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

2025-26

1. Solar PV System Design and Installation

Course Objectives

To provide knowledge of solar photovoltaic (PV) technology and its applications.
To develop skills in designing grid-connected and standalone PV systems.
To understand installation, testing, commissioning, and maintenance of PV systems.
To familiarize students with safety standards, regulations, and industry practices.

UNIT-I: Fundamentals of Solar Energy and Photovoltaic Technology

Energy scenario and renewable energy resources
Solar radiation, solar spectrum, solar geometry
Principle of photovoltaic energy conversion
Solar cells: Types, construction and characteristics
PV modules and arrays
I-V and P-V characteristics of PV modules
Factors affecting PV performance (irradiance, temperature, shading)

UNIT-II: Solar PV System Components

PV modules and module specifications
Inverters: String, Central and Micro-inverters
Charge controllers: PWM and MPPT
Battery technologies for solar applications
Balance of System (BOS) components
Mounting structures, cables, connectors, combiner boxes
Earthing and lightning protection systems

UNIT-III: Solar PV System Design and Sizing

Site survey and solar resource assessment
Load estimation and energy requirement analysis
Sizing of PV modules, batteries, charge controllers and inverters
Design of standalone (off-grid) PV systems
Design of grid-connected PV systems
Array configuration, tilt angle and orientation
Single Line Diagram (SLD) preparation

UNIT-IV: Installation, Testing and Commissioning

Installation planning and procedures

Mechanical installation of mounting structures and modules
DC and AC wiring practices
Safety precautions during installation
Testing of PV modules and system components
Commissioning procedures
Net-metering and grid interconnection concepts

UNIT-V: Operation, Maintenance and Economics of Solar PV Systems

Performance monitoring of PV systems
Preventive and corrective maintenance
Troubleshooting common PV system faults
Energy yield assessment
Economic analysis: Cost estimation, payback period and ROI
Government policies, subsidies and standards (MNRE, IEC, BIS)
Case studies of rooftop and utility-scale solar plants

After completion of the course, students will be able to:
CO1: Explain solar energy conversion and PV technologies.
CO2: Select suitable PV system components.
CO3: Design and size standalone and grid-connected PV systems.
CO4: Perform installation, testing and commissioning activities.
CO5: Analyze performance, maintenance requirements and economic feasibility of PV systems.

2. Industrial Automation using PLC & SCADA

Course Objectives
To understand the fundamentals of industrial automation and control systems.
To acquire knowledge of PLC hardware, programming, and industrial applications.
To develop skills in SCADA system design and monitoring.
To learn industrial communication protocols and system integration.
To provide hands-on experience in automation of industrial processes.

UNIT-I: Introduction to Industrial Automation and PLC Fundamentals

Evolution and need for industrial automation
Automation hierarchy and industrial control systems
PLC versus relay logic control systems
PLC architecture: CPU, memory, power supply, I/O modules
PLC scan cycle and operating modes
Applications of PLCs in manufacturing and process industries

UNIT-II: PLC Hardware, Interfacing and Programming
Digital and analog input/output modules
Sensors, actuators and field devices
PLC wiring practices and interfacing techniques
PLC programming languages (IEC 61131-3 overview)

Ladder Logic Programming
Basic instructions: Contacts, Coils, Timers, Counters, Latching circuits

UNIT-III: Advanced PLC Programming and Industrial Applications
Arithmetic and logical instructions
Data handling and comparison instructions
Sequential control and interlocking circuits
Motor control using PLC
Conveyor and batch process automation
PLC troubleshooting and debugging techniques

UNIT-IV: SCADA Systems and Human Machine Interface (HMI)
Introduction to SCADA and HMI systems
SCADA architecture and components
Data acquisition and supervisory control
Development of graphical HMI screens
Alarm management, trends and reports
Real-time monitoring and control of industrial processes

UNIT-V: Industrial Communication and PLC–SCADA Integration
Industrial communication concepts
Modbus, Profibus, Profinet and Ethernet/IP protocols
PLC-to-PLC communication
PLC-SCADA communication and data exchange
Industrial networking fundamentals
Case studies of automation in power plants, manufacturing industries and smart factories

After successful completion of the course, students will be able to:
CO1: Explain industrial automation concepts and PLC architecture.
CO2: Interface sensors and actuators with PLC systems.
CO3: Develop PLC programs for industrial control applications.
CO4: Design and implement SCADA/HMI systems for monitoring and control.
CO5: Integrate PLC and SCADA systems using industrial communication protocols.

3. MATLAB/Simulink for Electrical Engineers

UNIT–I: MATLAB Fundamentals and Programming
Introduction to MATLAB environment and applications in Electrical Engineering
MATLAB desktop, command window, workspace, and editor
Variables, constants, data types, and operators
Vectors, matrices, and matrix operations
Scripts and functions
Decision-making and looping statements
File input/output operations

Laboratory Exercises:

- Matrix manipulation and mathematical computations
- Development of MATLAB scripts and user-defined functions
- Solving systems of linear equations

UNIT–II: Data Analysis, Visualization, and Numerical Methods
Data import/export techniques
2D and 3D plotting functions
Plot customization and graphical visualization
Numerical methods in MATLAB:

- Root finding
- Numerical differentiation and integration
- Interpolation and curve fitting

Solution of ordinary differential equations (ODEs)

Laboratory Exercises:

- Plotting electrical characteristics
- Numerical solution of engineering problems
- Curve fitting and data analysis applications

UNIT–III: Signal Processing and Control Systems Using MATLAB
Representation and generation of continuous and discrete signals
Signal analysis using FFT
Digital filtering concepts
Transfer function and state-space models
Time-domain and frequency-domain analysis
Root locus, Bode plot, and Nyquist plot
PID controller design and tuning

Laboratory Exercises:

- Harmonic analysis of electrical signals
- Frequency response analysis
- PID controller implementation

UNIT–IV: Simulink Modeling and Simulation
Introduction to Simulink environment
Building and simulating dynamic system models
Sources, sinks, signal routing, and subsystem blocks
Model configuration and simulation parameters
Modeling first-order and second-order systems
Simulink analysis tools and debugging techniques

Laboratory Exercises:

- Modeling dynamic systems
- Simulation of control systems
- Performance evaluation using Simulink

UNIT–V: Electrical Engineering Applications Using Simulink

Introduction to Simscape Electrical
Modeling and simulation of:

- RLC circuits
- Transformers
- DC machines
- Induction motors
- Power electronic converters (Rectifiers and Inverters)

Power system simulation and fault analysis
Renewable energy system modeling (Solar PV and Wind Energy)

Laboratory Exercises:

- Electrical circuit simulation
- Machine modeling and performance analysis
- Power electronics and renewable energy system simulations

After successful completion of the course, students will be able to:
CO1: Apply MATLAB programming techniques to solve electrical engineering problems.
CO2: Analyze and visualize engineering data using MATLAB tools.
CO3: Design and evaluate signal processing and control system applications using MATLAB.
CO4: Develop and simulate dynamic system models using Simulink.
CO5: Model, analyze, and simulate electrical circuits, machines, power electronics, and power systems using Simulink and Simscape Electrical.

4. Industrial IoT for Smart Electrical Systems

UNIT–I: Fundamentals of Industrial IoT and Smart Electrical Systems
Introduction to Internet of Things (IoT) and Industrial IoT (IIoT)
Evolution of Industry 4.0 and smart manufacturing
Architecture of IoT and IIoT systems
Components of IIoT: Sensors, actuators, controllers, gateways, and cloud platforms
Smart electrical systems: Concepts, features, and applications
Communication technologies for IIoT: Wi-Fi, Bluetooth, ZigBee, LoRaWAN, NB-IoT, and 5G
Overview of smart grids and digital substations

UNIT–II: Embedded Systems and Communication Protocols for IIoT
Embedded platforms for Industrial IoT:
Arduino
ESP32/ESP8266
Raspberry Pi
Industrial communication protocols:

- MQTT
- CoAP
- Modbus
- OPC UA
- IEC 61850 (Introduction)

Edge computing concepts
Real-time data acquisition and transmission
IoT gateways and network architecture

UNIT–III: Cloud Computing, Data Analytics, and Cybersecurity

Cloud platforms for IIoT
Data storage and management
Real-time monitoring and visualization
Big data analytics for electrical systems
Introduction to Artificial Intelligence and Machine Learning in IIoT
Cybersecurity challenges in Industrial IoT
Security mechanisms:

- Authentication
- Encryption
- Secure communication protocols

Privacy and reliability considerations

UNIT–IV: Industrial IoT Applications in Smart Electrical Systems

Smart energy management systems
Smart metering and Advanced Metering Infrastructure (AMI)
Remote monitoring and control of electrical equipment
Condition monitoring of transformers, motors, and generators
Predictive maintenance using IIoT
Fault detection and diagnostics
Demand-side management and energy efficiency

UNIT–V: Smart Grid and Advanced IIoT Applications

Industrial IoT in smart grids
Distributed energy resources and renewable energy integration
Microgrids and virtual power plants
Electric vehicle charging infrastructure and monitoring
Digital substations and intelligent electronic devices (IEDs)
Digital twins for electrical systems
Emerging trends:

- AI-enabled IIoT
- Edge AI
- Industrial digital transformation

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

CO1: Explain the architecture, technologies, and communication frameworks of Industrial IoT for smart electrical systems.
CO2: Develop embedded IoT solutions for monitoring and controlling electrical equipment using industrial communication protocols.
CO3: Implement cloud-based data acquisition, analytics, and cybersecurity mechanisms for Industrial IoT applications.
CO4: Design Industrial IoT solutions for smart energy management, condition monitoring, and predictive maintenance of electrical systems.
CO5: Apply Industrial IoT concepts to smart grids, renewable energy systems, electric vehicle infrastructure, and advanced industrial automation applications.