Course Title: Biomass & Bioenergy **(Elective Course)**

Course Code: RE-822

Course Objectives: This course will establish a fundamental understanding of the characteristics of biomass resources, types of Biomass and Basic concepts of Bioenergy production technologies. Key topics covered include the basics in production, availability, and sustainability of biomass resources; characteristics of biomass as a fuel; design aspects on the pre-treatment, thermochemical conversion, and biochemical conversion processes of biomass. In particular, the environmental aspects of biomass energy, economics, and life-cycle analysis with case studies on biomass energy production will be emphasized.

Course Outcomes:

On completion of this course, student should be able to:

- Understand the Biomass types, resources, and potential for bioenergy production.
- Enable students to identify pretreatment methods based on Biomass characteristics, conversion technologies and fuel characteristics.
- It is expected that students will be able to conceive and integrate sustainable practices into bioenergy production and make an environmentally and socially responsible technology selection.

Detailed Contents:

Biomass, Bioenergy and Bio-Refinery

Biomass resources and potential: Properties and types of Biomasses: lignocellulosic, starchy, sugary, oilseeds, OFMSW, sewage sludge, manure. Biofuels: liquid (biodiesel, bioethanol), gaseous (syngas, biogas), solid (charcoal and biochar). Biopower, bioheat Biofuels, advanced liquid fuels, drop-in fuels Biobased products

Introduction to Biomass Energy Conversion Technology

Biomass conversion: Physical conversion: Dewatering, drying, size reduction, steam explosion, densification, pelleting, chipping, oil extraction. Biomass conversion: Chemical conversion; Oil trans-esterification (biodiesel production). • Hydrolysis. Biomass conversion: Biochemical conversion Anaerobic digestion (biogas production from organic waste and wastewater). • Fermentation (bioethanol production), Bio-electrochemical systems; Developments related to bioenergy such as MFC, MEC, (Biohydrogen) etc , Algal Biofuels Growth/harvest rates, transesterification

Feasibility of Bioenergy plant

Basic design elements for the Bioenergy plant (Feasibility analysis, Supply chain, Technology) Biomass storage and feeding systems. Combustion plants for heat generation; Gasification plants. Pyrolysis plants, Hybrid bioenergy plants: biomass to synthetic natural gas; Biomass to liquid biofuels through Fisher Tropsch; absorption enhanced reforming.

Environmental Aspects

Bioenergy and environment, Resource sustainability criteria pollutants, carbon footprint, Carbon capture, Life Cycle, Carbon capture and storage, Carbon credits. Basic concepts of circular economy based on organics.

Text/Ref Books:

- Khalid Rehman Hakeem, Mohammad Jawaid, Umer Rashid Biomass and Bioenergy Processing and Properties, Springer , First edition 2014
- Manish Srivastava, Neha Srivastava, Rajeev Singh, Bioenergy Research: Biomass Waste to Energy, Springer,
- Ashok Pandey, Duu-Jong Lee, Yusuf Chisti, Carlos R. Soccol, Biofuels from Algae, Elsevier , First Edition 2014
- Ozcan Konur, Bioenergy and Biofuels, Taylor & Francis , 1st Edition 2017