

Course number : ENR 126
 Course title : **Renewable energy conversion technologies-II**
 Number of credits : 4
 Number of lectures-tutorial-practicals : 56-0-0
 Faculty Name : Ms. Ashu Verma, Dr. V V N Kishore

Course outline

This course is designed to make the students conversant with various renewable energy technologies other than direct solar energy conversion technologies. The main technologies covered are: small hydro, wind energy technology, biomass conversion technologies (both thermo- chemical and bio-chemical methods of conversion), and liquid bio fuels. Other technologies such as geothermal energy, tidal energy, wave energy and ocean thermal energy conversion will also be covered. Basic principles of the technologies, along with experience gained on the ground with different technologies, levels of commercialization, challenges of integrating with conventional energy/power, will be covered in detail. Different applications of technologies will also be covered.

Evaluation procedure

- Term Paper / Assignments : 20%
- Two Minor Exams : 15% each
- Major Exam : 50%

Details of course contents and allotted time

Sr. No	Contents	Time allotted (hours)		
		Lecture	Tutorial	Practical
1.	Biomass Technology: Thermo-chemical conversion Thermo-chemical conversion of biomass, biomass processing, briquetting, pelletisation, biomass stoves, biomass carbonization, pyrolysis of biomass, biomass gasification, gasifiers: [updraft(forced draft & Natural draft), downdraft (Open core, throat type & modular)], Gasifier stoves, gasifier thermal applications, gasifier engine applications: dual fuel and 100% gas mode operation, power generation systems: (decentralized, grid interactive).	14	0	0

Sr. No	Contents	Time allotted (hours)		
		Lecture	Tutorial	Practical
2.	<p>Biomass Technology: Bio-chemical conversion Aerobic, and anaerobic processes, activated sludge process, plug flow reactors, anaerobic fixed film reactor, UASB reactor, anaerobic fluidized bed reactor, estimation of methane yield, anaerobic digestion system for MSW, Vermi-composting, different designs of biogas plants for animal waste, Biogas engine applications.</p>	14	0	0
3.	<p>Liquid Bio fuels: Liquid biofuels, non-edible oilseeds, oil extraction, preprocessing, transesterification, biodiesel, characterization of liquid fuels, production of syngas from biomass, production of methanol from syngas, production of ethanol from ligno-cellulosic biomass, Liquid bio-fuel applications.</p>	6	0	0
4.	<p>Wind Energy Rotor aerodynamics, aerofoils, rotor design, wind turbine and its subsystems, Induction generator- characteristics, wind farms, power evacuation aspects, site selection, Integration with electric grid.</p>	14	0	0
5	<p>Small Hydropower Classification of schemes, siting and economic considerations, System components: weir/intake, channel, desilting, forebay, spillway, penstock, turbine, generator, governor, control.</p>	3	0	0
6.	<p>Other Renewable Energy Technologies Geothermal, wave energy, tidal energy, ocean thermal energy.</p>	3	0	0
7.	<p><i>Financial feasibility of renewable energy technologies: case studies.</i></p>	2	0	0
	Total	56	0	0

The course is reviewed by the following experts.

Prof. T S Bhatti, Professor, Centre for Energy Studies, IIT Delhi

Dr. Sunil Singal, Senior Scientific Officer, Alternate Hydro Energy Centre, IIT Roorkee

Suggested readings

Text Books:

- **Renewable Energy Engineering and Technology – A Knowledge Compendium**, ed. VVN Kishore (TERI Press, 2008).

Reference Books:

- Donald Klass: **Biomass for Renewable Energy, Fuels, and Chemicals**, (Entech International Inc., USA)
- Paul Gipe: **Wind energy Basics: A guide to small and micro wind** (Chelsea Green Publishing, 2008)
- Adam Harvey, Andy Brown and Priyantha Hettiarachi: **Micro-Hydro Design Manual: A Guide to Small- Scale water power schemes** (ITDG Publishing, 1993)
- Godfrey Boyle: **Renewable Energy** (Atlantic Publishing Company, 2008)
- Thomas Read & Agua das: **Handbook of biomass downdraft gasifier engine systems** (The Biomass Energy foundation Press, 1988)
- Klaus von Mitzlaff: **Engines for Biogas – Theory, Modification, Economic Operation** (Deutsche Gesellschaft fur Entwicklungstechnologien GATE, 1988)