



TKR COLLEGE OF ENGINEERING AND TECHNOLOGY

AN AUTONOMOUS INSTITUTION

Accredited by NAAC with 'A+' Grade.

(Sponsored by TKR Educational Society, Approved by AICTE, Affiliated to JNTU H)

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Value Added Courses Syllabus

2023-24

1. Battery Management Systems (BMS) for EVs

UNIT–I: Fundamentals of Electric Vehicle Batteries

Introduction to Electric Vehicles (EVs) and Energy Storage Systems

Battery technologies for EVs: Lead-acid, Nickel-Metal Hydride (NiMH), Lithium-ion, Solid-state batteries

Battery chemistry, construction, and operating principles

Battery characteristics: Capacity, Energy Density, Power Density, C-rate, State of Charge (SOC), State of Health (SOH)

Battery pack configuration: Series and Parallel connections

EV battery pack architecture and specifications

Battery performance parameters and degradation mechanisms

UNIT–II: Battery Management System Architecture and Components

Introduction to Battery Management Systems (BMS)

Functions and requirements of BMS

BMS architecture: Centralized, Distributed, and Modular systems

Battery monitoring techniques

Voltage, Current, and Temperature sensing

Data acquisition systems for battery monitoring

Communication protocols: CAN, LIN, UART, SPI, I²C

Battery protection mechanisms

UNIT–III: Battery State Estimation and Cell Balancing

State of Charge (SOC) estimation methods

Coulomb Counting

Open Circuit Voltage (OCV) Method

Model-Based Estimation

State of Health (SOH) estimation techniques

State of Power (SOP) estimation

Battery modeling approaches

Electrical equivalent circuit models

Electrochemical models (Introduction)

Cell balancing techniques:

Passive balancing

Active balancing

Fault detection and diagnostics

UNIT–IV: Thermal Management and Safety in EV Batteries

Thermal behavior of batteries
Heat generation mechanisms in battery packs
Battery Thermal Management Systems (BTMS)
Air cooling and liquid cooling techniques
Thermal runaway and mitigation methods
Battery safety standards and regulations
Protection against overcharge, over-discharge, short circuits, and over-temperature conditions
Functional safety concepts for EV batteries

UNIT-V: Advanced BMS Design and EV Applications

BMS software and hardware design considerations
Embedded systems for BMS
Battery charging methods and charging infrastructure
Fast charging and battery life optimization
Cloud-connected and IoT-enabled BMS
Artificial Intelligence and Machine Learning applications in BMS
BMS integration in Electric Vehicles
Emerging battery technologies and future trends

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

CO1: Explain battery technologies, characteristics, and performance parameters used in electric vehicles.

CO2: Analyze the architecture, components, and communication systems of Battery Management Systems.

CO3: Apply battery state estimation techniques and cell balancing methods for efficient battery operation.

CO4: Evaluate thermal management strategies and safety mechanisms for EV battery systems.

CO5: Design and implement advanced Battery Management System solutions for electric vehicle applications using modern monitoring, communication, and control technologies.

2. Machine Learning for Power Systems

Course Objectives

To Introduce AI and Machine Learning concepts relevant to Electrical Power Systems.

To Understand data-driven approaches for monitoring, control, and optimization of power networks.

To Explore AI applications in smart grids, renewable energy integration, and predictive To maintenance.

To Develop practical skills using AI tools for power system analysis and decision-making.

UNIT – I: Fundamentals of Artificial Intelligence and Machine Learning

Introduction to Artificial Intelligence (AI)

Evolution and applications of AI in Electrical Engineering

Machine Learning (ML), Deep Learning (DL), and Data Analytics
Types of Learning: Supervised, Unsupervised, and Reinforcement Learning
Data preprocessing, feature extraction, and model evaluation
AI tools and platforms for power system applications

UNIT – II: AI-Based Load Forecasting and Power System Operation

Short-Term, Medium-Term, and Long-Term Load Forecasting
Artificial Neural Networks (ANN)
Support Vector Machines (SVM)
Decision Trees and Random Forests
Time-Series Forecasting using AI
AI-assisted Economic Load Dispatch and Unit Commitment

UNIT – III: AI for Fault Diagnosis and Predictive Maintenance

Condition Monitoring of Power Equipment
AI-Based Fault Detection and Classification
Transformer Health Assessment
Predictive Maintenance of Switchgear and Transmission Assets
Anomaly Detection Techniques
Digital Twins and Asset Management

UNIT – IV: AI Applications in Smart Grids and Renewable Energy Systems

Smart Grid Architecture and Data Analytics
AI-Based Demand Response Management
Renewable Energy Forecasting (Solar and Wind)
Microgrid Energy Management
AI for Voltage and Frequency Control
Intelligent Energy Storage Management

UNIT – V: Advanced AI Applications and Case Studies in Power Systems

Deep Learning Applications in Power Systems
AI-Based Power Quality Monitoring
Wide Area Monitoring Systems (WAMS) and PMU Data Analytics
Cybersecurity and AI in Smart Grids
Explainable AI (XAI) for Power Systems
Industrial Case Studies and Future Trends

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

CO1: Understand basic AI/ML concepts, workflows and Identify suitable AI techniques for power engineering problems.

AI and ML form the foundation for modern power system applications including forecasting, optimization, and decision support.

CO2: Apply AI models for electricity demand prediction and Analyze the role of forecasting in reliable grid operation.

CO3: Load forecasting is one of the earliest and most successful AI applications in power systems and Understand AI methods for equipment health monitoring.

CO4: AI enhances smart grid operation, renewable forecasting, energy storage management, and grid resilience.

CO5: Explore emerging AI technologies in power engineering and Assess challenges, security concerns, and future opportunities.

3. Electrical Design and Estimation using AutoCAD

Course Objectives

To introduce students to AutoCAD Electrical software and electrical drafting standards.

To develop skills in creating electrical schematics, layouts, and panel drawings.

To understand electrical load calculations and estimation techniques.

To prepare students for industrial electrical design and documentation.

To provide hands-on experience in project-based electrical drafting and estimation.

AutoCAD Electrical is widely used for schematics, panel layouts, wiring diagrams, single-line diagrams, and electrical documentation in industry.

UNIT – I: Introduction to AutoCAD Electrical and Drafting Fundamentals

Introduction to CAD and AutoCAD Electrical

User Interface, Workspace, Navigation Tools

Drawing Setup, Layers, Templates, Units and Dimensioning

Electrical Standards and Symbols (IEC/IEEE)

Creating and Managing Projects

Basic Drawing and Editing Commands

UNIT – II: Electrical Schematics and Wiring Diagrams

Creation of Electrical Schematics

Ladder Diagrams and Control Circuits

Wiring Diagrams and Interconnection Drawings

Wire Numbering and Component Tagging

Cross Referencing and Signal Arrows

Generation of Electrical Reports

UNIT – III: Electrical Panel Design and Power Distribution Drawings

Single Line Diagrams (SLD)

Distribution Board and Panel Layout Design

Motor Control Center (MCC) Drawings

PLC I/O Drawings and Control Panel Design

Cable Routing and Terminal Layouts

Bill of Materials (BOM) Generation

UNIT – IV: Electrical Design Calculations and Estimation

Electrical Load Calculation
Cable Sizing and Selection
Voltage Drop Calculations
Selection of Protective Devices (MCB, MCCB, Fuse)
Earthing and Lightning Protection Design
Preparation of Quantity Take-Off and Cost Estimation

UNIT – V: Building Electrical Services and Industrial Project Design

Lighting System Design and Layouts
Power Distribution Layouts for Buildings
Industrial Electrical Installation Drawings
Emergency Power and Backup Systems
Preparation of Complete Electrical Design Documentation
Mini Project using AutoCAD Electrical

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

CO1: Develop proficiency in AutoCAD Electrical environment and electrical drafting standards.

CO2: Create professional electrical schematic and wiring diagrams using AutoCAD Electrical.

CO3: Design industrial electrical panels and power distribution systems.

CO4: Perform design calculations and estimate electrical project requirements.

CO5: Develop complete electrical design and estimation documents for residential, commercial, and industrial applications.

4. Electric Vehicle (EV) Technology and Charging Infrastructure

Course Objectives

To Understand the fundamentals of electric mobility and EV architecture.
To Learn battery technologies, power electronics, and electric drives used in EVs.
To Study EV charging systems, standards, and infrastructure design.
To Analyze grid integration, smart charging, and Vehicle-to-Grid (V2G) concepts.
To Gain practical exposure to EV components and charging station design.

UNIT – I: Introduction to Electric Vehicles

Evolution of Electric Vehicles and E-Mobility
Need for Electrification of Transportation
Classification of EVs: BEV, HEV, PHEV, FCEV
EV Components and Architecture
Comparison of EVs with Conventional Vehicles
Indian EV Policy, FAME Scheme, and Market Trends

UNIT – II: Energy Storage Systems and Battery Management

Battery Fundamentals and Characteristics

Lithium-ion, Solid-State, and Emerging Batteries
Battery Pack Design and Sizing
Battery Charging and Discharging Characteristics
Battery Management System (BMS)
Cell Balancing, Thermal Management, and Safety

UNIT – III: Electric Propulsion System and Power Electronics

Electric Motors for EVs: BLDC, PMSM, Induction Motor
EV Powertrain Architecture
Motor Controllers and Drive Systems
DC-DC Converters and Inverters
Regenerative Braking System
Energy Management Strategies

UNIT – IV: EV Charging Technology and Infrastructure

EV Charging Principles and Charging Levels
AC Charging and DC Fast Charging
On-board and Off-board Chargers
Charging Standards and Protocols (CCS, CHAdeMO, Bharat DC-001, IEC 61851)
EVSE (Electric Vehicle Supply Equipment)
Design Considerations for Public and Residential Charging Stations

UNIT – V: Smart Charging, Grid Integration and Future Trends

Impact of EV Charging on Power Systems
Smart Charging Techniques
Vehicle-to-Grid (V2G) and Vehicle-to-Home (V2H)
Renewable Energy Integration with EV Charging
Charging Station Planning and Load Management
Future Trends: Wireless Charging, Battery Swapping, Autonomous EVs

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

CO1: Understand EV ecosystem, vehicle types, and industry developments.

CO2: Analyze battery technologies and BMS functions in EVs.

CO3: Understand propulsion systems and power electronic interfaces used in EVs.

CO4: Explain charging technologies, standards, and infrastructure requirements.

CO5: Evaluate smart charging solutions and EV-grid interaction technologies.