GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3140914

Semester – IV
Subject Name: Power Systems – I

Type of course: Engineering – Professional Core Course

Prerequisite: Fundamental knowledge of Electrical Engineering

Rationale: The course is aimed to provide exposure about methods of electricity generation, various AC supply systems, transmission lines and their parameters, underground cables and their parameters, substation equipments, neutral grounding and sources of over-voltages and protection against them

Teaching and Examination Scheme:

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Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1.	**Conventional Generation, Load Curves and Tariffs:** Generation scenario in India and Gujarat Steam power station, Schematic arrangement of steam power station, Equipments 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, Examples.	08	08
2.	**Introduction to Wind and Solar Power Generation:** The wind power plant – Introduction, wind turbine classes, Wind Turbine Components (Rotor, Nacelle, Tower, Electric Substation, Foundations)	08	10

	Wind Energy Conversion – Rotation principle, Forces on a rotor blade, Factors affecting performance of rotor (Aerodynamic efficiency, tip speed, tip seep ratio etc.), Thrust and torque on rotor, Power curve. Topologies and operation characteristics of SCIG based wind turbine power plant. Working Principal and operation characteristic of WRIG based wind turbine power plant. Concentrated Solar Power (CSP) plant Operation and its working, Photovoltaic Conversion – Introduction, Description and principle of working, performance characteristics of a solar cell, types of solar cell, photovoltaic system applications, Stand-alone PV system configurations, Grid-connected PV systems.		
3.	**Electrical Supply Systems:** Electric supply system, Typical ac power supply scheme, Advantages of high transmission voltage, Overhead v/s underground systems, Requirements of a distribution system, Connection schemes of distribution system. AC Distribution – Methods of solving AC distribution problems, Four wires star connected unbalanced load,Examples.	05	07
4.	**Power Factor and Power Factor Improvement of Load:** **Power factor, Power factor triangle, Causes of low power factor, Disadvantages of low power factor, Power factor improvement, Power factor improvement equipment, Calculations of power factor correction, Most economical power factor, Examples.**	05	08
5.	**Mechanical Features and Design of Overhead Transmission Line:** Main components of overhead lines, Conductor materials, Line supports, Insulators, Types of insulators, String efficiency, Methods of improving string efficiency, Examples, Sag in overhead lines, Calculation of sag, Examples.	08	15
6.	**Transmission Line Parameters:** Line resistance, Inductance of single conductor, Inductance of single phase lines, Flux linkages in terms of self and mutual inductances, Inductance of 3-phase transmission lines – Symmetrical spacing, asymmetrical spacing and transposed lines, Inductance of composite conductors, Inductance of 3-phase double circuit lines, Examples. Line capacitance, Capacitance of single phase lines, Capacitance of three phase lines, Effect of bundling, Capacitance of three phase double circuit	14	24

	lines, Effect of earth on the capacitance, Examples.		
7.	**Underground Cables:** Underground cables, construction of cables, Insulating materials of cables, Classification of cables, Cables for 3-phase service, Insulation resistance of a single core cable, Capacitance of a single core cable, Dielectric stress in single core cable, Most economical conductor size in cable, Grading of cables, Capacitance grading, Inter-sheath grading, Capacitance of 3-core cables, Measurement of core to core and core to earth capacitances, Examples.	07	12
8.	**Substations:** Classification of substations, Transformer substation, Pole mounted substation, Underground substation, Symbols for equipments in substations, Equipments in a transformer substation, Bus-bar arrangements in substations, Terminal and through substations, Key diagrams of 66/11 kV substation and 11/400 kV indoor substation.	04	08
9.	**Neutral Grounding:** System with ungrounded neutral, Neutral grounding, Advantages of neutral grounding, Methods of neutral grounding – Solid grounding, Resistance grounding, Reactance grounding, Resonant grounding, Voltage transformer earthing, Grounding transformer.	05	08

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	25	25	20	15	0

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (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.

Reference Books:

1. Principles of Power System: V. K. Mehta, Rohit Mehta, S. Chand Publications
2. Wind Power Technology: Earnest Joshua, PHI Learning Pvt. Ltd.
3. Solar Energy: S. P. Sukhatme, McGraw Hill Education India Pvt. Ltd.
4. Power System Analysis: Hadi Saadat, McGraw Hill Education India Pvt. Ltd.
5. Electrical Power systems: C. L .Wadhwa, New Age International Publishers
6. Electrical Power Systems: Dr. S. L. Uppal, Prof. S. Rao, Khanna Publications

7. Elements of Power Systems Analysis: W. D. Stevenson Jr., 4th Edition, McGraw Hill Education.
8. Power System Analysis : John J. Grainger, William D. Stevenson Jr., McGraw Hill Education
9. Modern Power system Analysis by I J Nagrath, D P Kothari, McGraw Hill Education

Course Outcome (Theory):

After learning the course, the students should be able to:

Sr. No.	CO Statement	Marks % Weightage
1.	Compare various means of electricity generation and evaluate load curves, tariff structures and power factor and load power factor improvement.	26
2.	Carry out mechanical design of overhead line.	15
3.	Compute resistance, inductance and capacitance of overhead lines and underground cables.	36
4.	Acquire knowledge about electrical supply system, substation equipments & layout and methods of neutral grounding.	23

Course Outcome (Laboratory):

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

1. Become conversant about generation scenario and power plants in Gujarat and India.
2. Develop programs for computations of design and performance parameters of power system transmission line and grounding.
3. Analyze unbalanced and balanced loading on the three phase supply systems, compute neutral current and examine its effect on its operation.

List of Experiments:

Suggested list of practicals but not limited to:

1. Survey of generation scenario and power plants of Gujarat.
2. Survey of different type of power plants of India to observe the power and energy supplied by them daily, their rates of energy, daily schedule etc.
3. Plot VI and PV characteristics of solar cell/panel.
4. Simulation of three phase system with three phase balanced load with neutral grounded
5. Simulation of three phase system with three phase load, effect of unbalanced load on the voltages of phases with and without neutral grounded.
6. Write a program to calculate string efficiency of string of insulating discs for voltage levels upto

400 kV.

7. Write a program for calculating line inductance for different conductor configurations and dimensions.
8. Write a program for calculating line capacitance for different configurations and design of line.
9. Write a program for calculating sag of transmission line under different loading conditions.
10. Prepare layout of substation for a given bus arrangement and given voltage rating with all necessary equipments.
11. Write a program for calculating voltage drop in a radial AC feeder.