



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Energy Engineering

Subject Code: ME02075011

Course / Subject Name: Solar Thermal Energy and Utilization

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	PCC

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.

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

No	Course Outcomes	RBT level
CO-1	Apply the concept of solar radiation and principle of measuring instruments.	Apply
CO-2	Analyze non-concentrating collectors.	Analyze
CO-3	Analyze concentrating collectors.	Analyze
CO-4	Apprise various applications of solar thermal energy.	Evaluate
CO-5	To make use of life cycle analysis method and uncertainties for economic analysis of solar thermal systems.	Apply

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
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	5	10



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2	Solar Non-Concentrating Collectors: Classification of solar non-concentrating collector, transmissivity-absorptivity product, overall losses and heat transfer coefficient and its calculation using empirical correlations for 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, nano fluid in solar collector, benefits of use of nanofluids in solar collectors	13	30
3	Solar Concentrating Collectors: 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	10	22
4	Solar Thermal Applications: Central receiver tower and its performance evaluation, 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 energy for production of hydrogen, fundamentals of energy storage - sensible, latent heat and thermo- chemical, f-charts for basic solar system and utilizability methods	10	22
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	16
Total		45	100

Requirement: Empirical correlations and relevant data in the form of charts/ tables etc. which are required to solve numerical must be provided by the paper setter in the question paper.

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
-	20	50	20	10	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)



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References/Suggested Learning Resources:

(a) Books:

1. Solar Energy – Principles of Thermal Collection and Storage by S. P. Sukhatme, McGraw Hill
2. Solar Engineering of Thermal Processes by J. A. Duffie and W. A. Beckman, Wiley
3. Solar Energy: Fundamentals, Design, Modeling and Applications by G. N. Tiwari, Alpha Science International Limited
4. Solar Energy Engineering – Process and Systems by Soteris A. Kalogirou, Academic Press
5. Principles of Solar Engineering, by 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.

(b) Open-source software and website:

1. <http://ocw.mit.edu/courses/energy-courses/>
2. <https://www.coursera.org/courses?query=solar%20energy>
3. <https://www.solarenergy.org/free-learning/>
4. <https://nptel.ac.in/courses/112105051/>
5. <https://nptel.ac.in/courses/121106014/18>

Practical List:

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

List of Laboratory/Learning Resources Required: Pyranometer with shading ring, Pyrheliometer, Sunshine recorder, Solar flat plate collector, Cylindrical Parabolic Collector, Compound Parabolic Collector, Solar air heater, Solar water heater, Box type solar cooker, Solar drier, Solar still, Solar Pond

Suggested Project List: (1) IoT based Monitoring System using Solar Energy (2) Wireless Power Transmission using Solar Energy (3) Harvesting Project based on Solar Energy (4) Solar Powered Auto Irrigation System



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Suggested Activities for Students: Students can make the prototype of different types of solar collectors, solar stills with consideration of all design criteria.
