SECOND SEMESTER 2020 – 2021

Course Handout part II

Date : 17th January 2021

In addition to part – I (General Handout for all courses appended to the timetable), this portion gives further specific details regarding the course.

Course No.	:	**ME F433**
Course title	:	**SOLAR THERMAL PROCESS ENGINEERING**
Instructor-in-Charge	:	**Dr. Manoj Kumar Soni**

Scope and Objectives:

Renewable energy sources have lately acquired a prominent place in energy policy decisions of countries all over the world. Sun is an inexhaustible source of clean energy which can be converted into useful heat and electrical energy in solar thermal and photovoltaic systems. Solar Thermal Processes play important role in these systems.

This course aims at enabling students to explore opportunities for research & development in the challenging area of solar thermal systems for various applications, by gaining exposure to the principle of their operation, construction, manufacturing technologies, system and components design & sizing, and analysis of techno-economic performance of the systems. The course offers ample opportunities for planning self-study, application of knowledge gained to practical situations, and honing skills required for undertaking independent study and research. Students are encouraged to engage with authentic web-resources of Government (MNRE) and other leading R & D Institutions for consolidating individual understanding.

Text Book:

1. "Solar Energy: Fundamentals, Fundamentals & Applications", H.P. Garg, J. Prakash, First Revised Edition, Tata McGraw Hill., (2000).

Reference Books:

1. "Solar Engineering of Thermal Processes", John A. Duffie, William A. Beckman, Third edition, John Wiley & Sons, (2006)
2. Concentrating Solar Power Technology: Principles, Developments and Applications edited by K Lovegrove, W Stein, Woodhead Publishing, 2012
3. MNRE publications and research papers (will be shared during class)

PLAN OF LECTURES:

Module No.	Lecture Session	Reference	Learning outcomes
1	1-2	Class Notes	Introduction: World and India solar energy resources. Brief overview of solar thermal systems.
2	3-6	TB Chapter 1 R1 Chapter 1, 2.1-2.16	Solar Radiation and Solar Collectors: Extraterrestrial solar spectrum. Beam, diffuse and global solar radiation. Calculation of total solar radiation incident on a tilted collector surface. Solar collector types – non-concentrating and focusing collectors.
3	7-9	TB Appendix (Heat Transfer)	Heat Transfer in Solar System Components : Heat transfer modes: conduction, convection, thermal radiation. Conduction in plane and cylindrical walls: temperature distribution and heat transfer rate. Convection: natural and forced. Heat transfer coefficient and heat transfer rate for laminar and turbulent flow of fluid. Overall heat loss coefficient of a solar collector.
4	10-12	TB Appendix (Heat Transfer) R1 Chapter 3.1-3.7, 3.10, 4.1-4.4, 4.7-4.10	Thermal Radiation: Black and grey bodies. Thermal radiation laws (Planck's, Stefan-Boltzmann and Kirchhoff's laws). Optical properties of solid surfaces: absorptivity, reflectivity, transmissivity and emissivity. Energy exchange by radiation between two grey surfaces with simple geometry: two parallel planes, convex body and enclosure.
5	13-19	TB Chapter 2.1-2.6, 3.8-3.12 R1 Chapter 6.1-6.4, 6.11-6.12,6.16, 6.17, 6.23, 6.24	Non-Concentrating Solar Collectors: Flat plate and evacuated glass tube collector: thermal analysis, performance (collector heat output rate and efficiency). Collector types used for heating water and air. Design calculation (examples).
6	20-25	TB Chapter 3.1-3.10 R1 Chapter 7.1, 7.2, 7.12, 7.16	Concentrating Solar Collectors: Concentrating collector types: line and point focus concentrators with receivers. Thermal analysis of parabolic trough concentrator. Performance and efficiency of concentrating collectors. Tracking mechanisms. Applications: solar process heat and power generation systems.

Module No.	Lecture Session	Reference	Learning outcomes
7	26-32	TB Chapter 16.1-16.5 R1 Chapter 8.1-8.10	Thermal Energy Storage: Sensible and latent heat storage systems. Storage media: liquid and solid; phase-change materials (PCM). Storage capacity, rates of storage charging and discharging, storage operation cycle.
8	33-40	TB Chapter 4,8,9,10,12,14 R1 Chapter 12-17	Solar Thermal Systems: Solar water and space heating and cooling (active and passive) systems: types, components, load calculation, solar fraction, fossil-fuel back up, system heat output, collector and storage sizing. Solar drying and sea (brackish) water distillation. Solar thermal power generation: solar energy to power conversion cycles, concentrator types, system useful power output, fossil-fuel back-up, heat storage. System design calculations (examples). Solar thermal system economics.
9	41-42		Review session

Evaluation Scheme:
Existing:

Evaluation Component	Duration	Weightage	Date & Time	Rem.
Project		15%	---	Take Home
Activity based evaluation		15%	-----	Take Home
Online Quiz	10 min	10%	To be announced	Online
Mid Sem Test*	90 Min	25%		Online
Comprehensive Exam	3 Hrs.	35%	3rd May 2021 FN	Closed book

- All the notices related to this course will be put up Nalanda only.
- Chamber consultation hours: Discussed in the class
- Make-up will be granted for genuine cases only. Certificate from authenticated doctor from the Medical Center must accompany make-up application (*only prescription or vouchers for medicines will not be sufficient*). Prior permission of IC is compulsory.

Instructor-in-Charge
ME F433