GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering (Part Time)
Subject Code: 2951910
Semester –V

Subject Name: RENEWABLE ENERGY ENGINEERING

Type of course: Elective

Pre requisite: Fluid Mechanics, Heat Transfer

Rationale: The course is designed to give knowledge of various renewable energy sources, systems and applications in the present context and need.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Scenario of Renewable Energy (RE) Sources:** Need of RE, advantages and limitations of RE, present energy scenario of conventional and RE sources.	1	2
2	**Solar Energy:** Energy available from the sun, spectral distribution, solar radiation outside the earth's atmosphere and at the earth's surface, solar radiation geometry, Instruments for solar radiation measurements, empirical equations for prediction of availability of solar radiation on horizontal, radiation on and tilted surface. Solar energy conversion into heat, types and working of solar collectors, evacuated and non-evacuated solar air heater, concentrated collectors, losses in liquid flat plate collector, thermal analysis of liquid flat plate collector, air heater and cylindrical parabolic concentrating collector, solar energy thermal storage, Solar space heating and cooling of buildings, solar pumping, solar cooker, solar still, solar drier, solar refrigeration and air-conditioning, solar pond, heliostat, solar furnace, photovoltaic system for power generation, solar cell modules and arrays, solar cell types, material, applications, advantages and disadvantages.	19	42
3	**Wind Energy:** Energy available from wind, basics of lift and drag, basics of wind energy conversion system, Betz limit theory, effect of density, angle of attack and wind speed, wind mill rotors, horizontal and vertical axes rotors, drag, lift, torque	8	18

	and power coefficients, tip speed ratio, solidity of turbine, wind turbine performance curves, wind energy potential and site selection, basics of wind farm, Safety and environmental aspects, wind energy potential and installation in India.		
4	**Bio Energy:** Biomass energy – modern energy carrier, energy plantation, gasification, types and applications of gasifiers, types of biogas plants, design of biogas plant, factors affecting biogas generation. advantages and disadvantages.	4	9
5	**Ocean Energy:** OTEC principle, open, closed and hybrid cycle OTEC system, Energy from tides, estimation of tidal power, tidal power plants, single and double basin plants, site requirements, advantages and limitations **Wave energy**: Wave energy conversion devices, advantages and disadvantages, Present scenario. **Geothermal energy:** Introduction, vapor and liquid dominated systems, binary cycle, hot dry rock resources, magma resources, advantages and disadvantages, applications. **MHD Power generation:** concept and working principle.	7	16
6	**Economic Analysis:** Initial and annual cost, Basic definitions Fundamentals of economic analysis, time value of money, payback period, present worth calculations, repayment of loan in equal annual installments, annual solar savings, cumulative saving and life cycle cost analysis, economic analysis of solar system, clean development mechanism	6	13

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**14**	**20**	**10**	**10**	**6**

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. Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme and J. K. Nayak, McGrawHill Education
2. Solar Engineering of Thermal Processes, John A. Duffie, William A. Beckman, John Wiley, New York
3. Non-conventional Energy Resources, B. H. Khan, Tata McGraw Hill
4. Non-Conventional Resources of Energy, G. S. Sawhney, PHI
5. Non-conventional energy resources, Shobh Nath Singh, Pearson India
6. Solar Energy Engineering, Soteris Kalogirou, Elsevier/Academic Press.
7. Principles of Solar Energy, Frank Krieth & John F Kreider, John Wiley, New York

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Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To design and develop solar systems for various applications To estimate solar radiation on the various surfaces and its applications for thermal and photovoltaic system.	20
CO-2	To analyze the performance of various solar collectors.	20
CO-3	To evaluate the potential of wind energy conversion systems.	15
CO-4	To illustrate Bio energy, Wave energy, Ocean energy and Geothermal Energy.	30
CO-5	To evaluate the life cycle cost and carry out economic analysis of renewable energy sources.	15

List of Experiment:

1) To study and measure the solar radiation on horizontal and tilted surface using solar radiation measuring instruments.
2) To evaluate the performance of solar liquid flat plate collector.
3) To evaluate the performance of solar air heater.
4) To evaluate the performance of concentrating collectors.
5) To evaluate the performance of solar still.
6) To evaluate the performance of box type solar cooker.
7) To study the various types of wind mill and evaluate the performance parameter of wind. mill.
8) To study the various types of gasifier and biogas plant.
9) To study the ocean energy, wave energy, geothermal energy conversion systems.
10) To estimate the economics of the solar energy conversion equipment.

Major Equipment:

Pyranometer, Sunshine recorder, Solar power meter, Solar liquid flat plate collector, Solar air heater, Cylindrical Parabolic Collector, Compound parabolic collector, Box type solar cooker, Solar drier, Solar still, wind mill.

Requirement: The paper setter is requited to ensure that empirical correlations and relevant data for analysis of problems be provided in question paper. No separate Energy data book is required to be provided in examination.

List of Open Source Software/learning website:

1) http://vlab.amrita.edu/
2) https://nptel.ac.in/courses/112/105/112105051/
3) https://nptel.ac.in/courses/108/105/108105058/
4) https://nptel.ac.in/courses/121/106/121106014/
5) http://ocw.mit.edu/courses/energy-courses/