KATHMANDU UNIVERSITY
End Semester Examination
09 January 2024

Marks Scored:

Level : B.Sc.
Year : IV
Course : ESEE 401
Semester : I

Exam Roll No. :
Time: 30 mins.
F. M. : 20

Registration No.:
Date :

SECTION "A"
[20Q. × 1 =20 marks]

Choose and encircle the most appropriate answers from the given choices.

1. Discrete volume of a hazardous waste landfill that employs a liner to isolate wastes from adjacent cells or waste is called
   a. Landfill cell b. Landfill area c. Landfill waste d. Landfill structure

2. Which of the following isn't the physical parameter considered for energy recovery from MSW?
   a. Size of constituents b. Density
   c. Moisture content d. Volatile solids

3. _____ is the crushing and grinding of municipal solid waste.
   a. Landfills b. Shredding c. Pulverization d. Composting

4. Which of the following is a biological method of disposal of municipal solid waste?
   a. Incineration b. Shredding c. Pulverization d. Composting

5. The problems and issues of Urban Waste Management of Kathmandu were first addressed in _____.
   a. 1971 b. 1970 c. 1990 d. 1991

6. Field capacity (FC) in a landfill may be determined by following empirical formula.
   a. $0.6 - 0.55\left[\frac{W}{(10000+W}\right]$ b. $0.6 - 0.55\left[\frac{W}{(1000+W}\right]$
   c. $0.6 - 0.55\left[\frac{W}{(100+W}\right]$ d. $0.6 - 0.55\left[\frac{W}{(10+W}\right]$

7. Time to move waste from collection station to disposal site including time to reach same or next station to return container is
   a. Pickup time b. Haulage time c. Transfer time d. Return time

8. MSW is composed of ..... plastics.
   a. 50-60% b. 10-20% c. 1-5% d. 100%

9. Which of the integrated waste management is reduced on an individual level?
   a. Source reduction b. Recycling
   c. Disposal d. Burning

10. The phase III German SWM project was held in
a. 1985-90 b. 1987-1990 c. 1985-1988 d. 1987-1991

11. This analysis is very useful to determine the stoichiometric equation of the municipal solid waste
a. Proximate analysis b. Simple analysis
c. Ultimate analysis d. Experimental analysis

12. Bench is provided when the height of the landfill exceeds to
a. 10 – 15 m b. 15 – 20 m c. 20 – 25 m d. 25 – 30 m

13. Which method is also known as progressive slope method?
a. Area method b. Trench method c. Ramp method d. Depression method

14. How does organic material in the buried solid waste decompose?
a. By the action of oxidation b. By the action of microorganism
c. By the flow of water d. By the soil particles

15. Which of the following temperature is optimum for incinerator?
a. 300 – 500^{0}C b. 500 – 700^{0}C c. 700 – 900^{0}C d. 900 – 1100^{0}C

16. The degradation rate of anaerobic digestion is _____ than that of aerobic digestion.
a. Higher b. lower c. equal d. negligible

17. Energy could be recovered from MSW by _____ in an incinerator.
a. direct incineration b. indirect incineration
c. direct combustion d. indirect combustion

18. Biomass pyrolysis is usually conducted at or above
a. 500^{0}C b. 200^{0}C c. 150^{0}C d. 300^{0}C

19. Which is the most used and standard analytical method available for determining nitrogen content?
a. Spectrophotometric method b. Kjeldahl method
c. Modified Duolong's method d. Monod method

20. The rate of production of leachate can be calculated by performing a
a. Mass balance b. Weight balance
c. Mass transfer d. Water balance

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SECTION "B"

Attempt *ALL* questions. Assume necessary data with explanation.

1. What are the basic information needed for the design of ISWM in your city? [8]

OR

Explain ISSWM. Identify and discuss briefly the issues that you feel will be important in the field of solid waste management in the 21st century. [8]

2. Calculate the length (L), breath (B) and height (H) (if L:B = 2:1) of the rectangular shaped landfill of Panauti Municipality if the per capita waste generation is 200gm and average projected population is 12,00,000 for one decade. Calculate the area required if 8% of the waste produced per capita is added for commercial and other wastes and 70% of the waste is expected to reach the landfill site. It is estimated that there will be 5 cells in 1 lift of 5 m including daily cover height of 15 cm and intermittent cover of 30 cm. The landfill allows maximum of 5 lifts. [8]

3. Solid waste from Godawari Municipality, Lalitpur is collected in HCS basis using hoist truck. Time taken to reach the first container site from the garage is 30 min. and to the garage from the last location is 45 min. If the average time required to drive between containers is 5 min. and one way distance to the disposal site is 20 km (speed limit 40 kmph); determine number of containers that can be emptied per day based on 8 hr/d working schedule. What would be the amount of waste that can be collected in a day by this truck if the 4 m^3 containers are in an average 3/4th full? Use annex to solve this numerical. [8]

4. Determine landfill gas generation distribution over time for a landfill with a useful life of five years based on following data: [8]
   - Landfill life = 5 years
   - Assume complete decomposition takes place
   - Readily biodegradable and slowly biodegradable wastes are 29.27%and 4.1% of total waste respectively
   - The sum of gas generated from annual readily biodegradable and slowly biodegradable wastes are 0.95 m3/kg and 1.16 m3/kg within the period of 5 and 15 years respectively
   - The gas production starts after one year of deposition
   - Use triangular gas production model
   - The amount of waste landfill is 100 ton everyday

5. Define proximate and ultimate analysis of solid waste. Estimate the total MC, total dry mass, overall density and volume from the waste sample given below. [4+4]

Components	% by mass	MC %	Density kg/m^3
food waste	14	70	290
paper	46	6	85
cardboard	10	5	50
plastics	10	2	65
Agriculture waste	10	60	105
wood	4.5	20	240
tin cans	6.5	3	90

6. Explain about the production of landfill gas with equations? Estimate the volume and mass of the methane gas generated in the landfill site for per ton wastes where the wastes from the Nepalgunj Sub-Metropolitan city is disposed. The composition of the waste in LFS is $C_aH_bO_cN_d$ where a=80, b=180, c=42 and d=1 [2+6]

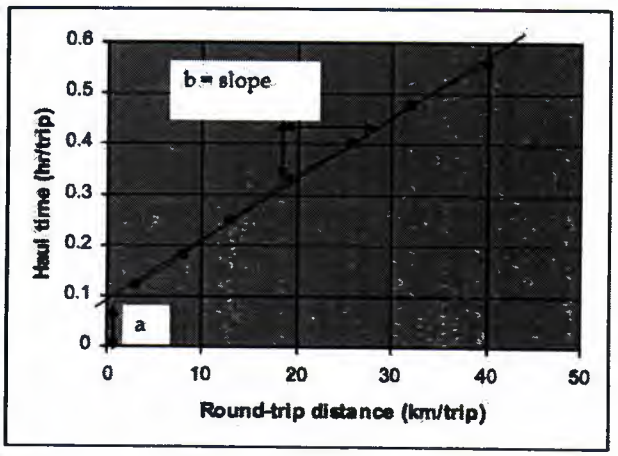
7. Write short notes on *ANY TWO* [2 × 3.5 = 7]
   a. Relation between climate change and solid waste
   b. Composting(bin or windrow or in-vessel)
   c. Waste collection methods

Annex

Determining the haul speed constants a and b.

Following are the observation of average speed and respective round-trip haul distance.

Round-trip distance (x) Km/trip	Average haul speed (y) Km/hr	Total haulage time (h = x/y) hr.
3	25	0.12
8	44	0.18
13	52	0.25
19	58	0.33
26	65	0.4
32	67	0.48
40	71	0.56



Vehicle type	Loading method	Comp-action ratio *r*	Time required to pickup + deposit empty container *Pc + Uc (hr/trip)*	Time required to empty contents of loaded container *(hr/container)*	At site time *s (hr/trip)*
Haul Container System					
Hoist truck	Mechanical	-	0.067	-	0.053
Tilt frame	Mechanical	-	0.4	-	0.127
Tilt frame with compactor	Mechanical	2~4	0.4	-	0.133
Stationary Container System					
Compactor	Mechanical	2~2.5	-	0.08~0.05	0.1
Manual	Manual	2~2.5	-	-	0.1

Pickup time per trip (hr/trip)

$$P_{hcs} = Pc + Uc + dbc$$

Here, Pc = time required to pickup loaded container; hr/trip
Uc = time required for unloading empty container; hr/trip
dbc = time required to drive betn. two container locations; hr/trip

Total time required per trip (hr/trip)

$$T_{hcs} = P_{hcs} + s + h$$

s = at site time; hr/trip
h = round trip haul time in hr/trip = a + bx

The number of trips per day N_d

$$N_d * T_{hcs} = [\ (1\text{-}W)H - (t_1 + t_2)]$$

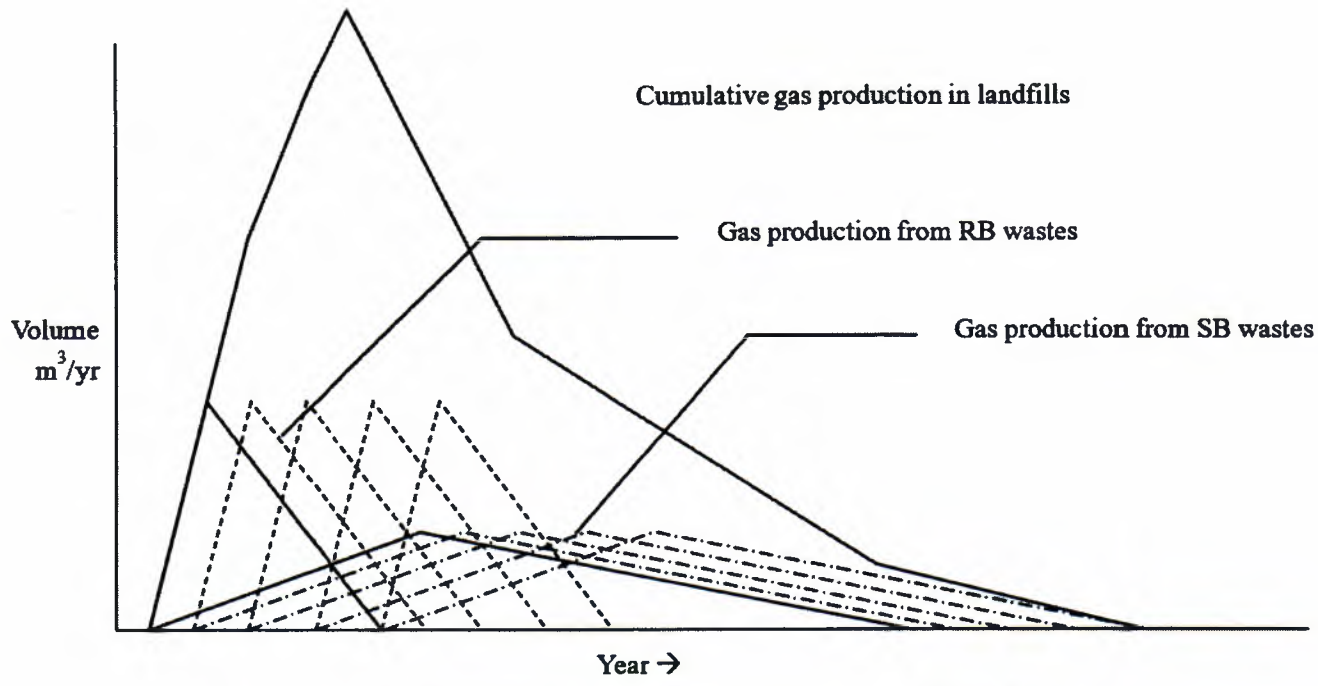
$$N_d = [\ (1\text{-}W)H - (t_1 + t_2)]/T_{hcs}$$

W = off route factor (expressed as a fraction; 0.1~0.25, normally 0.15 is taken)
H = length of the work days; hr/d
t_1 = time for garage to first container location; hr
t_2 = time for last container location to garage; hr

From waste generation relation,

$$N_d = (V_d / c*f)]$$

Where V_d = Average daily quantity of waste collected (m^3/d)
c = Average container size, m^3/trip
f = weighted average container utilization factor (volume actually filled/volume of container)



Triangular model for overall gas production in Landfills