GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Computer Aided Process Design

Subject Code: ME02072071

Subject Name: Biomass Conversion and Biorefinery

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	Nil
Rationale:	Biomass is not only renewable but also CO2 neutral hence researchers worldwide have drawn their attention to biomass based fuels as well as other value added products. This course will provide an insight to the basics of biomass, various conversion technologies, the different types of products that can be obtained upon successful conversion and the concepts of biorefinery long with LCA and TEA.

Completion of the Course, Student will able to:

No.	Course Outcomes	
01	Emphasis on variety of feedstocks available for biomass conversion.	**R**
02	Explain various pretreatment techniques applicable for biomass.	**R, U**
03	Explain different value added products and the challenges involved.	**A**
04	Develop necessary skills to design appropriate biomass based fractionation techniques as per need.	**A**

Teaching and Examination Scheme:

			Total Credits L+T+ (PR/2)	**Assessment Pattern and Marks**				**Total Marks**
				Theory		**Tutorial / Practical**		
L	**T**	**PR**	**C**	ESE (E)	PA / CA (M)	ESE (V)	PA/CA (I)	
3	0	2	4	70	30	30	20	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction:** World energy scenario, consumption pattern, fossil fuel depletion and environmental issues	3	6
2.	**Biomass**: Availability and abundance, photosynthesis, composition and energy potential, virgin biomass production and selection, waste biomass (municipal, industrial, agricultural and forestry) availability, abundance and potential, biomass as energy resources: dedicated energy crops, annual crops (maize, sorghum sugar beet, hemp), perennial herbaceous crops (sugarcane, switchgrass, miscanthus), short rotation woody crops (poplar, willow), oil crops and their biorefinery potential, microalgae as feedstock for biofuels and biochemical, enhancing biomass properties for biofuels, challenges in conversion.	10	19
3.	**Biorefinery:** Basic concept, types of biorefineries, biorefinery feedstocks and properties, economics.	3	6
4.	**Biomass Pretreatment:** Barriers in lignocellulosic biomass conversion, pretreatment technologies such as acid, alkali, autohydrolysis, hybrid methods, role of pretreatment in the biorefinery concept	6	11
5.	**Physical, Thermal and Microbial Conversion Processes:** Types, fundamentals, equipments and applications; thermal conversion products, commercial success stories	6	11
6.	**Biodiesel:** Diesel from vegetable oils, microalgae and syngas; transesterification; FT process, catalysts; biodiesel purification, fuel properties, **Bio Oil and Biochar:** Factors affecting biooil, biochar production, fuel properties, bio oil upgradation, **Bioethanol and Biobutanol:** Corn ethanol, lignocellulosic ethanol, microorganisms for fermentation, current industrial ethanol production technology, cellulases and their role in hydrolysis, concepts of SSF and CBP, advanced fermentation technologies, ABE fermentation pathway and kinetics, product recovery technologies and **other organic commodity chemicals from Biomass**	10	19
7.	**Hydrogen, Methane and Methanol:** Biohydrogen generation, metabolic basics, feedstocks, dark fermentation by strict anaerobes, facultative anaerobes, thermophilic microorganisms, integration of biohydrogen with fuel cell; fundamentals of biogas technology, fermenter designs, biogas purification, methanol production and utilization	8	14
8.	**Integrated Biorefinery:** Concept, corn/soybean/sugarcane biorefinery,	8	14

	lignocellulosic biorefinery, aquaculture and algal biorefinery, waste biorefinery, hybrid chemical and biological conversion processes, techno-economic evaluation, life-cycle assessment		
	Total	54	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
40	20	40	-	-	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Donald L. Klass, Biomass for Renewable Energy, Fuels, and Chemicals, Academic Press, Elsevier, 2006.
2. Prabir Basu, Biomass Gasification, Pyrolysis and Torrefaction, Academic Press, Elsevier, 2013.
3. A.A. Vertes, N. Qureshi, H.P. Blaschek, H. Yukawa (Eds.), Biomass to Biofuels : Strategies for Global Industries, Wiley, 2010.
4. S. Yang, H.A. El-Enshasy, N. Thongchul (Eds.), Bioprocessing Technologies in Biorefinery for Sustainable Production of Fuels, Chemicals and Polymers, Wiley, 2013.
5. Shang-Tian Yang (Ed.), Bioprocessing for Value Added Products from Renewable Resources, Elsevier, 2007.
6. D L Klass, Biomass for Renewable Energy, Fuels, and Chemicals, Academic Press, Elsevier, 2006.
7. P Basu, Biomass Gasification, Pyrolysis and Torrefaction, Academic Press, Elsevier, 2013

(b) Open-source software and website:

1. NPTEL lecture series.

Suggested Activities for Students:

1. Students may evaluate reduction in the amount of CO2 emission by blending various biofuels with conventional fossil fuels.
2. Students may be allotted one open-ended design project on compatibility and challenges involved with the current automobile engines by partially &/or completely replacing existing fossil fuels by biofuels.
3. Students may be allotted one open-ended design project on concepts of biorefinery.

Suggested Course Practical List:

Practical/Presentation based on above topics.

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