

## INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

1. **Name of the Academic Unit:** School of Energy Science & Engineering
2. **Subject Name:** Bioenergy Resources and Technologies: ES61209, **L-T-P:** 3-1-0  
**Credits:** 4
3. **Pre-requisites:** None
4. **Syllabus and reference books:**

### **Syllabus:**

Introduction to bioenergy, harvesting and availability assessment of biomass; Characterization and classification of biomass feedstock; Next Generation Biofuels: First, second, third and fourth generation biofuels; Different pre-treatment processes of biomass: Biophysical, Biochemical, Physicochemical, thermal; Cellular Bioenergetic Pathways; Enzyme Kinetics, Immobilized Enzymes; Microbial Growth kinetics, Metabolic engineering; Biochemical methods (anaerobic, enzymatic-saccharification and fermentation process, and dark fermentation, ABE fermentation) for biofuel production; Biodiesel production: chemical processes: trans-esterification, hydro-processing micro-emulsification; Thermochemical methods (combustion, gasification, pyrolysis, partial oxidation, auto-thermal reforming) for biofuels production including synthesis gas, ethanol, butanol, biogas, methanol and dimethyl ether for biofuel production; Different types of bioreactors and reactor analysis; Design, Analysis and Stability of Bioreactors; Production of Cellulosic Fuels: kinetics and thermodynamics; Bio-hydrogen production: Biophotolysis, Dark Fermentation, Poto-fermentation; Microbial Fuel Cell (MFC): Uncoupled bioreactor MFC, Integrated bioreactor MFC; Bio Jet Fuel Conversion Technologies: Alcohol-to-Jet (ATJ) Fuel, Oil-to-Jet (OTJ) Fuel, Gas-to-Jet (GTJ) Fuel, Sugar-to-Jet (STJ) Fuel.

### **Reference Books:**

1. By John Twidell, Tony Weir. Renewable Energy Resources, Taylor and Francis, 2015.
2. Jay J. C., Biomass to Renewable Energy Processes, Taylor and Francis, CRC Press, 2018.
3. Konur O., Bioenergy and Biofuels, Taylor and Francis, CRC Press, 2018.
4. Love J. and Bryant J. A., Biofuels and Bioenergy, John Wiley & Sons, 2017.
5. Henderson O. P., Biomass for Energy, Nova Science Publishers, 2011.

### 5. Lecture-wise break-up:

Sl. No.	Topic	No. of lectures
1.	1. Introduction to bioenergy, harvesting and availability assessment of biomass	2
2.	2. Characterization and classification of biomass feedstock	2
3.	3. Next Generation Biofuels: First, second, third and fourth generation biofuels	2
4.	4. Basic principles of chemical thermodynamics, Stoichiometry and Thermodynamics of biochemical reactions	4
5.	5. Different pre-treatment processes of biomass: Biophysical, Biochemical, Physicochemical, thermal	2
6.	6. Cellular Bioenergetics Pathways; Enzyme Kinetics, Immobilized Enzymes; Microbial Growth kinetics, Metabolic engineering	4
7.	7. Biochemical methods (anaerobic, enzymatic-saccharification and fermentation process, and dark fermentation, ABE fermentation) for biofuel production	4
8.	8. Biodiesel production: chemical processes: trans-esterification, hydro-processing micro-emulsification	2
9.	9. Thermochemical methods (combustion, gasification, pyrolysis, partial oxidation, auto-thermal reforming) for biofuels production including synthesis gas, ethanol, butanol, biogas, methanol and dimethyl ether for biofuel production	4
10.	10. Different types of bioreactors and reactor analysis	2
11.	11. Design, Analysis and Stability of Bioreactors; Production of Cellulosic Fuels: kinetics and thermodynamics	4
12.	12. Microbial Fuel Cell (MFC): Uncoupled bioreactor MFC, Integrated bioreactor MFC	2
13.	13. Bio-hydrogen production: Biophotolysis, Dark Fermentation, Photo-fermentation	4
14.	14. Bio Jet Fuel Conversion Technologies: Alcohol-to-Jet (ATJ) Fuel, Oil-to-Jet (OTJ) Fuel, Gas-to-Jet (GTJ) Fuel, Sugar-to-Jet (STJ) Fuel	4
	<b>Total number of hours</b>	<b>42</b>