Topic:
Biofuels and Surfactants

About the course:

This course provides an in-depth understanding of the science, engineering, and emerging technologies behind biofuels and surfactants. It bridges two important interdisciplinary domains—alternative engine fuels for sustainability and surface-active agents for fuel modification and formulation. Beginning with foundational aspects of alcohols, vegetable oils, and hydrogen as alternative fuels for internal combustion engines, the course advances into modern hybrid biofuel systems and the chemistry, synthesis, and application of surfactants in energy technologies.

Duration -
20 hours

Total Days required:
20 days (1hr per day)

Course Faculty:
Mr. Deepak B

Weekly plan for topic coverage:

Week	Topics Covered	Learning Outcomes / Activities
1	**Introduction to Alternative Fuels & Alcohols as Engine Fuels**	• Need for alternative fuels – depletion of petroleum reserves, environmental concerns, energy security • Overview of available alternative fuels for SI and CI engines • Alcohols (methanol, ethanol, butanol) – sources and production pathways • Properties of alcohols as fuels: physicochemical, combustion, safety

Week	Topics Covered	Learning Outcomes / Activities

		• Methods of utilization:
		  ○ Blending
		  ○ Dual fuel operation
		  ○ Surface ignition techniques
		  ○ Oxygenated additives
		• Performance, combustion, and emission trends with alcohol blends

2	**Vegetable Oils as Fuels**	• Common vegetable oils and their key properties affecting engine operation
		• Fuel modification methods:
		  ○ Blending
		  ○ Pre-heating
		  ○ Transesterification
		  ○ Emulsification
		• Comparison of straight vegetable oils (SVO) vs. biodiesel
		• Performance, emissions, long-term engine issues (coking, injector deposits, viscosity effects)

3	**Hydrogen as an Engine Fuel**	• Hydrogen production routes (steam reforming, electrolysis, biological methods, renewable hydrogen) • Combustion properties of hydrogen: flame speed, adiabatic flame temperature, quenching distance • Challenges and solutions for hydrogen in engine operation • Methods of hydrogen introduction in SI and CI engines • Engine performance and emission characteristics • Hydrogen storage technologies and safety considerations
4	**Hybrid Fuels and Surfactants**	• Concept of hybrid biofuels – motivation, advantages, and environmental relevance • Preparation pathways for hybrid fuels (biodiesel-alcohol blends, vegetable oil-alcohol systems,

Week	Topics Covered	Learning Outcomes / Activities

		hydrogen-assisted biofuels, microemulsion-based fuels)
		• Comparison of hybrid fuels with transesterified biodiesel
		• Challenges in fuel stability, phase behavior, and surfactant requirement
		• Introduction to surfactants:
		  o Ionic surfactants – anionic, cationic, zwitterionic
		  o Chemistry, raw materials, synthesis
		  o Physical properties and surface activity
		  o Surface tension and interfacial phenomena

5	**Microemulsions, Liquid Crystals & Analytical Techniques**	• Microemulsions for fuel applications
		  o Thermodynamics, phase behavior, stability
		  o Kinetic aspects of formation
		• Delayed-release emulsions and double emulsions – stabilization mechanisms
		• Liquid crystalline phases – structure, solvation, relevance to drug release and fuel additives
		• Surface reactions and interfacial catalytic phenomena
		• Modern analytical tools for studying surfactant and dispersed systems:
		  o SAXS
		  o Cryo-TEM
		  o DSC
		  o PGSE-NMR
		  o EPR
		• Applications in hybrid fuel characterization, stability analysis, and performance prediction

Total no of assignments in plan:
2

Final Evaluation Plan :

Online Exam