Ref No. –EX/PG/CE/T/113F/6/2017

MASTER OF CIVIL ENGINEERING 1st SEMESTER EXAMINATION, 2017

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) For a typical Indian metropolitan city describe the 'existing' solid waste management system with a flow diagram. As a probable solution describe the plausible flow diagram (with tentative material balance) of an integrated solid waste management considering waste generation as 100 units. What should be the considerations (constraints) to optimize the cost and impact of the integrated solid waste management system for the typical Indian metropolitan city?

3+7+5

b) Describe the different categories of bio-medical waste along with their treatment methods.

9

2.

a) Describe different types of material separation systems in municipal solid waste management system.

5

b) Design a landfill from the following basic data:
i) Current waste generation = 1100 t/d; ii) Estimated rate of increase of waste generation per year = 1.02%; iii) Active period = 20years; iv) Closure and post closure period = 25 years; v) Ground water table 10m below ground surface; vi) Subsoil type - sandy silt; vii) length : width of landfill = 2:1; viii) Maximum landfill height = 24m; ix) Number of phases = 10; x) lift height = 2m; [design of liner, leachate, cover, drainage and monitoring system excluded]
Draw the plan; Sectional elevation; Phasing of landfill and layout of landfill showing all details.

13

3.

a) Describe the basic processes of (i) Combustion; (ii) Pyrolysis; and (iii) Gassification with respect to solid waste transformation.

6

b) Determine the area requirement of a windrow composting yard considering 'longitudinal turning'. Given data: i) daily waste production 290 t; ii) specific weight of waste = 410 kg/m^3; iii) Maximum permissible length of windrow is ~ 50 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) active period 28 days and maturation period 1.5 months.

Draw a plan and sectional view of the windrow composting yard showing different components.

12

4.

a) Describe the average composition of MSW landfill gas? How the MSW landfill gas generation varies with the time?

5

b) A retort multi-chamber incinerator has to burn 160 kg/h of office waste comprising mostly of paper having a calorific value of 4100 Kcal/kg. Moisture content of the waste is 20%. Draw a neat sketch of a retort multi-chamber incinerator showing different components and find out

i) Total heat

ii) Heat loss; [when 1 kg of paper is burnt, 0.6 kg of water is formed]

iii) Net available heat

iv) Total combustion product; [when 300% excess air is supplied, 21.4 kg of combustion product are formed per kg of paper]

v) Average gas temperature

vi) Combustion air requirement; [4.25 m^3 of air is needed to burn 1 kg of dry paper]

vii) Grate area

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MASTER OF CIVIL ENGINEERING EXAMINATION, 2017

(1st Semester)

SUBJECT: Solid Waste Management

Full Marks 100

Time: Three hours

Use separate Answer-Scripts for each part

No. of Questions	Part II (40 marks for this part)	Marks
	Answer question number 1 is compulsory and any two from the rest. Assume relevant data if necessary.	
Q1. a)	A municipal area generates 200 kg of solid waste daily and can transfer the wastes to nearby sanitary landfill site and compost plant. The cost of transferring waste to landfill site is Rs 3 per kg and to compost site is Rs 8 per kg. No more than 80 kg of waste can be transferred to landfill site and at least 60 kg of waste should be transferred to compost plant for its advantageous operation. Determine the amount of wastes should be transferred to each site using linear programming method.	15
b)	Write in brief the significances of analysing the following properties in association with efficient solid waste management: i. Specific density ii. Field capacity iii. Volatile organic carbon iv. Permeability v. Fusing point of ash	5×1
Q2. a)	Why calorific value is an important property for solid waste? What is the difference between low heating value and high heating value for a solid waste? Determine the low heating value and high heating value of 100 ton solid waste in kJ having chemical formula $C_{718}H_{1708}O_{759}N_8S$ with moisture content 20% and ash content 10%.	1+3+6
b)	Discuss the advantages and disadvantages of different conventional methods used for quantifying solid waste.	5
Q3.a)	Differentiate between haul time and at site time in reference with solid waste transfer system. Explain what a transfer station is and how you will determine the necessity of the transfer station.	3+3
b)	Because of a difference of opinion among municipal collection members and management you are appointed as a consultant to evaluate collection operation of your municipality. The basic question is the amount of time spent on off-route activities by the collectors. The collectors say that it is less than 15% and management says more. You are given the following information: (i) A hauled container system, without container exchange is used. (ii) The average time spent from the garage to the 1st container is 20 min (iii) The average pick up time per container is 6 min (iv) The average time to drive between container is 6 min (v) The average time required to empty the container at the disposal site is 6 min (vi) 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 (vii) The average time required to redeposit a container after it has been emptied is 6 min	9

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No. of Questions	Part II (40 marks for this part)	Marks
	(viii) The average time spent from last container to the garage is 15 min (ix) The number of container emptied per day is 10. Depending on the information decide truth is on whose side?	
Q4.a)	List the advantages and disadvantages of source segregation of solid waste in high rise apartment house. Write two important factors that should be kept in mind before designing an onsite storage facility.	3+2
b)	With example write the significances of applying 4-R in connection with efficient solid waste management.	5
c)	Estimate the as-discarded density of the solid waste. If the solid waste is compacted to density of 600 kg/m^3, calculate the at-site compaction ratio.	5

Component	Mass (%)	Density (kg/m^3)
Newspaper	15	85
Other paper	24	85
Cardboard	33	50
Glass	4.2	195
Plastics	0.49	65
Aluminium	0.13	160
Ferrous metals	1.18	320
Non ferrous metal	0.35	160
Yard wastes	17.97	105
Food wastes	1.67	290
Dirt	2.01	480