


**Government of Karnataka  
Department of Technical Education  
Board of Technical Examinations, Bangalore**

Course Title: <b>SOLID WASTE MANAGEMENT</b>			
	Credits (L:T:P) : <b>4:0:0</b>	Total Contact Hours: <b>52</b>	Course Code: <b>15CE63C</b>
	Type of Course: <b>Lectures, Self Study &amp; Student activities</b>	Credit : <b>04</b>	Core/ Elective: <b>Elective</b>
CIE-25			SEE-100

**Prerequisites:** This course requires the student to know about Environmental Engineering

**Course Objectives:**

1. To characterize the waste and apply the knowledge of laws for municipal solid waste management, for handling of biomedical wastes and for handling of plastic wastes.
2. To apply the knowledge of mathematics, science, and engineering for effective solid waste collection systems, for waste collection route optimization and for processing of solid waste.
3. To design composting systems, maintain and operate the aerobic and anaerobic composting process for effective organic waste recycling.
4. To manage construction and operations of landfill facilities, energy recovery systems and management of leachate systems.

*On successful completion of this course, the student will be able to*

Course Outcome		CL	Linked PO	Teaching Hrs
<b>CO1</b>	Describe the components of solid waste management and the laws governing it.	<i>U/Ap</i>	1,2,5,6,7,8, 10	06
<b>CO2</b>	Discuss the solid waste collection systems, route optimization techniques and processing of solid wastes.	<i>U/Ap/Ay /E</i>	2,3,5,6,7,8, 9,10	10
<b>CO3</b>	Outline the design, operation, and maintenance of different methods of treatment.	<i>U/Ap/Ay</i>	2, 3,4,5,6,7,8, 9, 10	12
<b>CO4</b>	Explain the operation, and maintenance of sanitary landfill	<i>U/Ap/Ay</i>	2,4,5,6,7,8, 10	10
<b>CO5</b>	Examine the operation, and maintenance of Incineration	<i>U/Ap</i>	2,4,5,6,7,8, 10	08
<b>CO6</b>	Conclude the recent trends in reuse of solid waste	<i>U/Ap</i>	2,4,5,6,7,8, 9, 10	06
			<b>Total sessions</b>	<b>52</b>



Legend- R: Remember U: Understand Ap: Application Ay: Analysis C: Creation E: Evaluation



## MAPPING COURSE OUTCOMES WITH PROGRAM OUTCOMES

Mapping of COs with POs	PROGRAMME OUTCOME (PO)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
	Basic Knowledge	Discipline Knowledge	Experiments & practice	Engineering Tools	Engineer and society	Environment & Sustainability	Ethics	Individual and Team work	Communication	Lifelong learning
<b>SOLID WASTE MANAGEMENT</b>	1	3	3	3	3	3	3	3	3	3

### DETAILED COURSE CONTENT

UNIT	COURSE CONTENT	HOURS
1	<b>INTRODUCTION TO SOLID WASTES:</b> Definition of solid wastes, Sources, classification and characteristics of solid wastes, Municipal Solid Waste (Management and Handling ) Rules,	06
2	<b>COLLECTION OF SOLID WASTE:</b> Systems of collection of solid wastes, transfer stations, collection equipments, route optimization techniques and numerical problems on route optimization. Processing techniques of solid wastes (principle of operation and function only).	10
3	<b>TREATMENT METHODS:</b> Various methods of refuse processing, recovery, recycle and reuse.- Mechanical volume reduction, Chemical volume reduction, Mechanical size reduction and component separation <b>COMPOSTING:</b> Composting, factors affecting composting process, aerobic and anaerobic composting, Indore and Bangalore method of composting, mechanical composting process, vermin-composting.	12
4	<b>LANDFILLS:</b> Sanitary land filling – trench method and area method Factors considered for a landfill site selection, leachate collection systems, control of gas movement and gas recovery systems.	10
5	<b>INCINERATION:</b> Incineration process, factors affecting incineration process, and air pollution prevention in incinerators, pyrolysis process. Biomedical Waste, Biomedical Waste Handling Rules and its Impact on Human Health.	08
6	<b>RECENT DEVELOPMENT IN SOLID WASTE REUSE AND DISPOSAL:</b> Power generation, Building with construction materials and Best Management Practices (BMP)	06

**Course Delivery:** The course will be delivered through lectures and Power point presentations/Videos



## SUGGESTED LIST OF STUDENT ACTIVITES

The topic should be related to the course in order to enhance his knowledge, practical skill & and lifelong learning, communication, modern tool usage.

1	Prepare a report on Quantity of solid waste generated from village or town
2	Identify the different sources and types of solid waste generated for a village or town.
3	Write a report on visit to Sanitary landfill site nearby to your place.
4	Write a report on visit to Mechanical process of Composting plant nearby to your place.
5	Identify the different types of biomedical waste generated in hospital and then visit nearby Incineration unit.
6	Prepare a report on Best Management Practices (BMP) for disposal of solid waste generated in your places.
7	Prepare a report on treatment methods adopted in sanitary landfill area to reduce solid waste quantity.

### NOTE:

1. Students should select any one of the above or other topics relevant to the subject approved by the concerned faculty, individually or in a group of 3 to 5. Students should minatorily submit a written report and make a presentation on the topic. The task should not be repeated among students. Report will be evaluated by the faculty as per rubrics. Weightage for 5 marks Internal Assessment shall be as follows:

Unsatisfactory 1, Developing 2, Satisfactory 3, Good 4, Exemplary 5.

2. Reports should be made available along with bluebooks to IA verification officer

### Example of model of rubrics / criteria for assessing student activity

Dimension	Students score (Group of five students)				
	STUDENT 1	STUDENT 2	STUDENT 3	STUDENT 4	STUDENT 5
<b>Rubric Scale</b>	Unsatisfactory 1, Developing 2, Satisfactory 3, Good 4, Exemplary 5				
1.Literature	3				
2.Fulfill team's roles & duties	2				
3.Conclusion	4				
4.Conversions	5				
<b>Total</b>	14				
Average=(Total /4)	3.5=4				
<b>Note: Concerned faculty (Course coordinator) must devise appropriate rubrics/criteria for assessing Student activity for 5 marks One activity to attain last CO (course outcome) may be given to a group of FIVE students</b>					

Note: Dimension should be chosen related to activity and evaluated by the course faculty.



Dimension	Rubric Scale				
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary
1.Literature	Has not included relevant info	Has included few relevant info	Has included some relevant info	Has included many relevant info	Has included all relevant info needed
2. Fulfill team's roles & duties	Does not perform any duties assigned	Performs very little duties	Performs partial duties	Performs nearly all duties	Performs all duties of assigned team roles
3.Communication	Poor	Less Effective	Partially effective	Effective	Most Effective
4.Conversions	Frequent Error	More Error	Some Error	Occasional Error	No Error

### Course Assessment and Evaluation Scheme:

	What		To whom	When/Where (Frequency in the course)	Max Marks	Evidence collected	Course outcomes
Direct Assessment	CIE	IA	Students	Three IA tests (Average of three tests will be computed )	20	Blue books	CO1,CO2
				Test 1			CO3,CO4
				Test 2			CO5,CO6
			Student activities	05	Report	CO1 TO CO6	
	SEE	End Exam	End of the course	100	Answer scripts at BTE	CO1 TO CO6	
Indirect Assessment	Student Feedback on course		Students	Middle of the course		Feedback forms	CO1,CO2 &CO3 Delivery of course
	End of Course Survey			End of the course		Questionnaires	CO1 TO CO6 Effectiveness of Delivery of instructions & Assessment Methods

\*CIE – Continuous Internal Evaluation      \*SEE – Semester End Examination

**Note:** I.A. test shall be conducted for 20 marks. Average marks of three tests shall be rounded off to the next higher digit.

**Note to IA verifier:** The following documents to be verified by CIE verifier at the end of semester

1. Blue books ( 20 marks)
2. Student suggested activities report for 5 marks evaluated through appropriate rubrics.
3. Student feedback on course regarding Effectiveness of Delivery of instructions & Assessment Methods



## Weightage of Marks and blue print of marks for SEE

Unit No	Unit Name	Hour	Questions to be set for (5marks) PART - A				Questions to be set for (10marks) PART - B				Marks weightage
			R	U	A	Ap	A	U/Ap	C	E	
1	Introduction to Solid waste	06	-	01	-	-	-	01	-	-	15
2	Collection of Solid waste	10	-	01	01	-	-	01	-	01	30
3	Treatment methods: Composting	12	-	02	01	-	01	01	-		35
4	Landfill	10	-	01	01		-	02	-	-	30
5	Incineration	08	-	-	-		-	02	-		20
6	Recent development in solid waste reuse and disposal	06	-	01	-		-	01	-		15
	<b>Total</b>	<b>52</b>	<b>09(45marks)</b>				<b>10(100 marks)</b>				<b>145</b>

Legend: R; Remember, U: Understand A: Analysis Ap: Application, C:Creation, E:Evaluation

Questions for CIE and SEE will be designed to evaluate the various educational components such as:

1	Remembering and Understanding	70%
2	Applying the knowledge acquired from the course	20%
3	Analysis	10%
4	Evaluation	0%
5	Creating new knowledge	0%



## MODEL QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks		
Ex: I test/6 <sup>th</sup> weak of sem 10-11 Am	VI SEM	<b>SOLID WASTE MANAGEMENT</b>	20		
	Year: 2015-16	Course code:15CE63C			
Name of Course coordinator			CO1,CO2		
<b>Note: Answer all questions</b>					
Question no	Question	CL	CO	PO	
1	Define solid waste. Explain the composition of Municipal Solid waste. <p style="text-align: right;">5 MARKS</p>	U	1	1,2, 5,6, 10	
2	Differentiate between the Municipal, Industrial, Bio-medical & Hazardous wastes <p style="text-align: right;">5 MARKS</p>	U	1	1,2, 5,6, 10	
3	Explain with a neat sketch hauled container system and stationary container system of collection of solid waste. <p style="text-align: center;">OR</p> Enumerate the guidelines that must be taken into consideration when laying out the routes for collection of solid waste. <p style="text-align: right;">10 MARKS</p>	U	2	1,2, 6,10	



### **Text Books:**

1. George Tchobanoglous et.al., “Integrated Solid Waste Management”, Mc-Graw-Hill, Inc. New York, 1993.
2. Howard S.Peavy et.al., “Environmental Engineering”, Mc-Graw-Hill Book Company, New York, 1985.

### **Reference Books**

1. A.D. Bhide and B.B.Sudareshan, “Solid Waste management in Developing Countries”, NEERI, Nagpur 1983.
2. “Environmental Engineering (Vol II)”- S.K Garg Khanna Publishres, New Delhi 2009.
3. Robert A. Corbit, “Standard Handbook of Environmental Engineering”, Mcgraw Hill Inc, New Delhi,1990.
4. P. Aarne Vesilind, William Worrel and Reinhart, Solid Waste Engineering, Thomson Brooks, Cole.
5. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Govt. of India, 2000.
6. Management and Handling Rules for Municipal Solid Waste and Biomedical Waste and Plastic Waste, MOEF publications.



# MODEL QUESTION PAPER (SEE)

Code: 15CE63C

## Diploma in Environmental Engg.

VI Semester

Course Title: SOLID WASTE MANAGEMENT

Time: 3 Hours]

[Max Marks: 100]

- Note:** i) Answer any SIX questions from PART - A. Each question carries 05 marks.  
ii) Answer any SEVEN Questions from PART - B. Each question carries 10 marks.

### PART – A

1. Define solid waste. Explain the composition of Municipal Solid waste.
2. Explain the functional elements of Transfer and Transport of Solid waste.
3. List the factors that must be considered for location of transfer station.
4. Explain the Day to day SWM
5. Write a note on Mechanical Volume Reduction
6. Describe the Materials flow in society
7. List advantages and disadvantages of sanitary land fill
8. Explain the constituents of landfill gases.
9. List recent trends in reuse of solid waste

### PART – B

1. a) Write a short note on Hazards Waste.  
b) What are the properties of Solid Waste?
2. Explain Collection routes- layout of routes & schedules
3. Distinguish between hauled container system and stationary container system of collection of solid waste.
4. Explain Indore method of composting.
5. Describe the Materials recovery in solid wastes
6. Write a note on Lecheat movement and control of Lecheat movement.
7. With a neat sketch explain the land fill operational plan.
8. a) Define Incineration and list factors affecting incineration process  
b) List the various types of equipments used to control air pollution in Incinerators with objective.
9. With a neat sketch explain the process of incineration of MSW.
10. Explain with flow diagram power generation using gas turbines.

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# MODEL QUESTION BANK

Code: 15CE63C

## Diploma in Environmental Engineering

VI Semester

Course title: SOLID WASTE MANAGEMENT

**CO 1:** Understand the components of solid waste management and the laws governing it.

### UNDERSTANDING LEVEL QUESTION

1. Define solid waste. Explain the composition of Municipal Solid waste.
2. Explain the Types of solid wastes
3. List the different sources of Municipal Solid Waste.
4. List the Physical composition of solid wastes.

### APPLICATION LEVEL QUESTIONS

5. Explain the methods used to estimate the Solid waste quantities
6. Explain the Properties of Solid Waste
7. Explain the Chemical composition of solid waste - Individual components, particle size, density.
8. Differentiate between the Municipal, Industrial, Bio-medical & Hazardous wastes
9. Explain the sampling procedures for solid wastes.

**CO 2 :** Understand the solid waste collection systems, route optimization techniques and processing of solid wastes.

### UNDERSTANDING QUESTIONS

1. Explain the On-site storage- factors to be considered for MSW
2. Explain Types & sizes of containers, container locations
3. List and explain various means of transports used to transport solid waste and their suitability.
4. Explain the functional elements of Transfer and Transport of Solid waste.
5. Explain equipment & accessory requirement in MSWM.
6. Explain Transfer stations - Factors to be considered.
7. List the factors that must be considered for location of transfer station.
8. Explain Collection routes- layout of routes & schedules
9. Explain the Factors affecting generation rates

### APPLICATION LEVEL QUESTIONS

1. Explain the objectives of separation & processing
2. Describe terms curb, alley, set out, backyard carrying





3. Distinguish between hauled container system and stationary container system of collection of solid waste.
4. Enumerate the guidelines that must be taken into consideration when laying out the routes.
5. Explain the sampling procedures for solid wastes.
6. Explain the functional elements of Collection of solid waste.
7. Explain Collection services, collection systems- outline of operational tasks
8. Describe about Collection routes- layout of routes & schedules

#### **ANALYSIS LEVEL QUESTIONS**

1. Determination of total number of residences from which wastes are generated.

#### **EVALUATION LEVEL QUESTIONS**

1. Evaluate the optimised route for collection of solid waste in given area.

**CO 3:** Understand the design, operation, and maintenance of different methods of treatment.

#### **UNDERSTANDING QUESTIONS.**

1. Explain the Day to day SWM
2. Explain the objectives of separation & processing
3. What is Composting? Explain in brief aerobic and anaerobic composting of MSW
4. List the factors affecting the composting operations.

#### **ANALYSIS LEVEL QUESTIONS**

1. Explain separation and types of processing
2. Categorize different types of Mechanical Volume Reduction
3. Categorize different types of Thermal Volume Reduction

#### **APPLICATION LEVEL QUESTIONS**

1. Describe the Materials flow in society.
2. Explain the Reduction in raw material usage.
3. Explain the Reduction in solid waste quantities.
4. Describe how the Segregation of waste done.
5. Explain the Reuse of solid waste materials.
6. Describe the Materials recovery in solid wastes
7. Distinguish between Indore and Bangalore method of composting
8. Explain Mechanical process of composting.
9. Describe Vermi-composting.

**CO 4:** Know the operation, and maintenance of sanitary landfill

#### **UNDERSTANDING QUESTIONS**

1. List different types of disposal of solid waste by sanitary landfill.



2. List the factors to be considered in evaluating landfill sites
3. Explain in brief physical, chemical and biological reactions takes place in sanitary landfill site.
4. List advantages and disadvantages of sanitary land fill
5. Define the term Lecheat and explain composition of Lecheat.
6. Write a note on Lecheat movement and control of Lecheat movement.
7. List the various Biological, Physical and Chemical treatment processes are used for treatment of Lecheat.

#### **ANALYSIS LEVEL QUESTIONS**

1. Explain the constituents of landfill gases.

#### **APPLICATION / EVALUATION LEVEL QUESTIONS**

1. Explain with neat sketch in brief (1) Trench method (2) Area ramp method.
2. With a neat sketch explain the control of gas movement by vent and barrier method.
3. Explain Well systems used for recovery of gases from landfill.

#### **CO 5: Know the operation, and maintenance of Incineration**

##### **UNDERSTANDING LEVEL QUESTION**

1. Define Incineration and list factors affecting incineration process.
2. List types of Biomedical wastes.

##### **APPLICATION / EVALUATION LEVEL QUESTIONS**

1. With a neat sketch explain the process of incineration of MSW.
2. Explain in brief various types of equipments used to control air pollution in Incinerators.
3. With a neat sketch explain the process of Pyrolysis of MSW.
4. Explain biomedical waste handling rules.

#### **CO 6: Know the recent trends in reuse of solid waste**

##### **UNDERSTANDING LEVEL QUESTION**

1. List recent trends in reuse of solid waste
2. List Best Management Practices for safe disposal of solid waste.

##### **APPLICATION/ EVALUATION LEVEL QUESTIONS**

1. Explain with flow diagram power generation using gas turbines.
2. Explain building dismantled material can be disposed off safely.

