Course title: Energy Systems Lab			
Course code: DSE 116	**No. of credits:** 3	**L-T-P:** 17-00-56	**Learning hours:** 73
Pre-requisite course code and title (if any):			
Department: Sustainable Engineering			
Course coordinator: Prof. Naqui Anwer		**Course instructor:** Prof. Naqui Anwer	
Contact details: naqui.anwer@terisas.ac.in			
Course type: Core		**Course offered in:** Semester 2	

Course Description:

Laboratory experiments help in better understanding of the subjects discussed in the classes. The experiments based on science/engineering principles stimulate students for further investigation. This course is designed to provide a comprehensive understanding of energy technologies and their practical applications. It combines theoretical knowledge with hands-on laboratory work to prepare students for careers in the energy sector.

Course objectives:

- To provide hands-on experience on experimental setups related to solar radiation measurement
- To provide practical learning about the basic operation of solar thermal collector
- To provide hands-on experience on experimental setups related to box type solar cooker
- To provide practical learning about the biomass for energy

Course content

Module	Topic	L	T	P
1.	**Solar radiation measurement** Measurement of total and diffuse solar radiation on a horizontal surface at different hours (different incident angles)	2	0	4
2.	**Solar radiation measurement** Measurement of beam and total solar radiation on inclined plane at different tilt angle.	1	0	4
3.	**Box type solar cooker** To determine the top heat loss factor of a box type solar cooker and determination of first and second figure of merit.	1	0	4
4.	**Paraboloid concentrator solar cooker** Water boiling test on paraboloid solar concentrator. Estimation of conversion efficiency of the solar concentrator during water boiling test.	1	0	4
5.	**Solar Thermal Collector** Determination of heat loss factor F'UL of solar flat plate collector.	1	0	4
6.	**Solar PV module characteristics** I-V characterization and spectral response of solar cells under illumination.	2	0	4
7.	**Solar PV module characteristics** I-V and P-V characteristics of solar PV modules under variable radiation and temperature condition.	1	0	4
8.	**Power flow calculation for a stand-alone PV** Power flow calculation for a stand-alone PV system with DC load.	1	0	4
9.	**Power flow calculation for a stand-alone PV** Power flow calculation of stand- alone battery with DC load.	1	0	4
10.	**Power flow calculation for a stand-alone PV** Power flow calculation of stand-alone PV system with DC load, battery and Charge controller in circuit loop.	1	0	4
11.	**Power flow calculation for a stand-alone PV** Power flow calculation of stand-alone wind turbine with DC load, battery and Charge controller in circuit loop.	1	0	4
12.	**Biomass for energy** Estimation of volatile matter and fixed carbon inbiomass	2	0	4

	sample.			
13.	**Biomass for energy** Estimation of calorific value of solid fuels.	1	0	4
14.	**Biomass for energy** Energy and environment performance testing of cookstove: Water Boiling Test (WBT) and Kitchen Performance Test (KTP).	1	0	4
	Total	17	0	56

Evaluation criteria

Test 1: Performance during experiments - 30%
Test 2: Viva-voce (at the end of the semester) - 30%
Test 3: Practical Exam (at the end of the semester) - 20%
Test 4: Practical Records (spread over the entire semester) - 20%

Learning outcomes

After completing this course, students would be able to:

- Measure solar radiations and test the performance of different solar thermal applications
- Characterize solar cells and analyse different parameters such as power flow, efficiency of different components such PV module, battery, inverter and PV system
- Characterize the properties of solid biofuels along with performance testing of cook stove

Pedagogical approach

Students complete a procedure given in the laboratory manual to determine the behaviour of the equipment/prototypes/experimental setups and produce the expected characteristics

Materials:

Garg, H. P., and Kandpal, T. C. (1999). Laboratory manual on solar thermal experiments. Narosa Publishing House, New Delhi
Solanki, Chetan S.; Arora, Brij M.; Vasi, Juzer; (2012-reprint 2022) Solar Photovoltaics: A Lab Training Manual, Cambridge University Press, India

Additional information (if any): N.A.

Student responsibilities

Attendance, discipline, feedback as per TERI SAS rules

Course reviewers:

Dr Sunanda Sinha, Assistant Professor, MNIT Jaipur
Dr Rhythm Singh, Assistant Professor, IIT Roorkee