrs]
Origin of power quality variation & events, power quality indices, causes and effects of power quality disturbances, Characterization of power quality events & event classification.	
Unit II	**[12 Hrs]**
Power quality measuring instruments, Analysis of Power outages, unbalance, distortions, voltage sag, flickers & load balancing.	
Unit III	**[12 Hrs]**
Reactive Power Compensation under non sinusoidal conditions, Effect of Harmonics on Transformers, Power quality problems created by drives and its impact on drives.	
Unit IV	**[12 Hrs]**
Power factor improvement techniques, Passive Compensation, Harmonic Filters, DSTATCOM, DVR and UPQC: Structure & control of power converters.	
Unit V	**[12 Hrs]**
Load compensation using DSTATCOM, Generation of reference currents, DVR/UPQC structures & control.	

Text Books

S. N.	Title	Authors	Edition	Publisher
1	Power Quality Enhancement using Custom Power Devices	Ghosh A., Ledwich G., Kluwer	-	Academic publication
2	Power Quality	C. Sankaran	-	CRC Press

Reference Books

S. N.	Title	Authors	Edition	Publisher
1	Understanding Power Quality Problems Voltage Sags and Interruptions	Bollen Math H. J	-	IEEE Press
2	Power Quality in Power Systems and Electrical Machines	Fuchs E. F., Masoum Mohammad A. S.	-	Elsevier Press

FIRST SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25PE104T (i)	PE– II Substation Engineering - Design & Digital Concepts	4	-	-	4	40	60	100

Course Objectives	Course Outcomes
This course is intended to - 1. Explain the concepts behind substation engineering and design. 2. Demonstrate how to prepare and read SLD for substation. 3. Demonstrate how to size and select LV and HV equipment's for power distribution, protection and switchgear. 4. Formulate and analyze erection key diagram, layout preparation and necessary sectional clearance in substation installation. 5. Assess multi-disciplinary approach in substation erection.	**Students will be able to –** 1. Restate the key concepts of design, construction, operation and maintenance of electrical substations. 2. Develop design calculations in substation engineering such as earth-mat, lightning protection, earthing, lighting, and cable sizing. 3. Develop design calculations for sizing power transformers, diesel generator. 4. Select LV and HV equipment in substation for power distribution, protection, and switchgear. 5. Illustrate relay coordination and earth mat sizing using ETAP software with real time.

Unit I **[12 Hrs]**

Substation Basics: Substation Introduction and Classifications, Busbar Types in Outdoor Switchyard, Outdoor /Indoor Substation - Auxiliary Equipment in a Substation, Standards and Practices, Factors Influencing Substation Design -Different factors like Altitude, Ambient Temperature etc. with animation, Selection of Dielectric Strength for Electrical Equipment with animation on creepage distance, Testing of Electrical Equipment, Concepts of Single Line Diagram. **Case Study:** Equipment and Accessories with actual sample site videos

Unit II **[12 Hrs]**

Transformers and Switchgears: Classification of Transformers with a practical overview, Transformer Percentage Impedance and Losses, Construction including busbar arrangement and safety features, Classifications of MV Switchgear and Key Design Parameters, MV Switchgear Construction, LV Compartment, Security Interlocks & General Arrangement, Control Circuit Components - Control Relays, Time Delay Relays & Latched Relays), Control Scheme Basics, Trip Lockout, TCS and Anti-pumping Circuits, Logic Schemes. **Case Studies:** Transformer Installation techniques with actual site photographs with real case. Switchgear Compartments with actual sample site videos

Unit III **[12 Hrs]**

Protection and Station Auxiliary Equipment and Digital Substation: Power System Network, Protection System, Overcurrent and Earth Fault, Overcurrent and Earth Fault – Coordination. Distribution Feeder Protection, Transformer – Unit/Main Protection, Transformer Protection, Familiarization of NUMERICAL Relays, Diesel Generator System, Instrument transformers (CT), Basics of AC/DC Auxiliary Power System & Sizing of Aux. Transformer, DC System Components, Battery Sizing & charger Sizing, DG Set Classification, and sizing. Evolution of substation automation, Communication System Fundamentals, substation automation System, DI, DO, AI, AO, Remote Terminal Unit(RTU), substation automation requirements, Time Synchronizing, HMI, SCADA.

Unit IV **[12 Hrs]**

Cabling System & Illumination, Outdoor SS Layout engineering, Erection Key Diagram, Earthing and Lighting Protection: LV Cables - Power & Control, MV Cables, Methods for Cable Installation, Practical aspects of CableSizing, Cable Glands, Lugs, and their Accessories, Types and Classifications of Surge Arresters, Characteristics of Surge Arresters, Illumination System Design, Equipment Layout engineering aspects for Outdoor Substation and related calculations and guide lines, Basics of Outdoor Air Insulated Substation up to 33 kV - Statutory Clearances, Practical approach to Cable routing layout for Outdoor S/S, Practical approach to Erection Key Diagram (EKD) for outdoor switchyard, Importance and Types of Earthing, Earthing Design, Types of Earthing Material, Lightning Protection. **Case Studies:** Practical aspects of Cable Sizing with Case Study, Lightning Protection design with a case study, BIM modelling of a 33/11kV Substation

Unit V **[12 Hrs]**

MV substation Civil design, Fire Protection, HVAC, Maintenance and Safety: Transformer Foundation, Fire Wall, and Fire Rated Doors, Civil & Structural Engineering - MV SS, Fire Detection & Alarm System and Fire Suppression System, Heating, Ventilation and Air-conditioning (HVAC) for Substation, Need for maintenance of a substation & schedule, Electrical Safety Rules, Standard Operating Procedures.

Text Books

S. N.	Title	Authors	Edition	Publisher
1	Electric Power Substations Engineering	McDonald John D	3rd. Edition, 2012	CRC Press
2	Sub-station Design and Equipment	Partap Singh Satnam, P.V. Gupta	1st Edition, 2013	Dhanpat Rai
3	Switchgear Protection and Power Systems	Sunil S. Rao	14th Edition, 2019	Khanna Publications
4	Electrical Substation and Engineering & Practice	S. Rao	2015	Khanna Publishers

Reference Books

S. N.	Title	Authors	Edition	Publisher
1	Manual on Substation by Central Board of Irrigation and Power (CBIP)		Publication No 342	
2	Substation Automation System Design and Implementation			Evelio Padilla by Wiley

FIRST SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25PE104T(ii)	PE-II Energy Storage Technologies	4	-	-	4	40	60	100

Course Objectives	Course Outcomes
This course is intended 1. Introduce the role and necessity of energy storage in electricity systems. 2. Explain classification and working of different energy storage systems. 3. Describe technical features, standards and comparative aspects of EES technologies 4. Understand the configuration, management and future prospects of EES systems.	**Students will be able to** 1. Understand characteristics and roles of EES technologies. 2. Classify and compare different energy storage systems. 3. Analyse features and standards of EES technologies. 4. Evaluate market trends and applications of EES. 5. Understand management and integration of battery storage systems.

Unit I **[12 Hrs]**

The Roles of Electrical Energy Storage Technologies in Electricity Use: - Characteristics of electricity, Electricity and the roles of EES, Emerging needs for EES, The roles of electrical energy storage technologies. Applications of Energy Storage.

Unit II **[12 Hrs]**

Types of Energy Storage Systems: - Classification of EES systems ,Mechanical storage systems :- Pumped hydro storage (PHS) Compressed air energy storage (CAES), Flywheel energy storage (FES), Electrochemical storage systems :- Secondary batteries, Flow batteries, Chemical energy storage :- Hydrogen (H2), Synthetic natural gas (SNG).

Unit III **[12 Hrs]**

Features of Energy Storage Systems: - Electrical storage systems :- Double-layer capacitors (DLC) Superconducting Magnetic Energy Storage (SMES), Hydrogen Fuel Cell Vehicles, Thermal storage systems, Standards for EES Technical comparison of EES technologies.

Unit IV **[12 Hrs]**

Markets for EES: Present status of applications, Utility use (conventional power generation, grid operation & service) ,Consumer use (uninterruptable power supply for large consumers), EES installed capacity worldwide**,** New trends in applications :- Renewable energy generation Smart Grid Smart Microgrid Smart House Electric Vehicles.

Unit V **[12 Hrs]**

Management And Control Hierarchy of Storage Systems :- Internal configuration of battery storage systems, External connection of EES systems, Aggregating EES systems and distributed generation (Virtual Power Plant) “Battery SCADA” – aggregation of many dispersed batteries, EES market potential in the future.

Text Books

S. N.	Title	Authors	Edition	Publisher
1	Electrochemical Energy Storage for Renewable Sources and Grid Balancing	Patrick T. Moseley & Jürgen Garche	1st Edition, 2015	Elsevier
2	Energy Storage for Power Systems	Andrei G. Ter-Gazarian	2nd Edition, 2011	The Institution of Engineering and Technology (IET)
3	Energy Storage: A Vital Element in the Transition to Sustainability	Robert A. Huggins	1st Edition, 2010	Springer

Reference Books

S. N.	Title	Authors	Edition	Publisher
1	Energy Storage	Robert A. Huggins	2nd Edition, 2016	Springer
2	Electrochemical Energy	Joachim Janek & Werner G. Zeier	1st Edition, 2018	Wiley-VCH

FIRST SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25PE105P	Technical Seminar & Research Paper Writing	-	-	6	3	100	--	100

Course Objectives	Course Outcomes
1. To develop technical communication and presentation skills 2. To understand the structure and ethics of academic writing. 3. To identify research areas and analyze current trends. 4. To write and present a research/technical paper effectively.	1. Select a relevant technical/research topic. 2. Conduct literature review using scholarly resources. 3. Draft a well-structured technical or research paper. 4. Apply proper citation and referencing techniques. 5. Deliver effective oral presentations using visual aids.

Module I **[07 Hrs]**

Introduction to Technical Seminar: Purpose of seminars in academia and industry, Selection of seminar topics, Sources for current and emerging technologies, Guidelines for seminar report preparation.

Module II **[08 Hrs]**

Basics of Research Writing: Types of research papers: review, empirical, case study, conceptual, Components of a research paper (Abstract, Introduction, Literature Review, Methodology, Results, Discussion, Conclusion),Understanding the difference between technical and research writing.

Module III **[08 Hrs]**

Literature Review and Plagiarism:-Searching for literature (IEEE Xplore, Science Direct, Google Scholar, etc.),Summarizing and synthesizing research, Plagiarism: meaning, types, and how to avoid it,Use of plagiarism detection tools (Turnitin, Grammarly, etc.).

Module IV **[07 Hrs]**

Writing Tools and Referencing:-Citation styles (IEEE, APA, MLA, etc.),Reference managers: Mendeley, Zotero, EndNote, Formatting using MS Word / LaTeX.

Module V **[15 Hrs]**

Oral Presentation Skills:-Structure of a technical presentation, Designing effective PowerPoint slides, Public speaking tips, voice modulation, handling Q&A,Use of visuals and animations effectively

Seminar/Research Paper Presentation:-Individual presentation of seminar topic, Submission of research/technical paper/report, Peer feedback and self-assessment.

Text Books

S. N.	Title	Authors	Edition	Publisher
1.	Technical Communication: Principles and Practice	Meenakshi Raman & Sangeeta Sharma	3rd Edition	Oxford University Press
2.	A Manual for Writers of Research Papers, Theses, and Dissertations	Kate L. Turabian	9th Edition	University of Chicago Press

Reference Books

S. N.	Title	Authors	Edition	Publisher
1.	How to Write and Publish a Scientific Paper	Barbara Gastel& Robert A. Day	9th Edition	Cambridge University Press
2,	Technical Writing: Process and Product	Sharon J. Gerson, Steven M. Gerson	8th Edition	Pearson Education

FIRST SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25PE106P	Mini Project	-	-	6	3	100	--	100

Course Objectives	Course Outcomes
This course is intended 1. To provide an opportunity for the students to apply the knowledge, develop/apply the skills and provide hands-on experience on a practical based projects and open ended experiments.	**Students will be able to** 1. Apply theoretical knowledge gained and skills acquired to address real-world problems, showcasing research, problem-solving and critical thinking. 2. Effectively communicate project findings and demonstrate proficiency in project management and interdisciplinary learning. 3. Develop practical experience, ethical considerations, and the ability to adapt to challenges in a hands-on learning environment. 4. Develop the ability to document the programs, circuits, prototypes, methodologies and results effectively in the form of project report.

Student need to build a project by successfully applying their academic knowledge to solve practical problems, demonstrating research, critical thinking, design thinking, communication skills, use of advanced tools and softwares in a real-world context and prepare the project report.