Title: Power Distribution and Utilization

Code Number: EE3201

Credit Hours: 4 (3+1)

Prerequisites: EE2101 Electrical Network Analysis

Semester: 6th

Course Objectives
The course will enable students to:

1. Summarize the structure and components of various distribution systems, load calculations and analyze power factor improvement methods and grounding/ protection practices in low voltage networks for electrical safety.
2. Describe advanced battery technologies, diverse heating methods and lighting fundamentals in various applications.
3. Discuss basic knowledge of smart grids, encompassing advanced metering infrastructure and integration of renewable energy.
4. Conduct experiments to measure voltage drops, power losses, and efficiency in distribution systems and perform practical tests on power cables, transformers, and batteries, analyzing their thermal characteristics, capacitance, and dielectric power loss.
5. Express understanding of concepts of power distribution, methodologies, and problem-solving strategies.

Contents
Unit 1: Introduction to Distribution System
1. Urban, sub urban and rural distribution system
2. Primary, secondary and tertiary voltages
3. Distribution conductors & cables, Kelvin's law
4. Radial and ring main systems, application of distribution transformers
5. Calculation of voltage drop and regulation in distribution feeders
6. Substation switchgears and bus bar arrangements
7. Protection and Coordination of Distribution Systems

Unit 2: Power Cables
1. Cable Construction
2. Types of Cables
3. Insulating Materials
4. Conducting materials.
5. Capacitance of a Cable
6. Dielectric Power Loss
7. Thermal Characteristics of Cables
8. Cable Installation

Unit 3: Power Factor
1. Disadvantages and causes of low power factor
2. Methods for improvement,
3. Application of shunt capacitors in distribution network

Unit 4: Grounding and Earthing

1. Distribution transformer neutral
2. Earthing resistance
3. Earthing practice in L.V. networks
4. Electrical Safety

Unit 5: Economic Aspects of Power Distribution

1. Cost analysis of distribution systems
2. Tariff structures and rate design
3. Economic dispatch and load scheduling
4. Life cycle cost analysis
5. Regulatory and policy considerations

Unit 6: Batteries and Electro-Chemical Process

1. Main types of batteries and their working
2. Battery charging
3. Electroplating
4. Electrolysis
5. Electrometallurgical process.
6. Cathodic protection of poles, gas pipes, oil pipes and water structures.

Unit 7: Heating & Welding

1. Electric heating
2. Induction and dielectric heating
3. Electric furnaces
4. Microwave and infrared heating
5. Electric welding
6. Resistance welding and its types.

Unit 8: Fundamentals of Illumination Engineering

1. Basic lighting terminologies and laws of illumination
2. Requirements for good lighting,
3. Illumination schemes for various situations
4. Street lighting
5. Commercial/industrial lighting
6. Stadium/flood/stage/spot lighting
7. Types of lamps, their working and relative merit
8. Building lighting design

Unit 9: Smart Grids and Modern Distribution Systems

1. Introduction to smart grids
2. Advanced metering infrastructure (AMI)
3. Integration of renewable energy sources
4. Estimation of load, load characteristics
5. Demand response and energy management systems
6. Smart grid communication technologies
7. Microgrids and distributed generation

Unit 10: Distributed Energy Resources (DER)

1. Types of DER (solar, wind, energy storage)
2. Impact of DER on distribution systems
3. Grid-tied and off-grid systems
4. Control and management of DER
5. Regulatory and policy aspects of DER integration

Unit 11: Renewable Energy Integration

1. Overview of renewable energy sources

2. Grid integration challenges and solutions
3. Inverter-based generation and control
4. Renewable energy forecasting
5. Policy and regulatory frameworks for renewable integration

Unit 12: Distribution Automation

1. Concepts of distribution automation
2. Automated switchgear and reclosers
3. Fault detection, isolation, and service restoration (FDIR)
4. SCADA systems in distribution automation
5. Benefits and challenges of automation

Lab Work Outline:

In this laboratory course, students will engage in practical experiments focused on measuring voltage drops, power losses, and efficiency within distribution systems. They will conduct tests on power cables to analyze thermal characteristics, capacitance, and dielectric power loss, gaining insights into their performance under varying conditions. Additionally, students will implement and analyze distribution system automation techniques using SCADA systems and automated switchgear. They will perform protection coordination studies using fuses, circuit breakers, and relays, and investigate fault detection and isolation strategies in both radial and ring main systems. Through hands-on activities, students will develop skills in analyzing and optimizing the operational efficiency and reliability of power distribution networks.

Teaching-Learning Strategies:

The pedagogical approach to this course relies on face-to-face teaching in a university classroom environment. The lectures are delivered using multimedia support and on white board. Students are engaged and encouraged to solve real world problems using computer-aided tools.

Assignments/Types and Number with calendar:

A minimum of four assignments to be submitted before the written exams for each term.

Assessment and Examinations:

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2.	Sessional Assessment	25%	It is continuous assessment. It includes classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Recommended Books:

1. Principle of Power System by V.K Mehta, Latest Edition.
2. M. L. Anand, "A Textbook of Electrical Power", Latest Edition
3. Turan Gonen, "Electrical Power Distribution System", CRC