



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Power Electronics Engineering

Level: UG

Subject Code: BE04024051

Subject Name: Fundamentals of Power Systems

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

Prerequisite:	Basic Electrical Engineering
Rationale:	This course is designed to introduce students to the foundational concepts, components, and technologies that govern the generation, transmission, distribution, and management of electrical energy. As the backbone of modern infrastructure, power systems require engineers to understand both conventional and emerging technologies to ensure reliable, efficient, and sustainable energy delivery.

Course Outcomes:

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

No	Course Outcomes	% Weightage
01	Select the appropriate type of power generating station following norms and guidelines related to cost, environment, societal and ethical issues.	20
02	Calculate various parameters for analysis of electrical design aspects of the transmission system.	20
03	Analyze different types of Power System components and distribution systems.	20
04	Apply appropriate power factor improvement techniques for efficient system operation.	20
05	Demonstrate understanding of AC and DC transmission and distribution systems, including grounding methods and cable types used in practical installations.	20

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

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	15	90	03	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.	Introduction : Basic Layout of Power System- Electric Power and Generating Stations : Electric Power System, Sources of Electrical Energy, Generation, Transmission and Distribution of Electric Power, Schematic Arrangement of Different Power Plants like Hydro, Thermal, Nuclear, Diesel, Solar, Wind, etc., Other Renewable Sources of Energy – Gas Turbine Power Plant – Schematic Arrangement of Gas Turbine Power Plant – Comparisons of Various Power Plants	10
2.	Transmission Line Fundamental and Parameters: Introduction of Transmission lines - Constants of Transmission Lines – Flux Linkage in Current Carrying Conductors – Inductance of a Single Phase Two Wire Line and Composite Conductor Lines – Inductance of Three Phase Lines With Symmetrical and Unsymmetrical Spacing With and Without Transposition – Capacitance of a Single Phase and Three Phase Transmission Line- Bundled Conductors - Resistance in Transmission Lines – Skin Effect- concept of corona – Proximity Effect – Introduction to Double Circuit Three Phase Lines.	06
3.	Reactors and Insulator: Introduction to Reactors, Need and Types of Reactors – Location of Reactors – Selection of Power Reactors, Application of Reactor in Power System. Introduction to Insulators, Need, types of Insulators, Location of Insulator, Selection of Insulators, Consideration of Interface and corona, Tests on Insulator, characteristics of Insulator, string efficiency	04
4.	Sub-stations: Introduction – Classification of Sub-station, Types and comparison of Sub-station, Symbols for equipment in Sub-stations, Elements in a Transformer, Bus-bar Arrangements in Substation, Under Ground Sub Stations, Details of Indoor Substation.	05
5.	Power Factor Improvement: Power Factor, Power Triangle, Disadvantages of Low Power Factor, Causes of Low Power Factor, Advantages of Power Factor Improvement, Methods of Improving Power Factor – Calculations of Power Factor Correction – Most Economical Power Factor	06
6	Power System performance, Operation, Management and New Trends and Technology: Introduction- Concept of Series and Shunt Compensation – Concept Power System Stability – Introduction to FACTS Controllers – Power Electronics Interface with Renewable Energy Sources, Concept of Grid- Types of Grids and its importance in Power System.	05
7	HVDC Transmission: Introduction, Converter Basics, Types of DC Links, Structure and Principles of HVDC Control – Converter Performance – Advantages and Disadvantages – Applications	04
8	AC and DC Transmission and Distribution System:	05



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	Elements of Transmission and Distribution System - Concept of grounding and Earthing - Isolated Neutral – Requirement and Advantages of Neutral Grounding – Earth Neutral Systems: Solid, Resistance and Resonant Grounding (Earthing) – Arc Suppression Coil Grounding (Resonant Grounding) – Voltage Transformer Earthing – Grounding (Earthing) Transformer – Introduction and types of Cable.	
Total		45

Reference Books:

1. Principles of Power System, Fourth Edition by V. K. Mehta & Rohit Mehta,
2. Modern Power System Analysis, Fourth Edition by Kothari & Nagrath
3. Electrical Power, Dr. S.L. Uppal
4. Electric Power Generation: Transmission and Distribution, S. N. Singh.
5. Electrical Power Systems by C. L. Wadhwa
6. HVDC Power Transmission Systems by K. R. Padiyar.
7. A Textbook of Power System Engineering, A Chakrabarti, M. L. Soni, P. V. Gupta, U. S. Bhatnagar
8. Utilization of Electric Power and Electric Traction by J.B. Gupta
9. Power System Analysis by J. B. Gupta.

Suggested Course Practical List:

1. Survey of generation scenario and power plants of Gujarat and India.
2. Plotting I-V and P-V Characteristics of a Solar Panel.
3. Simulation of Inductance and Capacitance for Transmission Lines
4. Simulation of Balanced and Unbalanced Loads on Three-Phase Systems
5. Study of Skin and Proximity Effects on Conductor Resistance
6. Study of Corona Discharge
7. Study of Sag and Tension in Overhead Lines
8. Insulator String Efficiency and Flashover Testing
9. Study of Grounding
10. Preparation of Substation Layout
11. Study of Substation Bus-Bar Arrangements
12. Power Factor Improvement Using Capacitor Banks
13. Series and Shunt Compensation of Transmission Lines
14. Basic HVDC Link Simulation

List of Laboratory/Learning Resources Required:



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1. PC with appropriate simulation software.
2. Learning resources: NPTEL website courses
3. Web-based tools for design: - <https://etap.com/> <http://www.rpowerlabs.org/>
4. Open source Math Tools: - <http://maxima.sourceforge.net/>, <http://www.sagemath.org/>, <http://www.scilab.org/>, <http://www.gnu.org/software/octave/>
5. Learning website: <https://nptel.ac.in/courses/108105067/1>, <https://nptel.ac.in/courses/108102047/>, <https://nptel.ac.in/courses/108101040/download/lec-18a.pdf>, <https://nptel.ac.in/courses/108108078/1>,

• Activities suggested under Problem Based Learning:

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	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.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on video learning outcomes.
3.	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding-based assignments of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course based on the certificate produced.
6.	Complex problem solving	Maximum 2 problems. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7.	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8.	Discussion on research paper based on relevant subject	5 research papers = 20 h	Summarize research paper and evaluation critical parameters



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Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
9.	Poster/chart /power point preparation on technical topics	Duration = 6 h	Based on poster / chart Preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h non-working = 8 h	Based on inter department/ external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/ environment/ health/ any other issue	Duration = 10 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging / trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	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.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software

Note:

- All the suggested activities should be related to the subject.
- The number of hours are 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.
- 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.
- 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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