

Branch Name:	Civil Engineering
Program Code:	ET106
Course Title:	Waste Management (Open Elective-II)
Course Code:	2ET1060781T
Pre-requisite Course:	An Introductory knowledge of Solid and Hazardous Waste along with Some Basic Understanding of Solid Waste Management at Industries

Course Objective:

1. To provide in-depth knowledge of various types of solid and hazardous wastes.
2. To understand scientific principles and engineering techniques for waste management.
3. To develop skills for selection and design of waste treatment and disposal systems.
4. To familiarize students with environmental regulations and sustainable practices.

Teaching and Examination Scheme:

Credit	Teaching Scheme Hours per week				Evaluation Scheme (Marks)								
					Theory (Marks)				Practical (Marks)				Total (Marks)
	L	T	P	Total	SEE		CCA		SEE		CCA		
					Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
3	3	-	-	3	24	60	16	40	-	-	-	-	100

Subject Contents:

Sr. No	Topic	Total Hours	Weightage (%)
1	Unit 1: Fundamentals of Waste Management Definition and classification of waste. Sources and characteristics of municipal solid waste, industrial waste, biomedical waste, plastic waste, e-waste, agricultural waste. Physical, chemical, and biological properties of waste. Waste generation rates and composition analysis. Concept of integrated waste management, circular economy, and sustainability. Hierarchy of waste management: Reduce, Reuse, Recycle, Recover, Dispose.	8	20
2	Unit 2: Waste Collection, Storage and Transportation Primary and secondary collection systems. Waste storage containers and handling. Collection methods: door-to-door, community bin, curb side collection. Transfer stations: types, design considerations and operation. Transportation systems and route optimization techniques. Health and safety aspects in waste handling.	8	20
3	Unit 3: Waste Processing and Treatment Technologies Mechanical processing: screening, shredding, compaction. Biological treatment: composting (windrow, in-vessel), vermicomposting, anaerobic digestion and biogas production. Chemical treatment methods: neutralization, stabilization. Recycling processes for paper, plastic, metals and glass. Material recovery facilities (MRF) and their design.	8	20

4	Unit 4: Waste to Energy Technologies Principles of waste-to-energy conversion. Incineration: process, advantages, limitations and environmental concerns. Pyrolysis and gasification technologies. Refuse Derived Fuel (RDF) production and utilization. Biogas plants and energy recovery from organic waste.	6	15
5	Unit 5: Disposal of Solid and Hazardous Waste Landfills: types (sanitary, secure landfill), site selection criteria. Design aspects: liners, leachate collection system, gas collection system. Landfill operation, closure and post-closure care. Hazardous waste disposal methods: stabilization, encapsulation, deep burial. Environmental impacts of improper disposal.	6	15
6	Unit 6: Waste Management Legislation and Emerging Trends Overview of Indian environmental laws related to waste management. Solid Waste Management Rules (latest amendments), Plastic Waste Management Rules. Biomedical Waste Management Rules, E-waste Management Rules. Role of CPCB, SPCB and municipal authorities. Emerging trends: smart waste management, AI/IoT in waste monitoring, zero waste concepts.	4	10

Reference Books:

1. Tchobanoglous, G., Theisen, H., & Vigil, S. A. – *Integrated Solid Waste Management: Engineering Principles and Management Issues*, McGraw-Hill.
2. Vesilind, P. A., Worrell, W., & Reinhart, D. – *Solid Waste Engineering*, Cengage Learning.
3. Peavy, H. S., Row, D. R. – *Environmental Engineering*, McGraw-Hill.
4. Rao, C. S. – *Environmental Pollution Control Engineering*, New Age International.
5. Kiely, G. – *Environmental Engineering*, McGraw-Hill.
6. Cheremisinoff, N. P. – *Handbook of Solid Waste Management and Waste Minimization Technologies*, Butterworth-Heinemann.
7. Kreith, F., & Tchobanoglous, G. – *Handbook of Solid Waste Management*, McGraw-Hill.
8. CPHEEO Manual – *Manual on Municipal Solid Waste Management*, Government of India.
9. CPCB Guidelines – *Hazardous Waste Management Guidelines*, Central Pollution Control Board.

List of Open-Source Software/learning website:

1. NPTEL (<https://nptel.ac.in/>)
 - Courses on Solid Waste Management, Environmental Engineering
2. SWAYAM (<https://swayam.gov.in/>)
 - Government-certified courses on sustainability and waste management
3. USEPA (<https://www.epa.gov/>)
 - Technical guidelines, case studies, and waste management practices
4. CPCB (<https://cpcb.nic.in/>)
 - Indian regulations, reports, and compliance guidelines
5. MoEFCC (<https://moef.gov.in/>)
 - Environmental policies and legislative frameworks
6. World Bank Waste Management Portal
 - Global case studies and best practices
7. ISWA (International Solid Waste Association)
 - Reports, webinars, and global waste management insights

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Understand different types and characteristics of waste.	L-2
CLO2	Apply appropriate collection and transportation systems.	L-2
CLO3	Analyze and select suitable treatment technologies.	L-6
CLO4	Design basic waste disposal systems such as landfills.	L-2 and L-6
CLO5	Interpret environmental laws and apply sustainable waste management practices.	L-2

L1- Remember, L2- Understand, L3- Apply, L4- Analyze, L5- Evaluate, L6- Create

Mapping of CLOs with POs & PSOs

	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
Course Learning Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO1	M					M							M	M	
CLO2	M		M			M							M	M	
CLO3	M	M	M						L			M	M	M	M
CLO4	M	M	M										M	M	
CLO5	M		M										M	M	

H: High, M: Medium, L: Low