GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRICAL & ELECTRONICS ENGINEERING (08) & ELECTRICAL ENGINEERING (09)

ELECTRICAL POWER GENERATION

SUBJECT CODE: 2140908

B.E. 4th SEMESTER

Type of Course: Engineering Science (Electrical)

Prerequisite: Nil

Rationale: The course will provide understanding of power generation technology using conventional and non conventional energy sources which will be useful for understanding the operation and working of power plants. Students will learn basics of Tariff structure for energy production. Students will understand the operation, maintenance and working of substations.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	Introduction: Amount of generation of electric power from Conventional and non conventional sources of energy in Gujarat and India and some developed countries of the world.	01	00
2	Steam power station: Schematic arrangement, advantages and disadvantages, choice of site, efficiency of steam power station, Types of prime movers, characteristic, speed control & auxiliaries. Environmental aspects for selecting the sites and locations of thermal power stations.	04	08
3	Hydro power station: Schematic arrangement, advantages and disadvantages, choice of site constituents of hydro power plant, Hydro turbine. Environmental aspects for selecting the sites and locations of hydro power stations	03	06
4	Nuclear power station: Schematic arrangement, advantages and disadvantages, selection of site, types of reactors, Hazards, Environmental aspects for selecting the sites and locations of nuclear power stations.	03	06
5	Diesel power station: Introduction, Schematic arrangement, advantages and disadvantages, Choice and characteristic of diesel engines, auxiliaries.	03	06
6	Gas turbine power plant:	03	06

	Schematic arrangement, advantages and disadvantages of Gas turbine power plant. Open cycle and Closed cycle gas turbine power plant, Combined cycle power plant, Comparison of various power plants		
7	Tariff and Economic aspects in power Generation: Terms commonly used in system operation, various factors affecting cost of generation: Load curves, load duration curves, Connected load, maximum load, Peak load, base load and peak load power plants, load factor, Plant capacity factor, Plant use factor, Demand factor, diversity factor, Cost of power plant, Tariffs	05	10
8	Power Generation by Non Conventional Energy Sources: . Introduction**:**Need of Renewable energy • Fossil fuel based systems • Impact of fossil fuel based systems • Non-conventional energy – seasonal variations and availability • Renewable energy – sources and features • Distributed energy systems and dispersed generation (DG)	03	06
9	Photovoltaic Power Conversion systems**:** • Solar radiation spectrum. • Radiation measurement. • Applications of solar thermal systems **1.** Heating **2.** Cooling **3.** Drying **4.** Distillation **5.** Power generation • Solar Photovoltaic(SPV) systems 1. Operating principle 2. Photovoltaic cell concepts 3. Types of solar cells, fabrication of SPV cells 4. Cell, module, array (Series and parallel connections) 5. SPV system components and their characteristics, applications 6. Block diagram of general SPV system 7. Battery sizing and Array sizing • Applications of Solar Photovoltaic systems 1. Battery charging 2. Pumping 3. Lighting • Green Building (Solar – thermal, Solar – PV) 1. Sizing residential systems 2. Batteries and Inverters • Present Status of PV in India • Governmental incentives, Numerical	08	16
10	Wind Power Conversion System**:**	09	16

	• Introduction to wind energy • basic principles of wind energy conversion • forces on the blade • power in the wind – maximum power • wind energy conversion – wind data and (qualitative treatment only) energy estimation • Basic components of wind energy conversion systems • classifications of WECS-HAWT, VAWT, Geared wind power plants (WPPs), direct-drive WPPs and Hybrid (semi-geared) WPPs • Schemes of electric generation • Squirrel Cage Induction Generators (SCIG), wound rotor (WRIG), doubly-fed (DFIG), wound rotor synchronous generator (WRSG), Permanent magnet synchronous generator (PMSG) • Comparison/ advantages and disadvantages of WECS. • Site selection considerations. Numerical		
11	Substation Classification of Substations, substation equipments, Specification and selection of equipments, Site selection of substation	05	10
12	Neutral Earthing: Introduction, isolated neutral, earth neutral systems-solid, resistance, reactance. Arc suppression coil, voltage transformer and earthing, transformer, earthing systems.	05	10

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
35%	35%	15%	10-15%	0-05%

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate 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. A Text book of Power System Engineering, A Chakrabarti, M. L Soni, P. V. Gupta, U. S. Bhatnagar, Dhanpat Rai Publication
2. Renewable Energy Technologies, Solanki, Chetan S. , PHI Learning, New Delhi, 2011
3. Wind Power Technology, Earnest, Joshua, PHI Learning, New Delhi, 2013
4. Renewable Energy Sources for Sustainable Development, N.S. Rathore and N. L. Panwar, New India Publishing Agency, New Delhi
5. Wind Power in Power System, Thomas Ackermann, John Willey &Sons, 2005
6. Renewable Energy Resources, J. Twidell and T. Weir, E & F N Spon Ltd, London, 1999
7. Electric Power Generation: Transmission and Distribution, S. N. Singh, PHI Learning, New
8. Electrical Power, Dr. S.L. Uppal

Course Outcomes:

After learning the course the students should be able to:

1. Describe the working of thermal power station (TPS) using single line diagram and state the functions of the major equipment and auxiliaries of a TPS.
2. Explain hydro energy conversion process with block diagrams and identify the appropriate site for it.
3. Explain the working of Nuclear power station.
4. Describe the working ofDiesel power station and Gas turbine power plant.
5. Compare various economic aspects of different types of Tariffs.
6. Classify various substations and describe working of its equipments.
7. Measure earth resistance.
8. Describe and compare various types of Neutral Earthing.
9. Measure Solar insolation using Optical pyranometer
10. Obtain I-V characteristics and performance analysis of Solar cell/module/Array modelling,
11. Design module and its output analysis
12. Identify various components of Wind Energy Conversion system.
13. Prepare economic analysis for Commercial/ Industrial/ Residential PV energy conservation systems.
14. Compare various generating systems of Wind farm.

List of Experiments: (This is a suggestive list only)

1. Interpret the line diagram of Thermal Power Station (T.P.S.) and main cycles & explain working of T. P. S.
2. Prepare technical report of visit to a nearby T.P.S./Prepare a report on thermal power stations in Gujarat by collecting data from Internet
3. Study on load curve preparation and its interpretation.
4. Prepare technical report of visit to a nearby H.P.S./Prepare a report on Hydro power stations in Gujarat by collecting data from Internet.
5. Visit the website of MNRE/GEDA and prepare a report.
6. Draw and Interpret schematic diagram of gas based power plant
7. Study and working of various Equipments used in Diesel power plant/Diesel power plant
8. Study and working of various Equipments used in Nuclear power plant/Nuclear power plant
9. Study of Substation layout and equipments used in substations
10. Solar insolation measurement using Optical **pyranometer**
11. Solar cell/module/Array modelling, I-V char and performance analysis
12. PV module design and output analysis
13. Energy Conversion in Wind. (Prototype Wind Mill ~~of 500W~~)
14. Case studies of Commercial/ Industrial/ Residential PV energy conservation systems and their economic analysis
15. Visit of Wind farm. Analysis of various aspects of wind farm
16. Study of Lead Acid Battery as a energy storage.
17. Wind power and annual energy estimation from wind data.
18. Pay back analysis, financial work sheet of a renewable energy project

Design based Problems (DP)/Open Ended Problem:

Major Equipment:

1. Model s of various equipments used in power plants/ power plants
2. Solar module.

3. Optical **pyranometer**
4. Storage batteries – charging/discharging kit.
5. 2 kW concentrated solar power (CSP) system
6. 1 kW direct-drive small wind turbines
7. 5 kW geared small wind turbine

List of Open Source Software/learning website:

MATLAB/Scilab

1. Solar cell/module/Array modeling and I-V curve
2. Simulation of Battery charging/discharging

Active Learning Assignments (ALA) : Preparation of power-point slides: which may include videos, animations, pictures, graphics for better understanding of theory and practical work. The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus can be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of faculty and the department.