

Mark Scored:

KATHMANDU UNIVERSITY  
End Semester Examination  
February/March, 2019

FEB 21 2019

Level : B. Sc./B. Tech.  
Year : IV

Course : ENVS 431  
Semester: I

Exam Roll No. : Time: 30 mins.

F. M. : 20

Registration No.:

Date :

SECTION "A"

[10 Q. × 1 = 10 marks]

Tick (✓) the most appropriate answer(s) among the given choices or fill in the blank(s).

1. Bulky metallic waste is composed of metallic objects that occupy large volumes, usually greater than  
a.  $0.5 \text{ m}^3$                       b.  $3 \text{ m}^3$                       c.  $2 \text{ m}^3$                       d.  $5 \text{ m}^3$
2. In Nepal the density of compacted SW is taken as  
a.  $780 \text{ kg/m}^3$                       b.  $500 \text{ kg/m}^3$                       c.  $350 \text{ kg/m}^3$                       d.  $800 \text{ kg/m}^3$
3. Transfer station is consider when haulage distance is  
a. Greater than 7 km                      b. Greater than 10 km  
c. Less than 10 km                      d. Less than 7 km
4. High level radioactive waste can be managed in which of the following ways?  
a. Dumping in sealed containers                      b. Open dumping  
c. Composting                      d. Incineration
5. Biomedical waste may be disposed of by?  
a. Composting                      b. Autoclaving                      c. Mono Landfilling                      d. Both (b) and (c)
6. The waste carrying capacity of skip vehicle is .....
7. Biodegradable fraction is expressed as  $BF = \dots\dots\dots$
8. Write down one example of the followings.  
a. Corrosive waste ..... b. Infectious-waste .....
9. Bench is provided where the height of the landfill exceeds to .....
10. Increase in shear strength is calculated as  $\Delta S =$

SECTION "B"

[10 Q. × 1 = 10 marks]

Define the following terminologies in one sentence.

11. Lift in LFS:

12. Composting:
13. Hazardous wastes:
14. Sludge:
15. Proximate analysis of SW:
16. Types of landfills (name only):
17. 3 R principles:
18. Ultimate BOD (calculation formula):
19. Sanitary landfills:
20. Methods for waste quantification (name only):

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Time : 2 hrs. 30 mins.

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Semester: I  
F. M. : 55

SECTION "C"  
[55 marks]

Assume necessary data if not provided. Attempt *ALL* questions in serial order. Use the following formulae to solve the numerical.

$$\text{Field capacity (FC)} = 0.6 - 0.55 [W/(10000+W)] ,$$

$$\text{permeability (K)} = C d^2 (\gamma/\mu) = k (\gamma/\mu) ,$$

$$\text{Pickup time (P}_{hcs}) = P_c + U_c + \text{dbc for HCS} ,$$

$$\text{pickup time (P}_{scs}) = C_t * U_c + (n_p - 1)\text{dbc for SCS} ,$$

$$P_c + U_c = 0.067 \text{ hr/trip for hoist truck} ,$$

$$\text{At site time (s)} = 0.053 \text{ hrs/trip} ,$$

$$\text{Round trip haul time (h)} = a + bx ,$$

$$\text{Total time req. / trip (T}_{hcs}) = P_{hcs} + h + s ,$$

$$\text{Number of trip per day (Nd)} = \frac{[(1-W)H - (t_1 + t_2)]}{T_{hcs}} ,$$

$$\text{Total working hour (H)} = \frac{(t_1 + t_2) + Nd * T_{scs}}{1 - W}$$

$$\text{Number of container emptied per trip (Ct)} = V_r / C.F$$

$$\text{Annuity of future value of the investment (A)} = P \left( \frac{i(1+i)^n}{(1+i)^n - 1} \right) ,$$

$$\text{Volume of LFS} = P * E * C / \xi ,$$

$$\text{Ratio of cover to compacted fill (E)} = (V_{sw} + V_c) / V_{sw} ,$$

$$\text{Density of SW} = 500 \text{ Kg./m}^3 \text{ (assume it if not given)}$$

$$\text{Heat Value} = 337 C + 1428 (H - O/8) + 95S$$

$$\text{Change in moisture stored in landfill (MC)} = W_{sw} + W_c + W_p - W_{RO} - W_{lfg} - W_v - W_{evap} + W_{leach}$$

$$\text{Discharge (Q)} = K * I * A \text{ and } I = \Sigma H / L ,$$

$$\text{Hydraulic Retention Time (HRT)} = V / Q$$

$$\text{Ultimate BOD} = \text{BOD}_5 (1 - 10^{-Kt})$$

1. Calculate the radius of a circular shaped LFS of Kamalamai Municipality in Sindhuli District for one decade if the per capita waste generation is 250g (1 liter per capita by volume as discarded) and present population is 200,000 with 8% of annual population growth. Calculate the area required if 20% of the waste produced per capita is added for commercial and other wastes and 80% of the waste is expected to reach the landfill site. The density of waste after compaction in the landfill is expected to be  $500 \text{ kg/m}^3$ . 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. The landfill site is run for 6 days a week. [8]
2. You are asked to present what will be the break even haul distance between a direct haul system and a transfer station operation with the following properties: [8]
- Direct haul system uses  $4 \text{ m}^3$  skips
  - Cost of operation of skip vehicles = Rs. 9/m<sup>3</sup>-km
  - The transfer station (TS) uses  $20 \text{ m}^3$  transfer trailer
  - The cost of operation of tractor trailer = Rs. 3.50/m<sup>3</sup>-km
  - Initial investment in TS = Rs. 35000000 (for buildings, equipments, facilities, etc.)
  - Useful life of TS = 20 years
  - Interest rate = 10%
  - Cost of operation and maintenance of TS = Rs. 500000/yr
  - Volume of waste handled =  $400000 \text{ m}^3/\text{yr}$
- If the average two way distances to disposal site is 15km, what would be the amount of money saved annually by having TS? Use graph paper to solve this problem.
3. Solid waste from Jeetpur-Simra Municipality 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  $4 \text{ m}^3$  containers are in an average 3/4th full? [8]
4. Define assimilation capacity and landfill liners. [2+2+2+2]  
For the waste mixture given above:
- i. What is bulk density of the waste mixture prior to compaction? Assume that the compaction in the cell is  $600 \text{ kg/m}^3$ .
  - ii. Estimate the volume reduction (%) during the compaction in landfill.
  - iii. If the food and yard wastes are diverted for composting, what is the un-compacted bulk density of the remaining waste?

Description	Percentage by weight, $f_i$	Typical density, $D_i$ ( $\text{kg/m}^3$ )
Food wastes	39.5	290
Yard wastes	3.8	240
Paper	0.85	85
Plastic	0.7	65
Glass/ceramics	0.5	195
Metal	0.65	160
Textile	2	65
Leather	2.5	160
Stones/bricks	40.5	480
Miscellaneous	9	240
Total	100.00	

5. What is the mixed BOD value of a river if discharge of landfill leachate is  $0.25 \text{ m}^3/\text{sec}$  having BOD  $900 \text{ mg/L}$ . is mixed with the river with discharge  $2 \text{ m}^3/\text{sec}$  having BOD  $15 \text{ mg/L}$ . Draw the mass balance diagram? Calculate the time required by the monsoon landfill leachate to contaminate the ground water in Goharai municipality? [2 + 6]  
Given:

- Leachate discharge rate =  $3000 \text{ m}^3/\text{ha./day}$ ,
  - $\text{BOD}_5$  at  $20^\circ\text{C}$  of leachate =  $1800 \text{ mg/L}$ ,
  - The ground water sample is collected  $500 \text{ m}$  away from LFS,
  - $\text{BOD}_5$  at  $20^\circ\text{C}$  of GW =  $120 \text{ mg/L}$ ,
  - Depth of GWT =  $7.5 \text{ m}$ . and the average gradient of ground =  $4\%$
- Make proper assumption. Give logical and scientific explanation for your assumptions.

6. Estimate the total MC, overall density and chemical composition of solid waste sample obtained in Sisdoles LFS: [1 + 1 + 6]

Components	% by mass	MC %	Density $\text{kg/m}^3$	Volume $\text{m}^3$	Percent by weight (dry basis)				
					C	H	O	N	S
food waste	12	70	290	0.52	48.0	6.4	37.6	2.6	0.4
paper	48	6	85	5.29	43.5	6.0	44.0	0.3	0.2
cardboard	11	5	50	2.00	44.0	5.9	44.6	0.3	0.2
plastics	9	2	65	1.54	60.0	7.2	22.8	0	0
garden trimmings	11	60	105	0.95	47.2	6.0	38.0	3.4	0.3
wood	4	20	240	0.21	49.5	6.0	42.7	0.2	0.1
tin cans	5	3	90	0.56	4.5	0.3	4.3	0.1	0.2

7. Write short note on: biodegradable fraction and ISSWM. Calculate the heat value of Ethanol using Modified Dulong's formula. [2+2+3]

