

M.E. CIVIL ENGINEERING 1st YEAR 1st SEMESTER EXAMINATION, 2025
SOLID WASTE MANAGEMENT

Time: Three hours

Full Marks 100
(60 marks for part I)

Use a separate Answer-Script for each part

Part-I

Question no. 1 is compulsory

Answer any **two** from the rest

(Assume any data, if required, reasonably)

- 1.
- a) What are the different categories of bio-medical waste? What are the different coloured code is used for source segregation of bio-medical waste. 6+4
- b) What is trigeneration? Why trigeneration with bio-fuel is more sustainable than fossil fuel energy generation? Why it is considered as 'net zero CO₂ emission'? 5
- c) Please discuss with reason in the following cases what will be the fate of nitrogen - i) In the raw material for preparing compost if C/N ratio is 75; ii) In the raw material for preparing compost if C/N ratio is 14; iii) In the compost product if C/N ratio is 34; iv) In the compost product if C/N ratio is 10. 6
- e) Considering the typical composition of municipal solid waste of Kolkata metropolitan city, describe the plausible integrated solid waste management system with tentative material balance and draw the flow diagram showing the percentage amount. 9
- 2.
- a) A local waste management agency has proposed to set up a waste combustion facility next to the existing landfill to maximize the life span of the landfill. Given the following information, determine how much the life span of the landfill can be increased by setting combustion facility.
- (i) Raw garbage generation is 1850 t/d
 - (ii) Silt generation, having compacted specific weight of 750 kg/m³, is 12 % of garbage
 - (iii) Estimated landfill capacity remaining is 3,700,000 m³
 - (iv) Capacity of combustion facility is 65 t of raw garbage/h with 90% daily running efficiency
 - (v) Residue generation from combustion of 1000t of raw garbage is 250 t
 - (vi) specific weight of the raw garbage is 180 kg/m³
 - (vii) specific weight of compacted raw garbage in landfill is 560 kg/m³
 - (viii) specific weight of compacted residue (ash) in landfill is 725 kg/m³
- Yearly maintenance period of the combustion facility is 25%

- b) A 3 m diameter trommel, inclined at an angle of 3° , is used for separating glass from commingled Municipal Solid Waste (MSW). Capacity of the trommel is 210 t/h. Glass content in MSW is 12%. Total weight of screen underflow is 25 t/h and weight of glass in screen underflow is 20 t/h. Determine (i) critical speed in rpm; (ii) recovery rate of glass; (iii) purity of MSW; (iv) purity of glass; and (v) efficiency of the trommel screen. 5

3.

- a) Determine the area requirement of a windrow composting yard considering 'transverse turning'. Given data: i) daily waste production 230 t; ii) specific weight of waste = 410 kg/m^3 ; iii) Maximum permissible length of windrow is $\sim 50 \text{ m}$; iv) width of windrow = 4.5 m; v) height of windrow = 2 m; vi) windrow shape parabolic; vii) space between windrow = 1.2 m; viii) road width = 7.5 m; ix) drain width = 500mm; x) active period 35 days and curing period 1.2 months. Draw a plan and sectional view of the windrow composting yard showing different components. 10

- b) Draw a sectional view of the windrow composting yard showing different components. 5

4.

- a) Design a landfill from the following basic data:
 i) Current waste generation = 1500 t/d;
 ii) Estimated rate of increase of waste generation per year = 1.1%;
 iii) Active period = 24years; iv) Closure and post closure period = 25 years;
 v) Ground water table 12m below ground surface;
 vi) Subsoil type - sandy silt; vii) length : width of landfill = 2:1.2;
 viii) Maximum permissible landfill height = 28m; ix) Number of phases = 12;
 x) lift height = 2m;
 [design of liner, leachate, cover, drainage and monitoring system excluded] 10

- b) Draw the plan; Sectional elevation; Phasing of landfill. 5

M.E.C.E. 1st YEAR EXAMINATION, 2025

(1st Semester)

SUBJECT: Solid and Gaseous Waste Management

Full Marks 100

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Use a separate Answer-Script for each part

No. of Questions

Part II (40 Marks for This Part)

Marks

Q1. (A)	<p>Answer Question 1 (compulsory) and any two from the rest. Assume any data if not provided. All the drawings should be in pencil.</p> <p>A municipal area has four collection points and waste collection from each point are presented in tabular form. It has one compost plant, one biogas plant and one incineration plant for treating the waste. The capacities of each treatment facilities, the cost of waste transfer from each collection point to facility sites and revenue earned from each facility sites are also presented in the table below. Formulate the problem in the form of a linear programming problem to optimise the cost of solid waste management for the municipality.</p>	8																												
	<table border="1"> <thead> <tr> <th rowspan="2">Source</th> <th rowspan="2">Generation (kg)</th> <th colspan="3">Cost of transportation (Rs/kg)</th> </tr> <tr> <th>Compost Plant</th> <th>Biogas Plant</th> <th>Incineration Plant</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>550</td> <td>5</td> <td>12</td> <td>10</td> </tr> <tr> <td>2</td> <td>450</td> <td>7</td> <td>9</td> <td>5</td> </tr> <tr> <td>3</td> <td>300</td> <td>12</td> <td>8</td> <td>4</td> </tr> <tr> <td>4</td> <td>700</td> <td>13</td> <td>6</td> <td>8</td> </tr> </tbody> </table>	Source	Generation (kg)	Cost of transportation (Rs/kg)			Compost Plant	Biogas Plant	Incineration Plant	1	550	5	12	10	2	450	7	9	5	3	300	12	8	4	4	700	13	6	8	
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(B)	<p>Write in brief the significances of the following factors in association with the solid waste generation:</p> <ol style="list-style-type: none"> Collection fees and public attitude Collection frequency 	1×2																												
Q2. (A)	<p>Discuss the factors that you have to consider to design an on-site storage facility for low rise buildings. Write the advantages and disadvantages of door-to-door system collection considering public and municipal workers points of view.</p>	3+4																												
(B)	<p>Determine the round-trip haul time graphically for a site located 12 km away from the collection points. Given:</p>	8																												
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3. (A)	<p>With neat sketch explain break even time analysis for decision making in solid waste transfer. Write two factors that you may consider while design solid waste collection route.</p>	5+2																												
(B)	<p>Based on the information given below check whether the amount of time spent on off-route activities by the collectors exceeds or not the standard time as discussed in your class.</p> <ol style="list-style-type: none"> A hauled container system, without container exchange is used. The average time spent from the garage to the 1st container is 20 min The average pick up time per container is 5 min 	8																												

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4. (A)	<p>Differentiate between:</p> <ul style="list-style-type: none"> d. The average time to drive between container is 7 min e. The average time required to empty the container at the disposal site is 6 min f. The average round trip distance to the disposal site is 10km/trip and the haul constants are 0.004 h/trip and 0.02 h/km g. The average time required to redeposit a container after it has been emptied is 4 min h. The average time spent from last container to the garage is 15 min i. The number of containers emptied per day is 10. j. Total working time per day =8h 	3×2																												
(B)	<p>Decide graphically the size of the storage container for the Environmental Engineering Laboratory having solid waste generation per week for calendar quarter of operation are presented below.</p>	9																												
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