SOLAR ENERGY UTILIZATION
(Professional Elective IV)

II Semester

Course Code: 19ME2257

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Prerequisites: Heat Transfer

Course Outcomes: At the end of the course the student shall be able to

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.

UNIT-I: **(10-Lectures)**

An overview of solar thermal applications: Devices for thermal collection and storage, Thermal applications.

Solar radiation and measurement: Solar constant, Solar radiation at the Earth's surface, Solar radiation geometry, Solar radiation measurement – Instruments, Estimation.

Solar energy collectors: Physical principle of collection, Different types – Liquid flat plate collectors, Thermal analysis of flat plate collectors, Focusing-concentrating collectors – Performance analysis.

Learning Outcomes: At the end of this unit, the student will be able to

1. Define various parameters associated with solar radiation measurement. (L1)
2. Explain the working various types of solar energy collectors. (L2)
3. Apply principles of heat transfer and calculate the performance of solar collectors. (L3)

UNIT-II: **(10-Lectures)**

Solar energy storage: Classification – Thermal, Electrical, Chemical, Mechanical, Electromagnetic type of solar energy storage. Application.
Solar pond: Introduction, Principle of operation, Extraction of thermal energy.
Solar thermal electric conversion: Central receiver systems, Distributed collector system.

Learning Outcomes: At the end of this unit, the student will be able to

1. Summarize various methods of solar energy storage. (L2)
2. Explain the working of different types of solar ponds. (L2)
3. Explain the working of different solar thermal electrical conversion systems. (L2)

UNIT-III: **(10-Lectures)**

Solar PV Conversion systems: Principle of solar cell, Conversion efficiency – power output, A basic PV system, Solar cell modules, Solar cell connecting arrangements, Battery storage, Applications.

Learning Outcomes: At the end of this unit, the student will be able to

1. Demonstrate the working of a basic PV cell and its IV characteristics. (L2)
2. Apply basic principles and design a solar PV conversion system. (L3)
3. Identify different types of applications of solar PV conversion systems. (L3)

UNIT-IV: (10-Lectures)

Applications of solar energy: Solar water heating, Space heating, Agriculture and Industrial process heat, Solar distillation, Solar pumping, Solar furnace, Solar cooking, Solar green houses, Solar production of Hydrogen.

Learning Outcomes: At the end of this unit, the student will be able to

1. Demonstrate the working of solar still, solar furnace, solar cooker and solar greenhouse. (L2)
2. Explain the method of producing Hydrogen using solar energy. (L2)
3. Design a solar system for water heating/space heating & cooling/crop drying. (L6)

UNIT-V: (10-Lectures)

Economic analysis: Initial and annual costs, Definitions, Present worth calculations, Annual savings, Cumulative savings, Life cycle savings, Add-on solar systems, Payback period.

Learning Outcomes: At the end of this unit, the student will be able to

1. Define various parameters associated with economic analysis of a solar system. (L1)
2. Summarize the necessity of annual, cumulative and life cycle savings. (L2)
3. Apply basic principles of economic analysis and calculate the payback period of a solar system. (L3)

TEXT BOOKS:

1. G.D. Rai, *Solar energy utilization*, Fifth Edition, Khanna Publishers, 1995.
2. S.P. Sukhatme and J.K. Nayak, *Solar energy*, Fourth Edition, Tata McGraw Hill Education, 2017.

REFERENCE BOOKS:

1. John A. Duffie and William A. Beckman, *Solar engineering of thermal processes*, Fourth edition, John Wiley & Sons, Inc., 2013.
2. G.N. Tiwari, *Solar Energy*: *Fundamentals*, *Design*, *Modelling and Applications*, Revised Edition, Narosa Publishing House Pvt. Ltd., 2012.
3. D.Yogi Goswami, Frank Kreith and Jan F. Kreider, *Principles of solar engineering*, Second edition, Taylor & Francis, 2000.