ESE 801 - Biofuel Engineering

Credit Hours: **3**
Pre-requisites: **Nil**

Course Objectives: The primary objectives of this course are to familiarize students with practical applications of the principles of Biofuel processes and engineering pertaining to the production of biofuels, i.e., Biodiesel and Ethanol.

Course Contents: Process Machinery: This course will provide knowledge of machinery commonly found in a processing facility, such as pumps, valves, heat exchangers, cooling towers, centrifuges, compressors, thermal oxidizers, distillation towers, compressors, refrigeration principles and boiler systems. Startup, shutdown, operation and troubleshooting of each of these mechanical systems will be explained. Instrumentation and Control: Study in detail P& ID terminologies with applied applications. PFDs will be used to examine the sequence of operation, including residence time, pressures, and temperature seen in various stages of production. **Process Dynamics:** Cover in detail about major chemical process separation units and apply appropriate criteria for selecting among alternative separation technologies. Complete design calculations for equilibrium staged separation processes (e.g., distillation, absorption, solvent. extraction). Applying mass transfer fundamentals to calculate rates of mass transfer for practical situations and to identify rate-limiting processes. **Biodiesel Technologies and Regulatory Issues:** Investigates the underlying research and reaction processes that are used to produce biodiesel. Studying feedstock options coupled with past and present technologies provides foundational knowledge about the industry. The course includes an in-depth review of the ASTM Standards for biodiesel and the regularity issues that can arise from non-compliance. **Biodiesel Processes Analysis:** Provides detailed information regarding the overall process of biodiesel production. The course will include a review of biodiesel chemistry, process engineering, post-reaction processing, fuel specification and properties, feedstock preparation, treatment and recovery of side streams, fuel transportation storage and general plant operations. **Ethanol Process and Separation Technology:** Covers in detail the overall fundamental process of ethanol production. A process flow Diagram (PFD) of a typical ethanol plant will be used to examine the sequence of operation, including residence time, pressures, and the temperatures seen in various stages of production. This course will explain the rationale for feedstock and additives used in ethanol processing as well as product and co-product production and use. Covers the basic principles of ethanol distillation, evaporation, and dehydration. Included will be an understanding of the operating components in a distillation system; demonstrable familiarity with startup, cleaning operating, and shutdown procedures; and the ability and its role in processing plants will also be converted as well as the theory of the molecular sieve dehydration and how it is used in the ethanol process. **Reaction Kinetics and Reactor Design:** Covers in detail the kinetic data, determination of rate laws, analysis of complex reaction networks and design of ideal isothermal reactors. Analyze data for heterogeneous catalytic reactions—design reactor systems for given synthesis with special emphasis on trans-esterification and bio-fermentation.

Course Outcomes: The course will provide an intense treatment in bio-fuel production technologies. The students will be able to appreciate the design concepts of plant & machinery involved in the production chain, i.e., Crude production, bio-refining and characterization.

Recommended Reading (including Textbooks and Reference books)

- Drapcho, Caye M., Nghiem Phu Nhuan, and Terry H. Walker. Biofuels engineering process technology. New York: McGraw-Hill, 2008.
- Silla, Harry. Chemical process engineering: design and economics. CRC Press, 2003.
- George F. Baumiester. Standard Handbook for Mechanical Engineering