GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering (Mechanical, Energy Engineering)
Subject Code: 3723918
Semester – II
Subject Name: Solar Thermal Energy and Utilization

Type of course: Core Course

Prerequisite: Knowledge of thermodynamics and Heat transfer

Rationale: The course intends to provide knowledge of solar energy geometry, solar thermal energy collection devices, application of solar thermal energy and solar economics to graduate students.

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)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
1	**Solar Radiation:** Source of radiation, solar radiation geometry, solar radiation on horizontal surface and tilted surface, Empirical relation for the calculation of solar radiation, Solar radiation measuring instruments.	6
2	**Solar Non-Concentrating Collectors:** Introduction and classification of solar non-concentrating collector, Transmissivity-Absorptivity product, Overall losses and heat transfer coefficient and its calculation using empirical correlations in solar flat plate collector, Evacuated solar collector, Solar air-heater, Performance of solar flat plate collector and solar air-heater, Transient analysis, Testing procedure for solar flat plate collector and solar air-heater. Effect of various parameters on the performance of collector.	12
3	**Solar Concentrating Collectors:** Introduction and classification of solar concentrating collector, Tracking modes and performance of cylindrical parabolic collector, Solar swing angle, tracking requirement and performance of compound parabolic collector, Calculation of overall loss coefficient for concentrating collector, Effect of various parameters on the performance of collector, second law analysis, minimum entropy generation rate, optimum collector, temperature, non-isothermal collector.	9
4	**Solar Thermal Applications:** Introduction of central receiver tower and its performance evaluation, Introduction, working and performance analysis of solar pond, Solar water heating system - active and passive, Solar space heating system - active and passive, Solar cooling system - absorption and adsorption refrigeration system, Solar desalination systems – solar stills, Solar dryer, Solar chimney, Solar irrigation system, Solar dehumidifier, Solar power system, Solar Furnace, Solar Cooker, Solar production of hydrogen. Introduction and basic fundamentals of energy storage - sensible, latent heat and thermo- chemical storage, *f*-charts for basic solar system and utilizability methods.	8
5	**Solar Economic Analysis:** Various cost involved in solar economic analysis, Life cycle analysis, time value of money, description of the life cycle analysis method, the P1, P2 method, uncertainties in economic analysis.	7

GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering (Mechanical, Energy Engineering)
Subject Code: 3723918

Suggested Specification table with Marks (Theory): (For BE only)

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

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, McGraw Hill.
2) Solar Engineering of Thermal Processes, J. A. Duffie and W. A. Beckman, Wiley.
3) Solar Energy: Fundamentals, Design, Modeling and Applications, G. N. Tiwari, Alpha Science International Limited.
4) Solar Energy Engineering – Process and Systems, Soteris A Kalogirou, Academic Press.
5) Principles of Solar Engineering, D. Y. Goswami, F. Kreith and J. F. Kreider, Taylor and Francis.
6) Solar Energy: Fundamentals and Applications, H. P. Garg and Jai Prakash, McGraw Hill.
7) Engineering Thermodynamics of Thermal Radiation for Solar Power Utilization, R. Petela, McGraw Hill.
8) Fundamentals for solar energy conversion, Edward E. Anderson, Addison Wesley Publ. Co.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To appraise the concept of solar radiation and principle of measuring instruments.	12%
CO-2	To analyze non-concentrating collectors.	30%
CO-3	To analyze concentrating collectors.	20%
CO-4	To discuss various applications of solar thermal energy.	20%
CO-5	To make calculations of the life cycle analysis method and uncertainties in solar economic analysis.	18%

List of Experiments:

1) To study and performance of the solar radiation measuring instruments.
2) To study and performance evaluation of solar flat plate collector.
3) To study and performance evaluation of solar air heater.
4) To study and performance evaluation of concentrating collectors.
5) To study and performance evaluation of solar still.
6) To study and performance evaluation of solar air-dryer.
7) To study and performance evaluation of box type solar cooker.
8) To study and performance evaluation of solar pond.
9) To study and performance evaluation of solar water heater.
10) To study the solar thermal power systems, solar irrigation system and solar chimney.

Major Equipment:
Pyrenometer with shading ring, Pyreheliometer, Sunshine recorder, Solar flat plate collector, Solar air heater, Cylindrical Parabolic Collector, Compound Parabolic Collector, Box type solar cooker, Solar drier, Solar still, Solar pond, Solar water heater.

Requirement: Solar energy data book containing correlations are required for examinations.

List of Open Source Software/learning website:

1) http://ocw.mit.edu/courses/energy-courses/
2) https://nptel.ac.in/courses/112105051/
3) https://nptel.ac.in/courses/121106014/18