Enclosure VIIB

M.Sc. Industrial Chemistry

Semester - III		
Course Code	**Course Title**	**Course Credit**
19PICGE01	**Core 1: Generic Elective BIOMASS AND BIOENERGY**	**2 Credits**

Course Description:

- This course contains the fundamental and advanced knowledge of biomass and alternative energy resources. It also comprises various technology used for conversion of biomass to Bioenergy in order to solve the problems of energy being produce from Fossil fuels. Various thermochemical techniques for the Bioenergy production have also been listed in this course.

Course Purpose:

1. To apply basic and advance knowledge of biomass and Bioenergy.
2. To understand the technology advancement in the area of biomass and alternative energy resources.
3. To apply fundamental and basic knowledge of Fossil versus renewable energy resources and environmental impact of Biofuels as well.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (K_1 to K_6)
CO_1	Understand the basic concepts of Biomass.	K1, K2
CO_2	Understand the basic technology of Biofuels.	K1, K2, K3
CO_3	Understand the fundamental technology of biodiesel.	K1, K2, K4
CO_4	Understand the advance concepts of Bioethanol fuel.	K1, K2, K4
CO_5	Understand the basic and advanced technology of Biobutanol fuel.	K1, K2, K3, K4

Course Content	Hours
Module-I : Introduction to Biomass:	5 hrs
• Introduction, Types of biomass, Use of biomass, Methods of biomass extraction (Gasification, Liquefaction, Pyrolysis, Direct Combustion), Biomass availability issues, Benefits of biomass energy, composition and production of biogas, uses of Biogas.	
Module-II : Introduction to Biofuels:	4 hrs
• Introduction, Classification of Biofuels, Biochemical liquid fuels (Biodiesel, Bioethanol, Butanol), Debate on "food vs. fuel", Fossil versus renewable energy resources, environmental impact of Biofuels.	

Module-III : Biodiesel:	5 hrs
• Introduction, Compositions, Feedstocks (oils and animal fats) for Biodiesel Production, Various catalysts and alcohol for biodiesel synthesis, Various Methods for biodiesel synthesis, Esterification and transesterification, Advantages and disadvantages of the Biodiesel, Biodiesel chain, Uses.	
Module-IV : Bioethanol:	5 hrs
• Introduction, Bioethanol Production from (Lignocellulosic Raw-Material, Sorghum, Unhydrolyzed Cassava Starch, Steam Explosion Pretreated Straw), uses of bioethanol, Catalytic Hydrogen Production from Bioethanol.	
Module-V : Biobutanol:	5 hrs
• Introduction, Fuel properties, Biobutanol as a fuel, Biobutanol Production by (ABE process, Biobutanol Production from Hexose and Pentose Sugars, By Bioconversion Of Cheese Whey), Advantages and disadvantages of biobutanol, Application.	

Suggested laboratory experiments:
• Not Applicable

Pedagogic tools:
• Chalk and Board
• LCD and Videos.

Text books

1. R. Luque, J. Campelo and J. Clark, Handbook of Biofuels Production, A volume in Woodhead Publishing Series in Energy, 2011, ISBN: 978-1-84569-679-5.
2. A. Pandey, C. Larroche, S. Ricke, C. G. Dussap, E. Gnansounou, Biofuels,1st Edition, 2011, ISBN: 978012385099, 1-642.

Laboratory Manual/ Book
• Not Applicable

Suggested reading / E-resources

1. N. Sriram, M. Shahidehpour, Renewable Biomass Energy, Electric Power and Power Electronics Center Illinois Institute of Technology Chicago, Illinois 60616, 0-7803-9156-X/05.
2. M. Aurelio Pinheiro Lima and Alexandra Pardo Policastro Natalense, Bioethanol, 2012, ISBN 978-953-51-0008-9, InTech Design Team.
3. Biomass at a Glance, 2015, Secondary Energy Infobook, The NEED Project 8408 Kao Circle, Manassas, VA 20110.
4. A. K. Kurchania, Chapter 2, Biomass Energy, , Biomass Conversion, DOI: 10.1007/978-3-642-28418-2_2.
5. http://nptel.ac.in/courses/108108078/pdf/chap7/teach_slides07.pdf
6. H. Khalid, R. Jawaid, M.R. Umer, Biomass and Bioenergy, 2014, ISBN 978-3-319-07578-5, Springer, 1-397.
7. A. Dahiya, Bioenergy- Biomass to Biofuels, 2014, ISBN: 9780124079090, Elsevier © Academic Press, 1-670.

Suggested MOOCs

- Bioenergy- NPTEL.
- Bioenergy- Swayam, MHRD, New Delhi, INDIA.
- Bomass energy training course- Illinois Institute for Rural Affairs, 518 Stipes Hall, Macomb, IL 61455, USA.

Methods of assessing the Course Outcomes

The COs of the course will be assessed through

- CIE
- Assignments
- Quiz
- Seminar