

*Course Objective:*

- To enable the student to understand biofuel and in particular biodiesel blends.
- To help student to understand biodiesel characteristics, storage and safety issues.
- To give information about procedures for using in compression-ignition engines and boilers.

*Course Outcome:*

CO1. This course will guide student to blend, distribute and use biodiesel and biodiesel blends.

CO2. It provides students about basic information on the proper and safe use of biodiesel and biodiesel blends in engines and boilers.

CO3. It is intended to help students to understand procedures for handling and using biodiesel fuels.

CO4. It will give students some knowledge about safety, health and environmental issues related to biodiesel.

**Syllabus:**

*Module 1 – Biofuels:* Introduction to biofuels, energy units, terminology, energy security, different types of biofuels with their advantages and disadvantages, greenhouse gases and climate change, types of biomass and available resources (feedstocks of various types of biofuels), biology and chemistry of the biomass.

*Module 2 – Basics of Biodiesel:* Introduction to biodiesel, vegetable oils and other products, specification and regulations, difference of biodiesel from other renewable diesels, benefits of biodiesel usage, other biodiesel attributes, different types of biodiesels, process of ethanol production, understand how biofuels other than ethanol can be produced, biodiesel feedstocks, chemistry of biodiesel.

*Module 3 – Diesel from Vegetable Oils:* Types of vegetable oils, biodiesel production from vegetable oils, chemical transesterification reactions, acid catalyzed or base catalyzed transesterification of the feedstock, experimental steps for biodiesel synthesis, pre-treatment process, conventional transesterification/esterification process, biochemical or enzymatic transesterification reactions, other new methods of conversion, post-treatment or polishing process, usage of catalysts, knowledge of by-products.

*Module 4 – Biodiesel Blends:* B100 quality specification, variation in biodiesel properties, energy content, low-temperature properties, cetane number, transport and storage, microbial

contamination, cleaning effect, materials compatibility, use of B100 and high blend levels, B5 and lower blends, B6 to B20 blends, Glycerin from biodiesel - chemistry of glycerin, crude glycerin characteristics and their applications (tech-grade), refining and post-treatment process, refined glycerin (USP grade) characteristics and their applications.

*Module 5 – Biodiesel Purification, Potential Impact and Future Perspectives:* Equilibrium based separation – absorption, distillation, supercritical fluid extraction and liquid-liquid extraction, affinity-based separation - adsorption and ion exchange, membrane-based separation, solid-liquid or reaction separation based – reactive distillation. Safety, health, and environmental impact and issues – CO<sub>2</sub> emission and sequestering, global perspective of biofuel policies - biofuel policy in the USA (RFS2 and RINs) and India, barriers to the implementation of biofuels policy.

### References Books:

1. Biodiesel: Feedstocks, Production and Applications, Edited by Zhen Fang, 2016 Second Edition, ISBN-13: 978-953-51-0910-5.
2. Biodiesel Technology and Applications, Edited by Inamuddin, Mohd Imran Ahamed, Rajender Boddula and Mashallah Rezakazemi, 2021 Scrivener Publishing LLC.
3. Practical Handbook on Biodiesel Production and Properties, Edited by Mushtaq Ahmad, Mir Ajab Khan, Muhammad Zafar, Shazia Sultana, CRC Press, 2013 by Taylor & Francis Group, LLC.
4. Biofuel Technology Handbook, Dipl.-Ing. Dominik Rutz, Rainer Janssen, WIP Renewable Energies, Germany, 2008.
5. Biodiesel: A Realistic Fuel Alternative for Diesel Engines, Ayhan Demirbas, 2008 Springer-Verlag London Limited.

### *Scheme of Evaluation:*

Internal Assessment		End-semester Assessment	
Mid-semester exam	30 Marks	End-semester examination	50 Marks
Assignment	10 Marks		
Seminar	10 Marks		
Sub Total	50 Marks	50 Marks	
Grand Total		100 Marks	