CVM UNIVERSITY
Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF ENGINEERING & TECHNOLOGY

Effective from Academic Batch: 2022-23

Programme: Bachelor of Technology (Mechanical Engineering)

Semester: VI

Course Code: 202020622

Course Title: Waste to Energy

Course Group: Open Elective Course - II

Course Objectives: The course deals with the production of energy from different types of wastes through thermal, biological and chemical routes. The objective of the course is to provide insights into waste management options by reducing the waste destined for disposal and encouraging the use of waste as a resource for alternate energy production. This course is designed to provide an understanding of the various aspects of Waste to Energy. The various sources of waste generation and characterization will be discussed along with the existing norms for waste utilization for alternate energy source. Various Technological options available for the production of energy form waste will delineated along with economics of using alternate sources. Case studies will be discussed to provide a better understanding of the concepts of "Waste to Energy" in the Indian context.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	0	0	3	50/18	50/17	NA	NA	100/35

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Introduction to Waste for Energy:** Sources and Classification of waste. Agro based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous). Characterization of waste for energy utilization. 3R Principle of Reduce, Reuse and Recycle. Waste as a Resource and Alternate Energy source. Classification of methods of treatment of waste for energy.	8
2	**Energy Production by Incineration and Pyrolysis:** Incineration plants, applications and limitations, Types of Pyrolysis, Product characteristics and Applications, Types of reactors, Manufacture of pyrolytic oils and gases, yields, Effect of various parameters on pyrolysis.	8
3	**Energy production by Gasification:** Types of Gasifiers - Fixed bed systems, Downdraft and updraft gasifiers, Fluidized bed gasifiers. Design, construction and	8

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	operation of Gasifiers. Reactions and kinetics of gasification, Gasifier burner system for thermal heating, Gasifier engine arrangement and electrical power.	
4	**Energy production by Combustion:** Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors	**8**
5	**Biogas Production:** Biogas -Properties and composition, Biogas plant technology and status, Design and constructional features, Biomass conversion processes - biochemical conversion, anaerobic digestion. Types of biogas Plants and Applications. Energy production from wastes through fermentation and transesterification(Alcohol and biodiesel production)Introduction to microbial fuel cells, Urban waste to energy conversion.	**10**
6	**Case studies:** Success/failures of waste to energy, Indian Scenario on Waste to Energy production distribution and use in India.	**3**

Reference Books:

1	Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996
2	Waste Treatment and Disposal, Willams P. T. John Wiley and Sons, Ltd. 2005.
3	Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983
4	Biomass Gasification and Pyrolysis - Practical Design and Theory, PrabirBasu, Elsevier Science

Supplementary learning Material:

1	Video lectures available on the websites NPTEL/SWAYAM/COURSERA
2	CDs available with some reference books for the solution of problems.
3	Industrial and Urban Waste Management in India, TERI Press.
4	Wealth from Waste: Trends and Technologies by BanwariLal and Patwardhan, TERI Press.
5	Report of the task Force on Waste to Energy, NitiAyog (Formerly Planning Commission) 2014
6	Website: www.cpcb.nic.in www.mnre.gov.in www.eai.in/ref/ae/wte/typ/clas/india_industrial_wastes.html

Pedagogy: Following one or more points can be incorporated as relevant pedagogy methods.

- Direct classroom teaching
- Audio Visual presentations/demonstrations
- Assignments/Quiz
- Continuous assessment
- Interactive methods
- Seminar/Poster Presentation
- Industrial/ Field visits
- Course Projects

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Internal Evaluation:

The internal evaluation comprised of written exam (40% weightage) along with combination of various components such as Certification courses, Assignments, Mini Project, Simulation, Model making, Case study, Group activity, Seminar, Poster Presentation, Unit test, Quiz, Class Participation, Attendance, Achievements etc. where individual component weightage should not exceed 20%.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying;**N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25%	30%	30%	10%	3%	2%	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Conversant with the skill to understand the various waste generation and characterization.	**20**
CO-2	Apply the understanding of Waste to energy concept for efficient use of solid waste.	**30**
CO-3	To enable students to select best available technologies for waste to energy	**30**
CO-4	To learn the design concept of various technologies for waste management.	**20**

Curriculum Revision:

Version:	2
Drafted on (Month-Year):	June-2022
Last Reviewed on (Month-Year):	-
Next Review on (Month-Year):	June-2025

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