



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3171313

Semester – VII

Subject Name: RESOURCE AND ENERGY RECOVERY FROM WASTE

Type of course: Open Elective

Prerequisite: Knowledge of Energy Resources

Rationale: To understand the principles of recovery of materials and energy from wastes through biochemical, mechanical and thermo-chemical conversions.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	MECHANICAL PROCESSING FOR MATERIAL RECYCLING: Resource recovery for a sustainable development- Material and energy flow management and analysis - Systems and processes for reduction, reuse and recycling -Objectives of Waste Processing-Source Segregation and Hand Sorting- Waste Storage and Conveyance – Shredding – Pulping - Size Separation by Screens- Density Separation by Air Classification –magnetic and electromechanical separation processes- Design Criteria and Equipment selection	04
2	BIOLOGICAL PROCESSING FOR RESOURCE RECOVERY: Mechanisms of Biological Processing – Aerobic Processing of Organic fraction - Composting methods and processes- factors affecting- Design of Windrow Composting Systems- In Vessel Composting- Compost Quality Control- Vermiculture: definition, scope and importance - common species for culture - Environmental requirements - culture methods- Applications of vermiculture- Potentials and constraints for composting in India-Largescale and decentralized plants.	06
3	BIO-CHEMICAL CONVERSION OF WASTE TO ENERGY: Principles and Design of Anaerobic Digesters – Process characterization and control- The biochemistry and microbiology of anaerobic treatment - Toxic substances in anaerobic treatment - Methane generation by Anaerobic Digestion-	04

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	Anaerobic reactor technologies - Commercial anaerobic Technologies- Single stage and multistage digesters- Digester design and performance-Gas collection systems-Methane Generation and Recovery in Landfills – Biofuels from Biomass	
4	THERMO-CHEMICAL CONVERSION OF WASTE TO ENERGY: Principles and Design of Energy Recovery Facilities -Types and principles of energy conversion processes - Incinerator design - Mass Burn and RDF Systems- Composition and calorific value of fuels and waste, Determination of the stoichiometric air consumption, Calculation of the flue gas composition - grate firing designs, boiler design, removal of bottom ash, heat recovery- Emission Controls – flue gas cleaning, de-dusting, flue gas scrubbers, DeNOx processes, dioxins and furans - Alternative thermal processes: co-incineration, pyrolysis, gasification, plasma arc - Process characterization and control- waste heat recovery- Bottom ash: Quantity, quality, treatment, utilization, disposal- Facility design- decentralized mobile plants- Planning and construction of incineration plants	08
5	CASE STUDIES ON WASTE RECYCLING: Recycling technologies for paper, glass, metal, plastic – Used Lead Acid Battery Recycling –End of Life Vehicle Recycling – Electronic Waste Recycling – Waste Oil Recycling – Solvent Recovery - Drivers and barriers for material recycling: social, legal and economic factors - Environmental impacts of waste recycling - Design for the environment: the life cycle approach	06

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	30	40	10	00	00

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

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.

Reference Books:

1. Aarne Vesilind and Alan E Rimer (1981), "Unit operations in Resource Recovery Engineering ", Prentice Hall Inc., London



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2. Manser A G R, Keeling A A (1996). Practical handbook of processing and recycling on municipal waste. Pub CRC Lewis London, ISBN 1-56670-164
3. Chiumenti, Chiumenti, Diaz, Savage, Eggerth, and Goldstein , Modern Composting Technologies
4. JG Press October 2005
5. Charles R Rhyner (1995), Waste Management and Resource Recovery, Lewis Publishers
6. Gary C. Young (2010) Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons , John Wiley & Sons
- 7.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the fundamental principles of existing and emerging technologies for the treatment of waste to recover of materials and generation of energy from waste	10
CO-2	Understand the process of generation of energy from waste through biochemical conversion.	45
CO-3	Understand the process of thermo-chemical conversion of waste to energy.	25
CO-4	Analyze and describe the potential of solid waste as a secondary raw material, and the associated problems and possibilities in a sustainable society.	20

List of Practicals:

1. Determination of Composition of Municipal solid waste.
2. Determination of biogas generation from the different types of organic waste.
3. Determination of Bio-methane Potential of different agricultural waste.
4. Determination of ultimate and proximate analysis of given waste.
5. Determination of NPK of given compost.