KATHMANDU UNIVERSITY
End Semester Examination
January 2025

Marks Scored:

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

Course : ESEE 401
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date 23 JAN 2025

SECTION "A"
[20Q. × 1 = 20 marks]

Choose the most appropriate answer from the given alternatives and ***encircle****.*

1. What is the primary function of a transfer station in solid waste management?
   a. To sort recyclable materials
   b. To compress waste before transportation
   c. To store waste temporarily before final disposal
   d. To convert waste into energy

2. Which of the following is a common method of waste collection in urban areas of Nepal?
   a. Direct-to-landfill disposal
   b. Curbside collection
   c. Roadside collection
   d. Riverside collection

3. What type of vehicle is commonly used at a transfer station to transport waste to a landfill?
   a. Open-top dump truck
   b. Automated side-load truck
   c. Garbage compactor truck
   d. Railcar

4. Which waste collection method is commonly used in densely populated urban areas to optimize collection efficiency?
   a. Curbside collection
   b. Manual collection
   c. Containerized collection
   d. Door-to-door collection

5. What is a major advantage of using transfer stations in waste management?
   a. Reduces the need for recycling
   b. Decreases transportation distances and costs
   c. Reduces the volume of waste for incineration and landfills
   d. Increases waste recovery

6. The term "calorific value" in solid waste refers to:
   a. The amount of heat energy produced from waste incineration
   b. The quantity of waste generated per capita
   c. The weight of waste per unit volume
   d. The rate of biodegradation of waste

7. Which of the following factors most significantly influences the decomposition rate of organic waste?
   a. Color
   b. Moisture content
   c. Particle size
   d. Volume

8. Which biological process is primarily responsible for the decomposition of organic waste in landfills?
   a. Fermentation
   b. Incineration
   c. Pyrolysis
   d. Anaerobic digestion

9. The presence of which microorganism is most associated with the biodegradation of organic solid waste in composting?
a. Fungi b. Protozoa c. Viruses d. Bacteria

10. Which of the following is considered a biodegradable waste?
a. Plastic bottles b. Glass containers
c. Organic kitchen waste d. Metal cans

11. Which of these methods is most effective for recycling waste paper?
a. Thermal treatment b. Composting
c. Pulping and reprocessing d. Landfilling

12. What does the term "waste-to-energy" refer to?
a. Reducing waste through composting b. Converting waste into electricity or heat
c. Reusing waste materials d. Incinerating waste for energy recovery

13. Which of the following is NOT a major source of municipal solid waste (MSW)?
a. Residential waste b. Industrial waste c. Agricultural waste d. Commercial waste

14. Which of these is an example of source separation of waste?
a. Sorting recyclables at a materials recovery facility
b. Collecting all waste in one bin
c. Burning waste in an incinerator
d. Dumping waste in a landfill

15. The process of converting organic waste into compost is called:
a. Aerobic composting b. Fermentation
c. Pyrolysis d. Incineration

16. Which of the following materials is most commonly used in landfill liners to prevent leachate contamination?
a. Polyethylene b. Sand c. Concrete d. Metal

17. Which of these is NOT a typical component of a waste-to-energy plant?
a. Incinerator b. Boiler
c. Gasification reactor d. Pulping machine

18. The environmental issue most associated with landfills in Nepal is:
a. Air pollution b. Groundwater contamination
c. Managing cells and lifts d. Aesthetic concerns

19. Which of the following is a common method for reducing the volume of waste in landfills?
a. Composting b. Biological treatment
c. Incineration d. Shredding and baling

20. Which process is used to treat solid waste by reducing its volume through high heat in an oxygen-limited environment?
a. Incineration b. Landfilling c. Composting d. Pyrolysis

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Make a logical assumption wherever required.

SECTION "B"

[7Q. × 7 = 49 marks]

Attempt *ALL* questions.

1. What is integrated solid waste management system? Estimate the theoretical volume of methane gas that would be expected from the anaerobic digestion of a tonne of a waste having the composition: $C_a H_b O_c N_d$. Find a, b, c, d. [2+5=7]
   a. Determine the mass of methane produced per tonne of waste.
   b. Using a density of Methane 0.7167 kg/m^3 determine the volume of methane gas

2. Consider a 400 MT of resource (materials) are recovered daily at an MRF. Assume all the materials are collected in 15m^3 compactor tank, that provides an average density 900 kg/m^3 During a routine working day, how many trucks are needed? Assume the MRF works 12hrs a day and 5 days a week. [3+4=7]
   Calculate the Heat value of Ethanol (CH_3CH_2OH)) using Modified Dulong formula.

3. What are the considerations to construct and operate the transfer station? what will be the break-even haul distance between a direct haul system and a transfer station operation with the following priorities: [2+5=7]
   - Direct haul system uses 4m^3 skips
   - Cost of operation of skip vehicles = Rs. 9/m^3 km
   - The transfer station (TS) uses 20m^3 transfer trailer
   - The cost of operation of tractor trailer = Rs. 3.5 /m^{3}km
   - Initial investment in TS = Rs. 35,000,000
   - Useful life of TS = 20 years
   - Interest rate = 10%
   - Cost of operation and maintenance of TS = Rs. 500,000
   - Volume of waste handled = 400000 m^3/year
   - The average two-way distances of disposal site is 15km,

4. Provide the technical information for MSW composting. What is the area required for land filling the waste of a municipality if the per capita waste generation is 300 gm. (1 liter per capita by volume as discarded) and average projected population of the municipality is 800,000 for one decade. Calculate the area required if 15% of the waste produced per capita is added for commercial and other wastes and 90% of the waste is expected to reach the landfill site. The density of waste after compaction in the landfill is expected to be 500 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. [2+5=7]

P.T.O.

5. Waste from a city 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 km/hr); [7]

a. Determine the number of containers that can be emptied per day based on 8 hr/d working.

b. 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 3/4thfull.

Take, At site time 0.053 hr/trip, a = 0.050 hr/trip, b= 0.025 hr/km and Off-route factor = 0.15

6. Find the stoichiometric equation of the given waste sample. Also, find the overall density of the waste. [7]

Components	Mass (kg)	Moisture Content (Kg)	Dry Mass	Density (kg/m^3)	Composition (% by dry mass)				
					C	H	O	N	S
Food wastes	15.00	10.50	4.50	290.00	48.00	6.40	37.60	2.00	0.40
Paper	34.00	2.04	31.96	85.00	43.50	6.00	44.00	0.30	0.20
Cardboard	6.00	0.30	5.70	50.00	44.00	5.90	44.60	0.30	0.20
Plastic	10.00	0.20	9.80	65.00	60.00	7.20	22.80	0.00	0.00
Garden trimmings	18.00	11.10	7.40	105.00	47.80	6.00	38.00	3.40	0.30
Textiles	5.50	1.10	4.40	240.00	49.50	6.00	42.70	0.20	0.10
Inorganic	11.00	0.33	10.67	480.00	26.30	3.00	2.00	0.50	0.20
Total		25.57	74.43						

7. Discuss on a constructed wetlands design parameter for leachate treatment in a landfill sites.

The discharge of stream near landfill site is 0.25 m^3/sec with BOD 10 mg/L. The discharge of landfill leachate is 0.013m^3/sec with the BOD 900 mg/L. The landfill leachate is mixed with the stream near LFS. Calculate the mixed BOD. Draw mass balance diagram for the above statements. [3+4=7]

SECTION "C"

[6 marks]

8. Write Short Notes on ANY TWO of the following. Specify your answer as mentioned in bracket. [3+3=6]

a. Hazardous waste (characteristics)

b. Vermicomposting (design criteria)

c. Circular Economy (waste flow diagram)