SCHEME OF COURSE WORK:

Course Details:

Course Title	Solar Energy Utilization					
Course Code	19ME2257	**LTPC**	**3**	**0**	**0**	**3**
Program	M.Tech.					
Specialization	Thermal Engineering					
Semester	II					
Prerequisites	Heat Transfer					
Course to which is a prerequisite	NA					

Course Outcomes:

CO1	Illustrate solar radiation measurements and various solar energy collectors
CO2	Explain various solar storing methods and thermal conversion systems
CO3	Design of solar photovoltaic energy conversion systems
CO4	Illustrate various solar energy based devices and their applications
CO5	Explain economic analysis of solar energy conversion devices

Program Outcomes:

PO Code	**Program Outcome (PO)**
PO1	exhibit in-depth knowledge in thermal engineering specialization
PO2	think critically and analyse complex engineering problems to make creative advances in theory and practice
PO3	solve problem, think originally and arrive at feasible and optimal solutions with due consideration to public health and safety of environment
PO4	use research methodologies, techniques and tools, and will contribute to the development of technological knowledge
PO5	apply appropriate techniques, modern engineering tools to perform modeling of complex engineering problems with knowing the limitations
PO6	understand group dynamics, contribute to collaborative multidisciplinary scientific research
PO7	demonstrate knowledge and understanding of engineering and management principles and apply the same with due consideration to economical and financial factors
PO8	communicate complex engineering problems with the engineering community and society, write and present technical reports effectively
PO9	engage in life-long learning with a high level of enthusiasm and commitment to improve knowledge and competence continuously
PO10	exhibit professional and intellectual integrity, ethics of research and scholarship and will realize the responsibility towards the community
PO11	examine critically the outcomes of actions and make corrective measures

Course Outcome Vs Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M		M	S			M					
CO2	M			S			M					
CO3	M	M	S	M			M					
CO4	M			M			M					
CO5			S	S			M					

S - Strongly correlated, M - Moderately correlated, Blank - No correlation

Assessment Methods:

Assignment/Quiz/Seminar/Case Study, Mid term exam and End term examination.

Teaching-Learning and Evaluation

Week	Topic/Content	CO	Sample Questions	Teaching-Learning Strategy	Assessment method & Schedule
1	**An overview of solar thermal applications:** Devices for thermal collection and storage, Thermal applications	CO1	Explain various thermal applications of solar energy. What are the various devices for thermal collection and storage?	Lecture	Assignment (week 4-6) Mid term exam (week 9)
1	**Solar radiation and measurement**: Solar constant, Solar radiation at the Earth's surface, Solar radiation geometry	CO1	What are the reasons for variation in solar radiation reaching the earth than received at the outside of the atmosphere?	Lecture	Assignment (week 4-6) Mid term exam (week 9)
2	Solar radiation measurement – Instruments, Estimation.	CO1	Calculate the angle made by beam radiation with the normal to a flat collector on December 12th for a location at 28o35' N. The collector is tilted at an angle of latitude plus 10o, with the horizontal and is pointing due south	Lecture and problem solving	Assignment (week 4-6) Mid term exam (week 9)
3	**Solar energy collectors**: Physical principle of collection, Different types – Liquid flat plate collectors, Thermal analysis of flat plate collectors, Focusing-concentrating collectors – Performance analysis	CO1	What are the main components of a flat plate collector, explain its working with a neat sketch. Describe the advantages and limitations of concentrating collectors over flat plate collectors	Lecture	Assignment (week 4-6) Mid term exam (week 9)
4, 5	**Solar energy storage**: Classification – Thermal, Electrical, Chemical, Mechanical, Electromagnetic type of solar energy storage. Application.	CO2	What are the different solar mechanical storage systems? Explain. Find the stored energy per unit volume and mass of the pebble bed to store heat for air-type solar heating system, when its temperature is to be raised by 16oC. The bed is required to store 21 kW-hr. Average density and specific heat of the bed are 2252 kg/m3 and 0.92 kJ/kgK respectively	Lecture and problem solving	Assignment (week 4-6) Mid term exam (week 9)

5	**Solar pond**: Introduction, Principle of operation, Extraction of thermal energy.	CO2	Explain the working principle of a solar pond with a neat sketch	Lecture	Assignment (week 14-16) Mid term exam (week 18)
6	**Solar thermal electric conversion**: Central receiver systems, Distributed collector system	CO2	With a neat sketch describe the working of a solar thermal power station using a central receiver system	Lecture	Assignment (week 14-16) Mid term exam (week 18)
7	**Solar PV Conversion systems**: Principle of solar cell, Conversion efficiency – power output	CO3	With a neat sketch, explain the construction and working of a solar PV cell. With a neat sketch explain the I-V characteristics of a PV cell	Lecture	Assignment (week 14-16) Mid term exam (week 18)
8	A basic PV system, Solar cell modules, Solar cell connecting arrangements,	CO3	Explain the arrangement methods of Solar PV Cell in detail	Lecture	Assignment (week 14-16) Mid term exam (week 18)
9	Mid Term Examination				
10	**Solar PV Conversion systems**: Battery storage, Applications	CO3	What is BOS of solar power conversion system? Explain various components involved with a neat diagram.	Lecture	Assignment (week 14-16) Mid term exam (week 18)
11	**Applications of solar energy**: Solar water heating, Space heating, Agriculture and Industrial process heat	CO4	With a neat sketch explain the working of a solar air heater. Write its merits and demerits.	Lecture	Assignment (week 14-16) Mid term exam (week 18)

12	**Applications of solar energy**: Solar distillation, Solar pumping, Solar furnace, Solar cooking.	CO4	Describe the construction of a solar cooker and write its working in detail with a neat diagram	Lecture	Assignment (week 14-16) Mid term exam (week 18)
13	**Applications of solar energy**: Solar green houses, Solar production of Hydrogen	CO4	What is green house? Explain in detail the construction and working of a solar green house	Lecture	Assignment (week 14-16) Mid term exam (week 18)
14	**Economic analysis**: Initial and annual costs, Definitions, Present worth calculations	CO5	Explain the following: (a) Discounting and discount rate. (b) Cumulative savings and life cycle savings. (c) Payback period	Lecture	Assignment (week 14-16) Mid term exam (week 18)
15	**Economic analysis**: Annual savings, Cumulative savings, Life cycle savings	CO5	Derive an expression for CS and LCS and explain various terms involved in it.	Lecture	Assignment (week 14-16) Mid term exam (week 18)
16	**Economic analysis**: Add-on solar systems, Payback period	CO5	A solar PV street lighting system consisting of two lamps, three PV modules, a battery and other associated components costs Rs. 75,400. The cost of conventional energy saved due to its installation is Rs. 5350 in the first year and this cost inflates at the rate of 6% per year. Calculate the payback period, with and without discounting of the system. Assume discount rate of 12%.	Lecture and problem solving	Assignment (week 14-16) Mid term exam (week 18)
17	Revision of syllabus				
18	Mid Term Examination-II				
19-20	End Term Examination				