



# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Bachelor of Engineering**

**Level: UG**

**Branch: Electrical Engineering**

**Subject Code: BE04009041**

**Subject Name: Power Systems I**

WEF Academic Year:	2024-25
Semester:	4
Category of the Course:	PCC

<b>Prerequisite:</b>	Basic Electrical Engineering
<b>Rationale:</b>	This course provides a fundamental understanding of power generation, transmission and distribution systems. It covers the core components and principles that ensure the reliable and efficient delivery of electricity from generation plants to consumers. Topics like transmission line parameters, overhead lines, and underground cables is crucial for designing, analyzing, and maintaining the infrastructure of modern power grids. Additionally, the course addresses important aspects like safety (earthing, clearances) and efficiency (power factor improvement, sag and tension calculations), which are critical for both system performance and public safety. Overall, it lays the groundwork for understanding the complexities of a power grid and the challenges involved in its operation and expansion.

### Course Outcomes:

After Completion of the Course, Student will be able to:

No	Course Outcomes	% Weightage
01	Compare various means of Electricity generation and evaluate load curves and tariff structures.	20%
02	Describe the components, types of insulators, and mechanical design aspects of overhead transmission lines.	15%
03	Compute the electrical parameters of overhead transmission lines and underground cables under various configurations.	40%
04	Analyze distribution systems for voltage regulation and apply methods of power factor improvement for economical operation.	10%
05	Analyze substation equipment, earthing practices and concepts of step & touch potential.	15%

### Teaching and Examination Scheme:

Teaching-Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
L	T	P	PBL	TH		Theory		Tutorial/Practical			
						ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	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



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## Course Content:

Sr. No.	Course Content	No. of Hours
1.	<b>Conventional Generation, Load Curves, Tariffs :</b> Generation scenario in India and Gujarat Steam power station, Schematic arrangement of steam power station, Equipment of steam power station, Hydroelectric power station, Schematic arrangement of hydro-electric power station, Constituents of hydro-electric plants, Nuclear power station, Schematic arrangement of nuclear power station, Nuclear reactor, Gas turbine power plant, Schematic arrangement of gas turbine power plant, comparison of various power plants. Load curves, Important terms and factors, Load duration curve, Examples. Tariff, Desirable characteristics of tariff, Types of tariff, Numerical problems.	08
2.	<b>Overhead Line Insulators and Mechanical Design of Overhead Transmission Lines:</b> Insulating material, Types of insulators, String efficiency, Overhead line supports, Types of steel towers, Conductor configurations & spacings, Clearances, Sag and tension calculations for supports at equal level and unequal level with consideration of effect of ice and wind, Conductor vibrations – Resonant vibration and Galloping, Numerical problems.	06
3.	<b>Transmission Line Parameters:</b> Types of line conductors, Line resistance, Inductance of a single conductor due to internal and external flux linkages, Inductance of single phase (two-wire) line, Flux linkages of one conductor in an array, Inductance of composite conductor lines, Inductance of three-phase transmission lines with equilateral spacing, Transposition of lines, Inductance of transposed line with unsymmetrical spacing, Inductance of three-phase double circuit lines.  Line capacitance, Potential difference between two points due to a charge, Capacitance of single phase (two-wire) line, Capacitance of three-phase lines with symmetrical spacing, Capacitance of three-phase transposed lines with unsymmetrical spacing, Capacitance of three-phase double circuit lines, lines, Effect of ground on the capacitance using method of images, Skin and Proximity effect, Numerical problems.	13
4.	<b>Underground Cables:</b> Construction of cables, Insulating materials of cables, Classification of cables, Pressurized cables, Effective conductor resistance and inductive reactance, Parameters of cables, Dielectric stress in single core cable, Most economical conductor size in cable, Grading of cables, Capacitance of three-core belted cables, Measurement of core to core and core to earth capacitances, Numerical problems.	06



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5.	<b>Distribution Systems and Power Factor Improvement:</b> Comparison of various distribution systems, AC Distribution systems, Types of primary and secondary distribution systems, Voltage drop calculations in DC and AC distribution systems, Kelvins' law, Power factor improvement, Power factor improvement equipment, Calculations of power factor correction, Most economical power factor, Numerical problems.	06
6.	<b>Substations and Power System Earthing:</b> Classification of substations, Symbols of various equipment in substations, Bus bar arrangements, Switchyard layout of 132 kV, 220 kV and 400 kV substations, objective of power system earthing, Tolerable limits of body currents, Touch and step potential, Earthing Grid, Neutral earthing, Comparison of isolated neutral and earthed neutral systems, Types of neutral earthing.	06
<b>Total</b>		<b>45</b>

The above syllabus addresses Sustainable Development Goal No. 7,9, 11, 12, 13

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

\*R: Remember, U: Understand, A: Apply, N: Analyze, E: Evaluate ,C: Create

## Reference Books:

1. Power System Analysis and Design: B. R. Gupta, S. Chand Publications
2. Electrical Power Systems: D. Das, New Age International Publishers
3. Power System Analysis: Hadi Saadat, McGraw Hill Education India Pvt. Ltd.
4. Electrical Power systems: C. L .Wadhwa, New Age International Publishers
5. Power System Analysis and Stability: Dr. S. L. Uppal, Prof. S. Rao, Khanna Publications
6. Elements of Power Systems Analysis: W. D. Stevenson Jr., 4th Edition, McGraw Hill Education.
7. Power System Analysis : John J. Grainger, William D. Stevenson Jr., McGraw Hill Education
8. Modern Power system Analysis by I J Nagrath, D P Kothari, McGraw Hill Education
9. Power System Analysis and Stability: S. S. Vadhera, Khanna Publishers
10. Principles of Power system : V.K.Mehta, Rohot Mehta, S. Chand Publishers



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## Course Outcome (Laboratory):

After performing practical in this course, the students should be able to:

1. Develop programs for computations of string efficiency, sag and tension in overhead transmission lines.
2. Develop programs for computations of parameters of transmission line and underground cables.
3. Develop programs for computations of voltage drops in DC and AC distribution system.
4. Develop programs for computations of parameters of neutral earthing systems.

## Suggested list of practical but not limited to:

1. Survey of generation scenario and power plants of Gujarat
2. Development of programs for computations of sag and tension in overhead lines
3. Development of programs for computations of inductance of single-phase line inductance
4. Development of programs for computations of three-phase line inductance with symmetrical and unsymmetrical spacing
5. Development of programs for computations of inductance of single-phase line capacitance
6. Development of programs for computations of three-phase line capacitance with symmetrical and unsymmetrical spacing
7. Development of programs for computations line capacitance considering effect of ground
8. Development of programs for computations of resistance and capacitance of underground cables
9. Development of programs for computations of voltage drops in DC distribution system
10. Development of programs for computations of voltage drops in AC distribution system
11. Development of programs for computations of parameters of arc suppression coil

## • Activities suggested under Problem Based Learning:

Sr. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Power Station/Substation Visit	Visit = 05 hrs Report Preparation = 03 hrs Total 08 hrs	Evaluation should be based on topics and details covered in the report. (Report should include specifications of devices, its photograph, line diagram etc)
2.	Survey of different types of power plants of India to observe the power supplied by them daily, rates of energy, daily schedule etc.	Survey = 03 hrs Report Preparation = 02 hrs Total-5 hrs	Based on all findings
3.	Poster/Chart/Power point preparation & presentation on topics given by faculty	05 hrs	Based on content covered in the poster/chart/ppt & its presentation skill
4.	Assignments	01 assignment/chapter Time/Assignment = 02 hrs	Based on learning and timely submission



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Sr. No.	Name of the activity	No. of hours	Evaluation Criteria
5.	Online Technical Quizzes	01 quiz/chapter time/quiz = 01 hrs	based on score
6.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
7	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
8	Working/non-working model /Simulation on technical topics	Working = 12 h Non- working = 8 h	Based on department evaluation
9.	Real world case studies based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
10	Development of MATLAB or Android or iOS application for transmission line design	Duration- 8 hrs, Report preparation-2 hrs, Total 10 hrs	Based on dept. evaluation
11	Development of MATLAB or Android or iOS application for calculation of sag-tension	Duration- 8 hrs, Report preparation-2 hrs, Total 10 hrs	Based on dept. evaluation
12	Development of MATLAB or Android or iOS application for calculation of step and touch potential in ground grid design	Duration- 8 hrs, Report preparation-2 hrs, Total 10 hrs	Based on dept. evaluation
13.	Explore case studies of different overhead line failures due to insulator or mechanical issues. Prepare a presentation on causes and preventive measures.	Duration - 4 hours, Report presentation- 2 hours, Total 6 hrs	Quality and clarity of analysis; presentation skills; identification of key failure modes.
14	Survey local/regional standards for underground cable installation (using government or utility websites) and summarize key points.	Duration - 4 hours, Report presentation- 2 hours, Total 6 hrs	Relevance and accuracy of information
15	Carry out a load survey at home or campus (or use sample data). Calculate energy consumption and suggest power factor improvement measures. Research different	Duration - 8 hours, Report presentation- 2 hours, Total 10 hrs	Proper data collection and calculation, Relevance of devices chosen; clarity in comparison.



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Sr. No.	Name of the activity	No. of hours	Evaluation Criteria
	commercial devices used for power factor improvement and prepare a comparison chart.		
16	Write a brief report after interviewing (directly or via email) a field engineer or reviewing an online interview about substation operation and safety.	Duration - 1 hour, Report preparation - 1 hour, Total 2 hours	Insightfulness of questions; ability to capture important operational and safety considerations.
17	Find out various Standards related transmission lines (mechanical design standards and electrical parameter standards)	Duration - 2 hour, Report preparation – 2 hour, Total 4 hours	Based on BIS standards related to transmission lines
18	Find out various Standards related to cables	Duration - 2 hour, Report preparation – 2 hour, Total 4 hours	Based on BIS standards related to cables
19	Find out various Standards related to earthing, step and touch potential	Duration - 2 hour, Report preparation – 2 hour, Total 4 hours	Based on BIS standards related to earthing

Note:

- All the suggested activities should be related to the subject.
- Faculty can consider other subject based activities.
- 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.
- Rubrics for the evaluation can be prepared by the faculty.

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