ChE-404B	BIO-FUELS (OPEN ELECTIVE)	L T P C 4 - - 3

COURSE OBJECTIVES:

1. To provide the knowledge about properties, composition, features of bio fuels and uses of biomass and their environmental impacts.
2. To provide the students a substantial knowledge of bio fuel production technologies.
3. To provide knowledge about the process of biogas production and methods of production of biodiesel and comparison of the standards to the conventional diesel.
4. To provide knowledge about the production of lipids, bio hydrogen from different bacteria and algae.
5. To provide knowledge about the fuel cell technology

COURSE OUTCOMES:

After successful completion of the course, the students are able to

1. describe the functional principle of biofuel technologies in small and large scale.
2. describe the main steps and components in bioethanol, biodiesel and biogas production.
3. Participate actively in teamwork and work with case related problem solving.
4. work with professional problem solving in an industrial environment.
5. work in other fields of engineering.

UNIT I **(12)**

Types of biomass (e.g. wood waste, forestry residues, agricultural residues, perennial annual crops, organic municipal solid waste). Composition of lignocellulose (lignin, hemi cellulose, cellulose); energy crops; chemical pretreatment; enzymatic pretreatment; degradation of cellulose; trichodermacellulases; bacterial cellulases; and comparison with degradation of high starch crops.

Sources of energy, introduction of biofuels, availability of bio mass, composition of biomass, terrestrial biomass, aquatic biomass.Physical and chemical properties of biomass. Useful and undesirable features of biofuels.

UNIT II **(12)**

Biogas : The substrate, the digester, the microorganisms, the process of bio gas production, factors affecting bio gas yields, advantages, disadvantages.

Bioethanol : Bioethanol vs. Petrol, production of bio ethanol, ethanol recovery. Bio butanol.Properties and standards of bioethanol. Lignocellulosic biomass composition and characterizations.

UNIT III **(12)**

Sources and processing of biodiesel (fatty acid methyl ester); nature of lipids, especially fatty acids and triglycerides. Sources and characteristics of lipids for use as biodiesel feedstock; and conversion of feedstock into biodiesel (transesterification). Use of vegetable oil (SVO) and waste vegetable oil (WVO).

Engineering, economics and environmental issues of biodiesel; major policies and regulations pertaining to the production, distribution, and use of biodiesel. Comparison of bio diesel with conventional diesel. Standards of bio diesel, current technologies and challenges.

UNIT IV **(12)**

Hydrogen Production - Direct electrolysis of water, thermal decomposition of water, biological and biochemical methods of hydrogen production - Storage of Hydrogen - Gaseous, Cryogenic and Metal hydride.

Bio hydrogen : Production of bio hydrogen from anaerobic bacteria, photosynthetic algae, photosynthetic - hydrogenase system. Pyrolysis, bio-oil upgradation.

UNIT V **(12)**

Fuel cells : Enzymatic fuel cells, microbial fuel cells. Fuel Cell â€“ Principle of working, construction and applications.

Fuels for Fuel Cells : Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others.

LEARNING RESOURCES:

TEXT BOOK(s):

Robert C. Brown - Biorenewable Resources: Engineering, New Products from Agriculture, Wiley - Blackwell Publishing, 2003

REFERENCE BOOK(s):

1. Samir K. Khanal-Anaerobic Biotechnology for Bioenergy Production: Principles and Applications, Wiley - Blackwell Publishing 2008
2. Martin Kaltschmitt, Hermann Hofbauer - Biomass Conversion and Biorefinery, Springer Publishing, 2008.