



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: PG

Branch: Energy Engineering

Subject Code: ME02075051

Subject Name: Solar Refrigeration and Air-Conditioning Engineering

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

Prerequisite :	Knowledge of Thermodynamics, Alternate fuels
Rationale:	The course is design to provide comprehensive knowledge of solar energy conversion and utilization, understanding of various cooling technologies, various challenges to apply solar energy in air-conditioning or cooling technologies in different environments

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT level
CO-1	Explain basics of thermodynamic, refrigeration cycles and properties of refrigerants.	Understand
CO-2	Develop solar energy conversion systems with different available technologies.	Apply
CO-3	Examine cooling load calculation for the specific volume.	Analyze
CO-4	Analyze and evaluate the solar air-conditioning system.	Evaluate
CO-5	Evaluate the economics of solar refrigeration and air-conditioning systems	Evaluate

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



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Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Recapitulation of Refrigeration and Air-conditioning: Working and performance analysis of refrigeration cycles (vapor compression refrigeration system, vapor absorption refrigeration system etc.), types of refrigerants, characteristics of refrigerants, performance enhancement techniques for vapor compression and absorption refrigeration system, Psychrometry, psychrometric chart, Various psychrometric processes and analysis, different types of air-conditioning system, cooling and heating load calculation for enclosed spaces	7	15
2.	Solar energy: Source of solar radiation, solar radiation geometry, solar constant, solar radiation on horizontal and tilted surface, solar radiation measuring instruments. Solar Photovoltaic (PV): PV cell, module and array, energy storage, different materials for PV cell, present and proposed PV cell, maximizing PV cell performance, exotic junctions, photovoltaic system design, stand-alone PV system, solar photovoltaic air-conditioning system: design specification and implementation, PV power remote and mountain cabin: design specification and implementation, Hybrid system: design specification and implementation, small and medium utility interactive system	14	25
3.	Air-conditioning systems: Classification of refrigeration and air-conditioning systems, potential of solar energy in refrigeration systems and air-conditioning systems, domestic refrigeration systems and air-conditioning systems, automobile air conditioning systems	11	25
4.	Economic analysis of solar refrigeration and air-conditioning system: various cost involved in solar energy-based equipment, present worth calculation, repayment of loan in instalments, life cycle savings method, payback period, economic analysis for solar energy-based refrigeration and air-conditioning systems	11	25
5.	Servicing and maintenance: Solar PV panel cleaning, refrigerant leakage, electrical trouble shootings	3	10
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
-	20	40	20	20	-



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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 Energy: Principles of Thermal Collection and Storage by S. P. Sukhatme and J. K. Nayak, McGraw Hill
2. Solar Engineering of Thermal Processes by J. A. Duffie and W. A. Beckman, Wiley
3. Solar Energy: Fundamentals, Design, Modelling and Applications by G. N. Tiwari, CRC Press
4. Refrigeration and Air Conditioning by C. P. Arora, McGraw-Hill India
5. Refrigeration and Air Conditioning by Manohar Prasad, New Age International Publisher
6. Solar Refrigeration and Air-Conditioning by J. C. McVeigh and A. A. M. Sayigh, Pergamon Press
7. Photovoltaic Systems Engineering by R. A. Messenger and J. Venture, CRC Press
8. Solar photovoltaics: Fundamentals, Technologies and Applications by Chetan Singh Solanki PHI learning

(b) Open-source software and website:

1. <https://archive.nptel.ac.in/courses/112/105/112105129/#>
2. <https://eslwebroom.com/article/best-free-solar-pv-system-simulation-design-software/1811>
3. <https://www.engineeringpassion.com/best-free-solar-pv-system-simulation-design-software/>
4. <https://www.sunbasedata.com/blog/are-there-any-open-source-solar-design-software>

Practical List:

1. To study the various refrigeration cycles.
2. To study the various components of solar energy systems.
3. To study the various components of refrigeration systems.
4. To conduct experiment for exact cooling load calculation.
5. To conduct the solar PV system design and simulation for required air conditioning load.
6. To conduct the practical for energy generation from solar PV.
7. A case study on solar based automobile air conditioning system.

List of Laboratory/Learning Resources Required: 2 kW Solar PV system test rig, Refrigeration/Air-conditioning test rig, Data acquisition system/Data logger, Standalone and multi-refrigerant charging machine, Soldering kit, Digital Multimeter, Weather station

Suggested Project List:

1. Development of mini solar refrigerator
2. Solar-based automobile air-conditioning system
3. Use of different refrigerants in solar based air-conditioning system

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