Course title: Solar thermal power generation			
Course code: ENR 147	**No. of credits:** 3	**L-T-P:** 39-2-8	**Learning hours:** 49
Pre-requisite course code and title (if any):			
Department: Department of Energy and Environment			
Course coordinator: Dr. Som Mondal		**Course instructor:** Prof. S. C. Mullick	
Contact details: som.mondal@terisas.ac.in			
Course type: Elective		**Course offered in:** Semester 3	

Course description:

The course is focused on techno-economics of power generation through solar thermal technology. Different types of collectors used for concentrating solar radiation and the fundamental principles along with comparative performance characteristics are discussed in detail. Design of power generation unit along with balance of system such as tracking mechanism, heat transfer fluid selection and thermal energy storage is covered in the course. Case studies and emerging technologies related to solar thermalpower generation are also discussed. Finally, implementation of solar thermal power projects and their economic analysis is covered in this course.

Course objectives:

The objective of the course is to

- Develop a detailed understanding of design and evaluation solar thermal power plants.
- Provide economic analysis and implementation of solar thermal power projects.

Course contents

Module	Topic	L	T	P
1	**Introduction:** Overview of solar thermal power generation, Possibility of thermal energystorage, hybridization with solar thermal power plant	2	0	0
2	**Solar radiation review:** Models for radiation analysis and beam radiation calculations	4	0	0
3	**Solar concentrators:** Comparison of concentrators and flat plate collectors, Performancecharacteristics. Comparison of line focus and point focus concentrators (one-directionaland two directional focusing). Image formation and image enlargement due to errors. Second Law of thermodynamics for solar concentrators. Optical losses in solar concentrators. Intercept factor. Tracking & Non-tracking solar concentrators. Parabolic trough, paraboloidic dish: continuous type and Fresnel type,Compound parabolic concentrators	6	0	0

4	**Tracking:** Tracking requirements for different concentrator types and mechanisms:Single axis and double axis tracking, comparison.	2	0	0
5	**Solar thermal technologies:** Solar Parabolic trough: design considerations, thermal design of receivers.Possibilities with steam power plant and Organic Rankine cycle Solar parabolic dish: design considerations, Sterling engine, Brayton cycle(tracking and control system) Solar tower concept and design: tower and heliostat, thermal losses,receiver types, (tracking and control system) Product/technology overview for the above technologies	10	0	0
6	**Heat transfer fluids and thermal energy storage systems:** Solar fraction and solar multiple. Impact of thermal storage. Continuously operating steam power plants with augmentation by solarthermal energy (in energy conserving or power boosting mode). Impact of Cogeneration (or CHP) on solar thermal power plants.	6	0	0
7	**Other technologies:** Linear Fresnel Reflector Collector, Solar chimney, Supercritical carbon-di-oxide cycle for solar power, Comparison between different technologies for power generation, examples of operational plants	5	0	0
8	**Case studies**	2	2	0
9	**Solar thermal power plants:** Sizing of plants. Testing of Receivers Engineering design of a solar thermal power plantSite selection and resource assessment Power evacuation, Performance evaluationO&M, PPA. Economics of CSP plant	2	0	8
	Total	**39**	**2**	**8**

Evaluation criteria:
Test 1: Assignments (after completion of module 8) - 20%
Test 2: Written test (after completion of modules 1, 2, 3 and 4) - 30%
Test 3: Written test (after completion of modules 5, 6, 7 and 9) - 50%

Learning outcomes:

After completing this course, a student will be able to:

- Develop a comprehensive understanding on different collector technologies and theircomparative performance characteristics (Test 2 and 3)
- Design a solar thermal power plant through appropriate selection of collector, receiver, powercycles, heat transfer fluid and tracking mechanism (Test 1)
- Carry out the economic analysis of a solar thermal power plant and develop understanding onimplementation process of a solar thermal power project (test 1, 2 and 3)

Pedagogical approach:

A combination of class-room interactions, group discussion and presentations, tutorials, practical andassignments

Materials:

Reference books:

Solar Engineering of Thermal Processes, J.A. Duffie and W.A. Beckman, 3rd ed.(John Wiley & Sons,2006)

S.P. Sukhatme and J. Nayak: Solar Energy: Principles of Thermal Collection and Storage, ThirdEdition (Tata McGraw Hill, 2008)

Renewable Energy Engineering and Technology – A Knowledge Compendium, ed. V.V.N. Kishore(TERI Press, 2008).

Additional information (if any):

Student responsibilities:

Adopt peer learning and knowledge sharing within the classAttendance, feedback,
discipline: as per university rules

Course reviewers:

1. Prof. J. K. Nayak, Professor, Energy Science & Engineering, IIT Bombay
2. Mr. S. K. Singh, Director General, National Institute of Solar Energy