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|---|---|---|---|
| **Course title:** Biomass and other renewable technologies | | | |
| **Course code:** ENR 153 | **No. of credits:** 3 | **L-T-P:** 42-0-0 | **Learning hours:** 42 |
| **Pre-requisite course code and title (if any):** NA | | | |
| **Department:** Department of Energy and Environment | | | |
| **Course coordinator:** Dr. Som Mondal | **Course instructor(s):** Dr. Lakshmi Raghupathy | | |
| **Contact details:** som.mondal@terisas.ac.in | | | |
| **Course type**: Core | **Course offered in:** Semester 2 | | |

**Course description**

This course is designed to make the students conversant mainly with various Biomasses to energy technologies. Other RE technologies, such as geothermal energy, tidal energy, wave energy and ocean thermal energy conversion will also be covered. The main topics covered are: biomass conversion technologies (both thermo-chemical and bio-chemical methods of conversion) and liquid bio fuels. Basic principles of the technologies, experience gained on the ground, levels of commercialization, challenges of integrating with conventional energy/power system are covered.

**Course objectives**

- To develop understanding the various route to generate energy from biomass and other renewable resources
- To calculate energy production potential; energy content in various resources.
- To identify challenges and strength of various energy convention technologies

**Course contents**

| Module | Topic | L | T | P |
|---|---|---|---|---|
| **1** | **Biomass Technology: Thermo-chemical conversion**<br><br>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 |
| **2** | **Biomass Technology: Bio-chemical conversion**<br><br>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. | 10 | 0 | 0 |
| **3** | **Liquid Bio Fuels**<br><br>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. | 10 | 0 | 0 |
| **4** | **Other Renewable Energy Technologies**<br><br>Geothermal, wave energy, tidal energy, ocean thermal energy. | 4 | 0 | 0 |
| **5** | **Case Study**<br><br>India specific and global context | 4 | 0 | 0 |
| | | **42** | **0** | **0** |

**Evaluation criteria**

- Assignments: 20%
- Two minor tests: 15% (each)
- Major exam: 50%

**Learning outcomes**

On successful completion of this course the students will be able to:

- Calculate Bioenergy and Other Renewable energy potentials
- Identify the best solution
- Quantify the amount of Energy produced
- Translate theories into practice

**Pedagogical approach**

A combination of class-room interactions, tutorials, field visits, assignments and projects.

**Materials**

**Recommended readings**

**Text Books**

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

**Reference Books**

Donald Klass, **"Biomass for Renewable Energy, Fuels, and Chemicals"**, (Entech International Inc., USA)
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)

**Additional information (if any):** NA

**Student responsibilities**

Attendance, feedback, discipline: as per university rules.

**Course Reviewers**

1. Prof. T S Bhatti, Professor, Centre for Energy Studies, IIT Delhi
2. Dr. P. Basu, Director & Professor, Dept. of Mechanical Engineering, Dalhousie University, Canada