GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Electrical Engineering
Subject Code: BE05009091
Subject Name: Electrical Distribution System

w.e.f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Elective Course - 2

Prerequisite:	Basic Electrical Engineering and Power Systems –I
Rationale:	This course provides an understanding of how electrical energy is distributed efficiently, reliably, and safely from substations to end users. It equips students with the knowledge required to analyze voltage drop, power losses, and load behavior in distribution networks. The subject develops skills in planning, design, maintenance, protection, and performance evaluation of feeders, transformers, cables, and overhead lines. It also introduces reliability assessment, rural electrification, and modern automation practices such as distribution SCADA. With increasing demand for energy efficiency, smart grids, and distributed generation, knowledge of distribution systems is essential for modern power engineers.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	Marks% weightage
01	Describe the structure, classification, components, and configurations of electrical distribution systems	15
02	Analyse DC and AC distribution systems and perform voltage drop, current, and power loss calculations under various feeding conditions.	20
03	Evaluate the design, construction, installation, and maintenance of underground cables, overhead lines, and earthing systems in distribution networks.	30
04	Assess reliability, protection, automation, and performance of electrical distribution systems including SCADA and interruption indices.	20
05	Apply concepts of rural electrification, loss minimization, energy conservation, HVDS, and modern smart distribution practices in planning and improvement of	15

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/CA (I)	PBL (I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

Course Content:

Unit No.	Content	No. of Hours	%of Weightage
1.	**Introduction to Electric Power Distribution:** Structure of power systems, importance of distribution, classification of distribution systems, AC and DC distribution, radial, ring main and interconnected systems, primary and secondary distribution.	04	10
2.	**Distribution System Components:** Feeders, distributors and service mains, distribution substations, transformers, switchgear, poles, conductors and insulators used in distribution networks. Types of distribution transformers, ratings, cooling methods, losses, efficiency, all-day efficiency, transformer loading, installation in distribution networks. Examples.	06	15
3.	**DC & AC Distribution Systems:** Voltage drop calculations in DC distributors, distributors fed at one end, both ends and at intermediate points, load distribution and current calculations, numerical problems. Single-phase and three-phase distributors, power factor considerations, voltage drop calculations, distributors fed from one end and both ends, ring main distributors. Causes of voltage drop, power losses in feeders and distributors, regulation of voltage, comparison of distribution arrangements. Examples	10	25
4.	**Underground Cables**: Types of cables, insulation materials, protective coverings, cable laying methods, cable joints, faults in underground cables, cable testing. Examples	04	10
5.	**Overhead Distribution Lines** Construction of overhead lines, conductor types, line supports, sag and tension, mechanical design aspects. Examples.	05	10
6	**Earthing in Distribution Systems** Purpose of earthing, types of earthing systems, earthing of substations and lines, earth resistance measurement. Examples	04	10

7	**Reliability of Distribution Systems and Distribution Automation** Reliability indices, causes of interruptions, reliability improvement methods, system planning. Need for automation, SCADA, load monitoring, fault detection, system control. Examples	05	10
8	**Rural Electrification** Objectives, planning of rural distribution systems, load characteristics, challenges and solutions.	03	05
9	**Modern Developments in Distribution Systems** High voltage distribution systems (HVDS), loss minimization techniques, energy conservation, introduction to smart distribution practices.	03	05

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	20	30	20	20	0

Where, R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised
Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The syllabus of Electrical Distribution Systems directly contributes to

SDG 7	**Affordable and Clean Energy**: The syllabus covers the efficient distribution of electrical energy, analysis of power losses, and the introduction of modern practices like Smart Grids and Distributed Generation, which are essential for providing reliable and sustainable energy services
SDG 9	**Industry, Innovation and Infrastructure Industry, Innovation, and Infrastructure**: The course focuses on the planning, design, and performance evaluation of feeders, transformers, and cables. It introduces modern automation practices such as Distribution SCADA, contributing to resilient and innovative infrastructure.
SDG 11	**Sustainable Cities and Communities:**

	By teaching reliability assessment and rural electrification, the course ensures that urban and rural settlements have the necessary power infrastructure to be safe and resilient
SDG 13	**Climate Action:** The focus on reducing power losses and improving energy efficiency in distribution networks directly contributes to lowering carbon emissions associated with energy waste.

References / Suggested Learning Resources:

Reference Books:

1. Electric Power Distribution – A.S. Pabla. Tata McGraw-Hill Education
2. Electrical Power Distribution Systems – V. Kamaraju, McGraw-Hill Education
3. Electric Power Distribution Engineering – Turan Gönen, CRC Press
4. Power Distribution Engineering – James J. Burke, Marcel Dekker Publishers
5. Electrical Power Systems – C.L. Wadhwa, New Age International

Suggested list of practicals:

1. To study and identify various components of an electrical distribution system.
2. To develop a program for voltage drop calculation in DC distributors.
3. To write a program for voltage drop and current calculation in single-phase and three-phase distributors.
4. To determine efficiency and all-day efficiency of a distribution transformer.
5. To examine types, insulation materials, and testing methods of underground cables.
6. To develop a program to compute sag and tension in overhead lines.
7. To measure earth resistance using an earth tester.
8. To calculate reliability indices of a distribution network.
9. To develop a program to calculate SAIFI, SAIDI, and CAIDI for a distribution system.
10. To understand monitoring and control of distribution systems using automation techniques.
11. To estimate load and plan a basic rural distribution network.

Design based Problems (DP)/Open Ended Problem:

1. Design a Distribution system to supply power to a rural houses
2. Design a Distribution system to supply power to a industry/industrial area
3. Design a small-scale AC and DC Distribution network and analyze them
4. Design and prepare a simulation to study the effect of loading types and patterns of distribution network

These problems may be done on paper by hand and/or using some simulation software.

Major Equipment:

Lab/Equipments of power systems and machine lab may be used for the above suggested practicals

List of Open-Source Software/learning website:

ETAP/MATLAB/Scilab and similar software and NPTEL courses on Electrical power systems and Electrical machines

Activities Suggested for Self-Learning:

Sr. No.	PBL Category	Name of the Activity	No. of Hours	Evaluation criteria
1	Industry / Research Laboratory Visit	Visit a nearby substation (urban/rural). Identify transformer ratings, feeder layout, and observe distribution practices. Compare with IS 1180 and NEC 2023 standards.	10	Understanding of system components, comparison with standards, report quality, observations & technical analysis
2	Video Based Learning	Watch NPTEL / expert lectures on distribution systems, SCADA, HVDS, and smart grids. Summarize key learnings.	5	Concept clarity, summary accuracy, relevance to syllabus, presentation
3	Assignment / Technical Writing / Research Writing	Solve GATE questions related to distribution systems and write technical notes on voltage drop, losses, and reliability indices.	10	Accuracy of solutions, clarity of steps, coverage of topics, technical writing quality
4	Complex Problem-Solving / Mini Project (SDG-based)	Design a rural distribution system OR industrial distribution network including load estimation, voltage drop, and loss minimization.	10	Correct design methodology, calculations, feasibility, alignment with SDG 7 & 13
5	Research Paper Review / Analysis	Review papers on smart distribution systems, SCADA, or loss minimization techniques.	5	Understanding of paper, critical analysis, relevance, summary clarity

6	Poster / Chart / PowerPoint Presentation	Prepare presentation on distribution components, HVDS, reliability indices, or smart grids.	5	Visual clarity, technical content, explanation ability, creativity
7	Micro Project	Develop MATLAB/Excel program for voltage drop calculation or transformer efficiency analysis.	5	Correct coding, output accuracy, interpretation of results
8	Group Discussion / Quiz / Simulation	Conduct quiz or simulation on AC/DC distribution systems, voltage drop, and power loss comparison (radial vs ring).	5	Participation, conceptual understanding, correctness of answers
9	Case Study Analysis / Seminar	Case study of Gujarat/India distribution feeder: calculate SAIFI, SAIDI, CAIDI and suggest improvements.	10	Correct calculations, logical assumptions, interpretation, presentation
10	BIS (Bureau of Indian Standards)	Case study on energy efficiency standards (BEE star rating aligned with BIS) for distribution transformers and appliances.	5	Concept clarity, correct linkage with efficiency, analytical explanation
11	BIS (Bureau of Indian Standards)	Technical report on the role of BIS in ensuring safety, reliability, and quality in electrical distribution systems.	5	Depth of content, relevance, clarity, presentation
12	Other	Awareness session on energy conservation and power factor improvement for local community/school.	10	Practical relevance, communication, impact, technical correctness

Note:

1. These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.
2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.
3. All the suggested activities should be related to the course contents/ Topics.
4. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
5. Rubrics for the evaluation can be prepared by the faculty and disclose to the students well in advance.
6. All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
7. Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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