MEC7111: Biochemical Energy Engineering

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
35	10	10	45	100	60	40	3

Course description:

The production of methane and alcohol-based fuels and their roles as a transportation fuel will lead to a re-discovery of opportunities to replace fossil-based fuels. Bio-diesel and vegetable oil topics are necessary to show a true alternate energy source for internal combustion engines. Throughout this course, students will examine advanced energy conversion technologies and bio-systems. The course gives a further in-depth knowledge of relevant fundamental aspects connected to the utilization of biomass and the biomass fractions of waste streams for energy purposes in biochemical conversion processes for production of 1st and 2nd generation biofuels.

Course objectives

The aim of this course is to:

- Empower the student with in-depth knowledge of how to obtain bioenergy by means of biochemical processes using different resources.

Learning Outcomes

At the end of the course the student should be able to;

- Describe the theory of operation of the different types of bio-chemical conversion process and how they produce energy.
- Students will have gained knowledge on Uganda's potential for ethanol biodiesel production and able to apply advanced approaches/techniques to its production.
- Design systems for harnessing ethanol, biodiesel and biogas in the most appropriate way.

Course Outline

Biological Conversion (9 Hours)

- Biodegradation and biodegradability of substrate; Biochemistry and process parameters of bio-methanation;
- Biogas digester types; Digester design and biogas utilization; Chemical kinetics and mathematical modeling of biomethanation process;
- Economics of biogas plant with their environmental and social impacts; Bioconversion of substrates into alcohol:
- Methanol & ethanol Production, organic acids, solvents, amino acids, antibiotics etc.

Waste Treatment and Disposal (6 Hours)

- Size Reduction: Aerobic composting
- Environmental impacts;
- Land Fill method of solid waste disposal;
- Land fill classification; Types, methods & siting consideration;
- Layout & preliminary design of landfills:
- Composition, characteristics, generation;
- Movement and control of landfill leachate & gases;
- Environmental monitoring system for land fill gases

Energy Generation Form Waste (6 Hours)

- Types: Biochemical Conversion: Sources of energy generation, Industrial waste, agro residues;
- Anaerobic Digestion: Biogas production; Types of biogas plants; thermo-chemical conversion: Sources of energy generation,
- Environment benefits of biochemical conversion

Alcohol as Bio-energy source (3 Hours)

- Bio-Methane; Bio-Ethanol & Bio-Hydrogen

Bio-Diesel and Vegetable Oils as an energy Sources (5 Hours)

- History, Production methods of Bio-diesel:
- Transesterification, Fuel quality, standards and properties,
- Availability of Raw materials for bio-diesel, Applications.

General on Bio-energy (3 Hours)

- Bio-energy Systems; Future R&D of Bio-fuels & Bio-energy; Bio-fuels Testing
- Methods; Compare / contrast to diesel fuel test methods; Bio-fuels marketing; Petroleum Industry Perspective on Bio-fuels;
- Current Trends in Bio-fuels Use; Development: government and industrial

Power generation (3 Hours)

- Operation of spark ignition and compression ignition engine with methanol, ethanol & biogas;
- Biomass productivity: Energy plantation and power programme.

Laboratory: (10 Hours)

- Experimental Study on thermal performance and efficiency of biomass downdraft gasifier and sampling and analysis of air and flue gas from biomass energy system (gasifier, combustor and cook stoves using as chromatography technique)
- Biogas production by anaerobic digestion and analysis
- Fuels: density, viscosity, flash-point, fire point, pour-point, ASTM distillation of liquid fuels
- Proximate and ultimate analysis, calorific value of solid fuels

Delivery Methods

Lectures, exercises, laboratory work, assignment, study visits

Assessment

- Written exam, laboratory reports, written assignment, Examination 60% and Assignment 40%

References

1. Donald L. Klass, (1998) "Biomass for Renewable Energy, Fuels, and Chemicals", Academic Press, ISBN-13: 978-0-12-410950-6, ISNB-10: 0-12-410950-0
2. Anthony San Pietro, (1980) Biochemical and Photosynthetic aspects of Energy Production, Academic Press, New York, David Boyles, "Bio Energy Technology Thermodynamics and costs", Ellis Hoknood, Chichester, 1984
3. R. C. Maheswari, "Bio Energy for Rural Energisation" , Concepts Publication, 1997
4. EL - Halwagi M M,(1986) "Biogas Technology : Transfer & Diffusion", Elsevier Applied SC, London
5. Parker, Colin, & Roberts, "Energy from Waste - An Evaluation of Conversion Technologies", Elsevier Applied Science, London, 1985
6. Manoj Datta, (1997)Waste Disposal in Engineered Landfills, Narosa Publishing House.
7. Bhide AD., Sundaresan BB, (1983)"Solid Waste Management in Developing Countries", INSDOC, New Delhi.
8. Donald L.Klaswss,(2002) Biomass for Renewable Energy, Fuels, and Chemicals, Academic press