GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Mechanical Engineering (Thermal Engineering)

Course / Subject Code : ME01083021

Course / Subject Name : Solar Energy Engineering

w. e. f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PEC

Prerequisite:	Nil
Rationale:	The course is designed to give knowledge and relevant technologies in the area of solar energy

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT level
1	Apply the concepts of solar radiation and make use of the measuring instruments	Apply
2	Choose appropriate concentrating and non-concentrating collectors for given requirements	Evaluate
3	Select proper solar thermal device for given requirements	Apply
4	Analyze solar thermal power systems	Analyze
5	Compare different solar thermal devices using different methods of economic analysis	Evaluate

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	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 measuring instruments, solar constant, solar radiation on tilted surface, solar charts	5	12

2.	**Solar Concentrating Collectors:** Optical and thermal analysis of compound parabolic collectors, optical and thermal analysis of parabolic through collectors, second law analysis, minimum entropy generation rate, optimum collector temperature, non-isothermal collector, solar non-concentrating collectors, design considerations	8	18
3.	**Performance of Solar Collectors:** Collector thermal efficiency, collector energy losses, collector incident angle modifier, concentrating collector acceptance angle, collector time constant, dynamic system test method, collector test results and preliminary collector selection, quality test methods, analysis of concentric tube collector	9	20
4.	**Solar Thermal Applications:** Selection criteria of storage materials for heating and cooling applications, selection of heat transfer fluid for heating and cooling applications, active and passive solar water heating system, solar space heating, solar cooling with absorption and adsorption refrigeration, solar desalination systems, solar powered absorption air conditioning system, solar irrigation system, solar chimney, drier, dehumidifier, solar still	9	20
5.	**Solar Thermal Power System:** Parabolic through collector system, power tower system, dish systems, thermal analysis of solar thermal power plants, solar ponds, *f*-chart and utilizability methods	7	15
6.	**Solar Economic Analysis:** Life cycle analysis, time value of money, description of the life cycle analysis method, the P_1, P_2 method, uncertainties in economic analysis, construction concepts, energy storage -sensible, latent heat and thermo-chemical storage - pebble bed etc. Materials for phase change - Glauber's salt - organic compounds, solar ponds	7	15
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
-	-	**35**	**15**	**50**	-

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

References/Suggested Learning Resources:
(a) Books:

1. Solar Engineering of Thermal Processes, Duffie J A, Beckman W A, Wiley
2. Solar Energy Engineering – Process and Systems, Soteris A Kalogirou, Academic Press
3. Solar Energy – Principles of Thermal Collection and Storage, S P Sukhatme, McGraw Hill
4. Principles of Solar Engineering, D Y Goswami, F Kreith and J F Kreider, Taylor and Francis
5. Engineering Thermodynamics of Thermal Radiation for Solar Power Utilization, Petela R, McGraw-Hill
6. Fundamentals for solar energy conversion, Edward E Anderson, Addison Wesley Publ. Co.
7. Thermal Energy Storage , Dincer I, Rosen M, Wiley

(b) Open-source software and website:

1. https://onlinecourses.nptel.ac.in/noc24_ge51

Suggested Course Practical List:

1. Measurement of solar radiation using pyranometer and other solar radiation measuring instruments.
2. Performance evaluation of solar flat plate collector.
3. To study the effect of solar flat plate collector in parallel combination.
4. Performance evaluation of concentrating solar collector.
5. To study the effect of concentrating solar collector in series arrangements.
6. Performance evaluation of solar cooker.
7. Performance evaluation of solar air dryer.
8. Performance evaluation of solar still.
9. To compare of solar thermal power systems.
10. Performance evaluation of solar funnel.

List of Laboratory/Learning Resources Required: Pyranometer, pyrheliometer, solar flat plate collector, solar air heater, solar dryer, concentrating solar collector, solar cooker, solar still

Suggested Project List:

1. Design a solar dryer for a specific product
2. Develop a solar cooker for a family
3. Develop a solar still for desired output

Suggested Activities for Students: Students are required to download 3-5 research papers from reputed international journals on the recent advancement in the areas of solar energy. They need to go through the same and prepare a review for the research papers. The review should have three parts: Summary, Critical Evaluation and Creative synthesize

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