Course title: Renewable Energy Technologies			
Course code: NRC 184	**No. of credits:** 3	**L-T-P:** 38-4-0	**Learning hours:** 42
Pre-requisite course code and title (if any): NRC 183			
Department: Energy and Environment			
Course coordinator(s):	**Course instructor(s):** Dr. Naqui Anwer/Dr Som Mondal		
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Course type: Elective	**Course offered in:** Semester 3		

Course description

The course is designed to make the students conversant with the renewable energy technologies. The course focuses on constructional details, working principles and operation of different RE technologies for power generation and beyond. It provides an opportunity to the students to get widespread knowledge and train with the tools and techniques used in RE industry

Course objectives

The objective of the courses is to develop in-depth knowledge for the following:

- Construction and operation of different solar PV technologies and their applications
- Solar PV business models
- Construction and operation of different solar thermal technologies and their applications
- Construction and operation of different Wind Energy Conversion Systems (WECS) and their applications
- Construction and operation of different biomass and biogas technologies and their applications
- Introduction to Geothermal, wave energy, tidal energy, ocean thermal energy technologies for power generation

Course Content

Module	Topic	L	T	P
	SOLAR			
1.	**Solar Photovoltaic Technologies** Solar PV systems, Balance of System (BoS) components: battery, PCU (charge controller, inverter, data logger), transformer, cables and connectors, switches/circuit breakers, energy meters, bypass and blocking diodes Types of PV systems: Standalone, grid-connected, hybrid, Rooftop business models – CAPEX and RESCO	8	2	0
2.	**Solar PV applications** Lighting, agriculture, refrigeration, telecommunications, space, BIPV, fencing, water purification, navigation, defence, offshore, etc.	2	0	0
3.	**Solar Thermal Collectors** Flat plate collectors: general design features and characteristics, materials. Unglazed, Single and double glazed solar collectors, Optical losses and thermal losses Evacuated tube collectors: general design features, characteristics, materials, Concentrating solar collectors: General description; concentrators, receivers, Orienting/tracking requirements, Materials parabolic trough collectors (PTC), Parabolloid dish collectors, Scheffler dish, Linear Fresnel Reflector Collector	6	2	0
4.	**Solar Thermal Applications** Solar hot water systems, Solar cookers: box type, dish type and others; dryers; desalination systems; absorption cooling; furnace, Process heating systems, community cooking system; power generation	4	0	0

	WIND			
5.	**Wind power generation technologies** Basic concept of Wind Energy Conversion System (WECS), classification/types of wind turbines, different types of generators used in wind power generation and their applications.	6	0	0
	BIOMASS			
6.	**Biomass Technologies** Biomass to Energy conversion technologies: Combustion, Gasification, Pyrolysis, Aerobic and Anaerobic processes; Transesterification, Methanol, Ethanol, Bio diesel, Bio CNG, MSW & Energy	8	0	0
	SMALL HYDRO			
7.	**Small hydro technologies** Difference between large and small hydro technologies, construction and operation of small hydro power plant, special requirements.	2	0	0
	GEOTHERMAL AND OCEAN ENERGY			
8.	Geothermal, wave energy, tidal energy, ocean thermal energy technologies for power generation.	2	0	0
	Total	**38**	**4**	**0**

Evaluation procedure

- Quizzes/Assignments : 30%
- Test 1 : 30%
- Test 3 : 40%

Learning outcomes

At the end of the course the student will be able to:

- Identify appropriate RE technology for power generation
- Design and develop the power generation fixtures based on RE technologies
- Provide performance evaluation for RE plants

Pedagogical approach

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

Suggested Readings
Materials

Text Books

1. Renewable Energy Engineering and Technology–A Knowledge Compendium, ed. VVN Kishore (TERI Press, 2008).
2. CS Solanki: Solar Photovotaics–Fundamentals, Technologies and Applications, Third Ed (PHI Learning, 2015)
3. Paul Breeze, "Wind power generation", Academic Press (Elsevier), First edition, 2015

Reference Books

1. Handbook of photovoltaic science and engineering, ed. Antonio Luque and Steven Hegedus (John Wiley and Sons, 2011)
2. JA Duffie and WA Beckman, "Solar Engineering of Thermal Processes", Third Edition (John Wiley & Sons)
3. S Sukhatme and J Nayak, "Solar Energy: Principles of Thermal Collection and Storage", Third Edition (Tata McGraw Hill, 2008)
4. TERI Energy Data Directory (TEDDY) 2016 (TERI Press, 2016)

5. Paul Gipe, “Wind energy basics: A guide to small and micro wind)”, Chelsea Green Publishing, 2008)
6. Adam Harvey, Andy Brown and Priyantha Hettiarachi: Micro-Hydro Design Manual: A Guide to Small-scale water power schemes (ITDC Publishing, 1993)
7. Donald Klass, “Biomass for Renewable Energy, Fuels, and Chemicals”, (Entech International Inc., USA) GodfreyBoyle, “Renewable Energy”, (Atlantic Publishing Company, 2008)

Websites

1. Ministry of power
2. Ministry of new and renewable energy
3. Planning commission

Additional information (if any)

There will be test before and after the completion of the course

Student responsibilities

Attendance, timely feedback, discipline: as per university rules, adopt peer learning and knowledge sharing within the class.

Course Reviewers

The course is reviewed by the following experts.

1. Dr. Ashu Verma, Assistant Professor, IIT Delhi, Hauz Khas, New Delhi
2. Dr. Apel Mahmud, Associate Professor, Deikin University, Australia