Solar Energy Technology - Web course

COURSE OUTLINE

The need for alternate energy sources, Potential of solar and wind options, Advantages and lacunae, The Sun, Physical description, Reactions that generate thermal energy, An estimate of energy emitted by sun and energy that reaches the earth, Sun-Earth geometry, Angles of incidence, zenith angle, azimuthal angle, hour angle, latitude and longitude, Solar spectrum, Solar constant, Extraterrestrial radiation – definition and analytical calculation procedures on different time scales, Terrestrial radiation and attenuation in the atmosphere, Terrestrial radiation components, Clearness index, Diffuse fraction, Terminology, definitions and notations, Measurement of solar radiation, Available data bases, Short Term Radiation Processing - Number of sunshine hours at a location, Duration of sunshine for a surface of general orientation, Tracking surfaces, Solar radiation on tilted surfaces; Direct, sky diffuse and ground reflected components, Long Term Radiation Processing; the daily tilt factor,*R* ; estimation of monthly average daily radiation on tilted surfaces; Extraterrestrial approximation and terrestrial calculations; Surfaces with double sunshine period , Optical Properties: Effective transmittance absorptance product; daily and monthly average daily transmittance-absorptance product; Computational and analytical approaches, Solar Flat Plate Collectors: Liquid based and air based collectors, different configurations; Assumptions behind the theory, Overall loss coefficient, Temperature distributions, efficiency factor, heat removal factor, optical and thermal efficiency; Experimental determination of efficiency, Unsteady Performance of solar flat plate collectors, Heat capacity effects, Operational time period of solar collectors, **C**oncentrating Collectors: Concentration ratio and thermodynamic maximum; Tracking modes; angle of incidence for different tracking modes, Estimation of solar radiation on tracking surfaces, short term and long term; thermal performance of concentrating collectors; Compound parabolic collector, Solar energy thermal systems; Components in typical solar energy systems, component performance visa vis system performance, Methods to predict long term system performance; Component models and Simulations, Software: TRNSYS, SIMSHAC, SOLCOST etc., Utilizability concepts, Calculation of short term (hourly, daily) and long term (monthly, yearly) utilizability; Equivalent Mean Day (EMD) method *(2),* Design methods such as *f*-Chart and-Φ,*f*-Chart. Methods to predict long term system performance, Economic and Energy viability, P1 and P2 Method. Low Temperature Applications: water heating, air heating, drying, industrial process heat ; Desalination, Green houses, Solar ponds, Solar cookers, High Temperature Applications: Schemes for process steam, power generation, air conditioning and refrigeration, cold storages. Solar furnaces, Solar energy applications in building design for heating, illuminance, shading and passive cooling, Overhangs and wing walls, calculation of shading factor, Wind Energy potential, Planetary winds, Location characteristics, Historical perspective, Types of wind machines; Vertical axis and horizontal axis wind machines, Vertical axis machines: Savonius, Darrius types, combined Savonius and Darrius type, airfoil type and solar chimney, Horizontal axis wind machines: Single and multi bladed, bicycle multi-bladed, upwind and downwind. Sail wing and cross wind Savonius type machines, Power generated by wind mills, total power and Maximum power, Forces on blades, Performance of wind Machines: Free propeller analysis, Shrouded actuator theories.Yearly performance and wind energy economics.

COURSE DETAIL

Lecture No.	Topics
1.	Energy and Dependence on External Sources and Sun, Physical Descriptions and Reactions
2.	Sun - Earth Geometry

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Mechanical Engineering

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3.	Terminology Extra - Terrestrial Radiation Terrestria Radiation
4.	Measuring Instruments
5.	Estimation of Solar Radiation or Details
6.	Radiation Processing - Long Term
7.	Evaluation of the Apparent Sunrise and Sunset Angles
8.	Estimation of Daily/Monthly Average daily Tilt Factor Under Terrestrial Conditions
9.	Solar Colector Basics
10.	Transmission - Absorptance Product
11.	Daily (Or Monthly Average Daily) Transmittance - Absorptance Product Analytical Evaluation
12.	Theory of Flat Plate Collectors - Liquid Based (A)
13.	Theory of Flat Plate Collectors - Liquid Based (B)
14.	Theory of Flat Plate Collectors - Liquid Based (C)
15.	Mean temperature and Heat Capacity Effects
16.	Theory of Air Based Solar Flat Plate Collectors
17.	Theory of Air Based Solar Flat Plate Collectors (Contd.)
18.	Other Collector Geometries
19.	Concentrating Collectors
20.	Concentrating Collectors (Contd.)
21.	Concentrating Collectors (Contd.)

22.	Compound Parabolic Collectors
23.	Exercise - I
24.	Exercise - I (Contd.)
25.	Device and System Performance
26.	Long Term Solar Energy System Performance
27.	Exercise - I (Contd.)
28.	Long Term Solar Energy System Performance Simplified Design Methods
29.	Long Term Solar Energy System Performance Simplified Design Methods (Contd.)
30.	Monthly Average Daily Utilizability
31.	The phi(bar) - f chart method (Contd.)
32.	The phi(bar) - f chart method Tank Losses and Finite Heat Exchanger
33.	Exercise – 2
34.	Exercise - 2 (Contd.)
35.	Exercise - 2 (Contd.)
36.	Economic Analysis
37.	Life Cycle Savings : The P1 and P2 Method
38.	Passive Devices
39.	Passive Architecture, Overhangs and Wing Walls
40.	Passive Architecture, Overhangs and Wing Walls (Contd.)
41.	Summary

42.	Summary (Contd.)
43.	Summary (Contd.)