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

2024-25

1. Data Analytics for Electrical Engineering Applications

Course Objectives
To Understand the fundamentals of data analytics and its role in modern electrical engineering systems.
To Learn techniques for acquiring, preprocessing, and managing large-scale electrical engineering data.
To Apply statistical and machine learning methods for analysis of power system and energy data.
To Develop predictive models for load forecasting, fault diagnosis, and equipment condition monitoring.
To Utilize modern software tools for visualization and decision-making in smart grid and energy management applications.

UNIT-I: Introduction to Data Analytics for Electrical Engineers
Introduction to Data Analytics
Data Science and Data Engineering
Sources of Electrical Engineering Data
SCADA Systems
Smart Meters and PMUs
Data Collection Techniques
Data Types and Data Quality
Data Cleaning and Pre-processing
Handling Missing Data and Outliers

UNIT-II : Statistical Analysis of Electrical Data
Descriptive Statistics
Mean, Median, Mode
Variance and Standard Deviation
Correlation Analysis
Regression Analysis
Probability Distributions
Hypothesis Testing
Exploratory Data Analysis (EDA)

UNIT-III : Machine Learning Fundamentals
Introduction to Machine Learning
Supervised Learning
Unsupervised Learning
Linear Regression

Logistic Regression
Decision Trees
K-Nearest Neighbors
Clustering Techniques
Model Evaluation Metrics

UNIT-IV: Data Analytics Applications in Power Systems
Electrical Load Forecasting
Time Series Analysis
Energy Demand Prediction
Fault Detection and Diagnosis
Transformer Condition Monitoring
Predictive Maintenance
Power Quality Monitoring
Smart Grid Analytics

UNIT-V: Renewable Energy and Smart Grid Analytics
Solar Power Forecasting
Wind Power Prediction
Energy Consumption Analytics
Demand Response Analysis
Energy Management Systems
Data Visualization Techniques
Dashboard Development
Case Studies in Smart Grids

Upon successful completion of the course, students will be able to:
CO1: Explain the concepts of data analytics, data preprocessing, and data management in electrical engineering applications.
CO2: Apply statistical techniques to analyze electrical and energy-related datasets.
CO3: Develop machine learning models for classification, prediction, and clustering of electrical system data.
CO4: Perform load forecasting, fault detection, and predictive maintenance using data analytics techniques.
CO5: Use modern analytical tools to solve practical problems in power systems, smart grids, and renewable energy systems.

2. Python Programming for Electrical Engineers

Course Objectives
To Introduce Python programming concepts for engineering applications.
To Develop problem-solving skills using Python.
To Apply Python for electrical circuit and power system analysis.
To Perform data visualization and data analytics for electrical engineering data.
To Implement basic machine learning techniques for electrical engineering applications.

UNIT – I: Fundamentals of Python Programming

Introduction to Python; Features and Applications of Python in Electrical Engineering; Installation and Development Environment; Variables and Data Types; Operators; Input and

Output Statements; Conditional Statements; Loops; Functions; Modules and Packages; File Handling; Exception Handling.

UNIT – II: Numerical Computing for Electrical Engineering

Introduction to NumPy; Arrays and Matrix Operations; Mathematical Functions; Linear Algebra Operations; Solving Simultaneous Equations; Numerical Integration and Differentiation; Root Finding Methods; Curve Fitting and Interpolation.

UNIT – III: Data Visualization and Engineering Data Analysis

Introduction to Pandas; Data Import and Export; Data Cleaning and Processing; Statistical Analysis; Data Visualization using Matplotlib; Line Graphs, Bar Charts, Histograms, Scatter Plots; Real-Time Data Representation; Dashboard Concepts.

UNIT – IV: Python Applications in Power Systems and Electrical Machines

Power System Modeling using Python; Transmission Line Calculations; Fault Analysis Basics; Load Forecasting Concepts; Electrical Machine Performance Analysis; DC Motor Characteristics; Induction Motor Characteristics; PMSM Speed-Torque Analysis; Simulation of Electrical Engineering Problems.

UNIT – V: Artificial Intelligence and Machine Learning for Electrical Engineering

Introduction to Machine Learning; Scikit-Learn Library; Regression Techniques; Classification Techniques; Model Evaluation; Fault Detection and Diagnosis; Predictive Maintenance Concepts; Load Forecasting using Machine Learning; Introduction to Smart Grid Analytics and Industry 4.0 Applications.

Course Outcomes

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

CO1: Apply Python programming fundamentals to solve engineering problems.
CO2: Use numerical computing techniques for electrical engineering analysis.
CO3: Analyze and visualize electrical engineering datasets using Python.
CO4: Develop Python-based solutions for power systems and electrical machine applications.
CO5: Implement basic machine learning models for intelligent electrical engineering applications.

3. Artificial Intelligence Applications in Power Systems

UNIT–I: Fundamentals of Artificial Intelligence and Power Systems
Introduction to Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL)
Evolution and applications of AI in Electrical Power Systems
Overview of power system components: Generation, Transmission, Distribution, and Utilization
Data-driven approaches in power system analysis
Power system datasets and data preprocessing techniques
Feature extraction, feature selection, and performance metrics
Challenges and opportunities of AI in modern power systems

UNIT–II: Machine Learning Techniques for Power System Analysis

- Supervised learning techniques:
  - Linear Regression
  - Logistic Regression
  - Decision Trees
  - Random Forests
  - Support Vector Machines (SVM)
- Unsupervised learning techniques:
  - Clustering
  - Dimensionality Reduction
- Model training, validation, and testing
- Performance evaluation metrics
- Applications of machine learning in load forecasting and power system monitoring

UNIT–III: AI-Based Monitoring, Fault Diagnosis, and Predictive Maintenance

- Intelligent monitoring of power system assets
- AI techniques for fault detection and classification
- Transformer condition monitoring
- Transmission line fault diagnosis
- Predictive maintenance of electrical equipment
- Anomaly detection in power systems
- Reliability assessment using AI techniques

UNIT–IV: Deep Learning and Intelligent Control in Power Systems

- Fundamentals of Artificial Neural Networks (ANN)
- Deep Neural Networks (DNN)
- Convolutional Neural Networks (CNN)
- Recurrent Neural Networks (RNN) and Long Short-Term Memory (LSTM)
- Intelligent control of power systems
- AI-based voltage and frequency control
- Intelligent energy management systems
- Applications in smart grid operation and optimization

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

- AI-enabled smart grids
- Renewable energy forecasting:
  - Solar power forecasting
  - Wind power forecasting
- Demand response and demand-side management
- AI for microgrids and distributed energy resources
- Electric vehicle integration and charging optimization
- Reinforcement learning applications in power systems
- Future trends: Explainable AI (XAI), Digital Twins, Edge AI, and Autonomous Power Systems

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

CO1: Explain the fundamentals of Artificial Intelligence and its role in modern power system applications.
CO2: Apply machine learning algorithms for power system analysis, forecasting, and operational decision-making.
CO3: Develop AI-based solutions for fault diagnosis, condition monitoring, and predictive maintenance of power system equipment.
CO4: Design deep learning and intelligent control models for smart grid and energy management applications.
CO5: Implement AI techniques for renewable energy forecasting, smart grid optimization, electric vehicle integration, and next-generation autonomous power systems.

4. Energy Auditing and Energy Management

Course Objectives

To Understand the principles of energy conservation and efficient energy utilization.
To Learn methodologies for conducting energy audits in electrical systems and industries.
To Analyze energy consumption patterns and identify energy-saving opportunities.
To Develop skills in energy management practices and standards.
To Promote sustainable energy use in industrial, commercial, and utility sectors.

UNIT – I: Fundamentals of Energy and Energy Conservation

Energy scenario: Global and Indian perspectives
Energy resources and utilization
Need for energy conservation and efficiency
Energy consumption patterns in industrial, commercial, and residential sectors
Energy performance indicators (EnPIs)
Energy policy, Energy Conservation Act, and role of energy managers and auditors

UNIT – II: Energy Auditing Principles and Methodology

Introduction to Energy Auditing
Types of Energy Audits: Preliminary, Walk-through, and Detailed Audit
Energy audit methodology and procedures
Data collection and measurement techniques
Energy accounting and benchmarking
Preparation of energy audit reports and recommendations

UNIT – III: Energy Efficiency in Electrical Systems

Energy-efficient motors and motor control systems
Energy conservation in transformers
Power factor improvement and reactive power management
Energy-efficient lighting systems (LED and smart lighting)
Energy efficiency in pumps, fans, compressors, and HVAC systems
Electrical energy monitoring and measurement instruments

UNIT – IV: Energy Management and ISO 50001

Principles of Energy Management
Energy Management System (EnMS)
ISO 50001: Energy Management Standard
Energy policy, planning, implementation, and operation
Energy baseline and Energy Performance Indicators (EnPIs)
Monitoring, measurement, verification, and continuous improvement

UNIT – V: Energy Audit Applications and Case Studies
Energy audit of industrial electrical systems
Energy management in commercial buildings
Demand-side management and load management
Renewable energy integration and energy conservation
Cost-benefit analysis of energy conservation measures
Industrial case studies and best practices

After successful completion of the course, students will be able to:
CO1: Understand the importance of energy conservation and Identify major areas of energy consumption and efficiency improvement.

CO2: Conduct basic energy audits and Analyze energy data and prepare audit reports.

CO3: Energy audits involve systematic evaluation of energy use, identification of significant energy-consuming systems, and recommendations for improvement.

CO4: Evaluate energy-saving opportunities in electrical equipment.

CO5: Recommend suitable efficiency improvement measures and Apply ISO 50001 concepts to improve organizational energy performance.

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