

KATHMANDU UNIVERSITY  
End Semester Examination  
May/June, 2022

Marks scored:

Level : B.E./B.Sc./B.Tech.

Course : ENVE 101

Year : I

Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date :

SECTION "A"

[20Q × 1 = 20 marks]

Mark [X] in the most appropriate options.

1. A residential area of 320 houses is being planned. For planning purposes, average daily consumption of 120 liters per person per day is used. Estimate the average daily volume of water that must be supplied to this residential area if each house is occupied by 5 people.  
[ ] 182,000 L/d    [ ] 192,000 L/d    [ ] 150,000 L/d    [ ] 1 MLD
2. Fine particles settle at a terminal velocity of 0.1 m/s in a water tank of a depth of 1 m. What is the settling time of the particle?  
[ ] 1 s    [ ] 0.1 s    [ ] 10 s    [ ] 100 s
3. The concentration of toluene ( $C_7H_8$ ) in subsurface soil samples, collected after an underground storage tank was removed, indicated the toluene concentration of 5 mg/kg. What is the toluene concentration in ppm<sub>m</sub>?  
[ ] 5 ppm<sub>m</sub>    [ ] 0.5 ppm<sub>m</sub>    [ ] 50 ppm<sub>m</sub>    [ ] 500 ppm<sub>m</sub>
4. Suppose air in the vicinity of a power plant is said to contain 20 ppm SO<sub>2</sub>. What is the mole fraction of SO<sub>2</sub> in the air?  
[ ]  $2 \times 10^{-6}$     [ ]  $2 \times 10^{-5}$     [ ]  $6.4 \times 10^{-4}$     [ ]  $20 \times 10^{-3}$
5. Which of the following is NOT a gaseous biogeochemical cycle in an ecosystem?  
[ ] Water cycle    [ ] Nitrogen cycle    [ ] Phosphorus cycle    [ ] Carbon cycle
6. A city has a population of 6000 and the daily per capita water demand is 100 L/day. If wastewater production is 80% of water demand, what is the wastewater generation rate of the city?  
[ ] 600 m<sup>3</sup>/hr    [ ] 0.6 m<sup>3</sup>/hr    [ ] 20000 m<sup>3</sup>/hr    [ ] 20.0 m<sup>3</sup>/hr
7. Removal of fat, oil and grease from the wastewater generated in Kathmandu University's canteen is an example of which of the following mass transfer:  
[ ] Liquid-solid    [ ] Solid-liquid    [ ] Liquid-gas    [ ] Liquid-liquid
8. For steady state with conservative pollutants:  
[ ] Transformation rate  $\neq$  0  
[ ] Accumulation rate = Input rate – Output rate  
[ ] Input rate = Output rate  
[ ] Transformation rate = Input rate – Output rate

9. Which one of following chemical is NOT related to disinfection unit:  
 Ozone  Sodium Hypochlorite  
 Alum  Cl<sub>2</sub>
10. In a Monod Equation, the condition  $S = K_s$  yields which of the following statements?  
  $\mu = \mu_m$    $\mu = \frac{1}{2}\mu_m$    $\mu = 2\mu_m$    $\mu = 4\mu_m$
11. Which of the following is the unit of turbidity?  
 NTU  mg/L  m<sup>3</sup>/m<sup>2</sup>.day  day<sup>-1</sup>
12. During the growth of biomass, death rate exceeds the bacterial growth rate in ..... phase.  
 Lag  Log-growth  Stationary  Endogeneous
13. Organic material resistant to biological degradation are:  
 Inorganic  Refractory  Biodegradable  Volatile
14. Sedimentation of coagulated surface waters is an example of .....settling.  
 Type I  Type II  Type III  Type IV
15. An electrostatic precipitator with 3000 square meters collector plate area is treating 200 cubic meters per second of flue gas from an incinerator. If the effective drift velocity of the particles approaching is 0.117 m/s, the efficiency of the ESP is .....%.  
 82.7  97  77.6  48.5
16. In which of the following atmospheric conditions can result in the serious air pollutant episodes  
 Super-adiabatic lapse rate  Adiabatic lapse rate  
 Inversion  Sub-adiabatic lapse rate
17. Transfers stations may NOT be considered when:  
 Small containers are used  
 Haulage distance is short  
 Resource recovery facilities are to be planned  
 Small collection vehicles are being used
18. Properties that are considered nice to have by the customers' preferences and therefore do not affect product substitutability are called ..... properties.  
 positioning  obligatory  functional  marginal
19. While doing an LCA of a White Board Marker, a student found that 80 g of aluminum is required per functional unit. If the known global reserve per person for aluminum is 660 kg, what is the material consumption in mPR?  
 0.012 mPR  0.12 mPR  1.2 mPR  12.0 mPR
20. Which has the lowest degree of freedom?  
 Incrementalism  Re-defining the problem  
 Re-defining the system boundary  Re-engineering the system

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Year : I  
Time : 2 hrs. 30 mins.

Course : ENVE 101  
Semester : II  
F. M. : 55

SECTION "B"

Attempt *ALL* questions. Make logical assumptions for any missing data or information.

1.
  - a. Define an Engineering Project with examples of your engineering domain. What is the major aspect to be considered while undertaking the engineering decisions? [1+3]
  - b. Differentiate between traditional design and context-sensitive design. [3]
2.
  - a. How can you apply the knowledge of natural biogeochemical cycles in pollution remediation? [3]
  - b. Suppose the rainfall is 1000 mm/yr, of which 50% percolates into the ground. The farmer irrigates crops using well water. Of the extracted well water, 80% is lost by evapotranspiration; the remainder percolates back into the ground. How much groundwater could a farmer on an 800 ha farm extract from the ground per year without depleting the groundwater reservoir volume? Show a clear mass balance diagram [4+1]
3.
  - a. List functions of any four physico-chemical water treatment processes. [2]
  - b. Find the dimensions of a rectangular settling tank to treat raw water for a population of 20,000 with a daily per-person water demand of 120 liters. Consider an overflow rate of 0.5 m/hr, and detention time of 2 hours. Assume at least two tanks with  $L: W = 5$ . [3]
  - c. A completely mixed continuous culture system has got the following data. [2+2+2]  
 $\mu_m = 12 \text{ day}^{-1}$ ,  $K_s = 75 \text{ mg/L}$ ,  $Y = 0.65 \text{ kg/kg}$   
 $k_d = 0.1 \text{ day}^{-1}$ , Initial BOD ( $S_0$ ) = 500 mg/L, HRT = 12 hours  
Find the values of final BOD in the effluent ( $S$ ) and biomass concentration in the reactor ( $X$ ). Calculate the volume of the biological treatment unit. Consider 80% of water demand will be returned as wastewater from the population of 50,000 having a daily per person water demand of 120 liters.
4.
  - a. What sound power level results from combining the following three levels: 68 dB, 79 dB, and 75 dB? [2]
  - b. What are the health implications of noise pollution? [2]
  - c. What is particulate pollution? Briefly discuss its sources. [2]
  - d. During a 2-week-long major air pollution episode in a city, it is estimated that 25,000 metric tons of coal that had an average sulfur content of about 2% were burned per week. The mixing depth (height of the inversion layer or cap over the city that prevented the pollutants from escaping) was about 150 m over an area of 1200 km<sup>2</sup>. If initially there was no SO<sub>2</sub> in the atmosphere (a conservative assumption), what is the expected SO<sub>2</sub> concentration at the end of the 2 weeks? [6]

5. a. Estimate the total moisture content, dry mass and overall density of solid waste sample obtained from the Kathmandu University, Dhulikhel campus (hypothetical): [2+2+2]

Component	% by mass	Moisture Content (%)	Typical density, kg/m <sup>3</sup>
Food waste	25	70	290
Paper	35	6	85
Garden Trimmings	15	50	105
Plastics	10	2	65
Cardboard	5	5	50
Wood	5	10	240
Metals waste (construction waste)	5	2	120

- b. Assume that on average Kathmandu University Dhulikhel campus daily generates around 600 kg of solid waste with the hypothetical composition (% by mass) given in the table in question 5. a. Present a flow chart of the proposed integrated solid waste management plan focusing on resources recovery options you have proposed. [5]
6. a. The functional unit (FU) of a marker is taken as writing 20 hours per week for 2.5 months. The marker could continuously write for 10 hours. Find the number of markers essential to serve the Functional Unit (FU). [2]
- b. Answer the following questions based on the information given in the paragraph below. The following paragraph provides an example of goal definition during an LCA study. [1+1+1+1]

**Example of a goal definition**

*The purpose of this study is to identify the environmental impacts of the product life cycle of hand drying by electric equipment and by hand towels for use in strategies planning and to establish general guidelines for our product development. The study is not intended for communication to any third party and the results of the study can therefore not be used to assess our present specific products or suppliers. The data used are generally from the environmentally best technology known to us. The results of the study are highly dependent on the actual electricity production technology, and the results are thus only valid in Denmark for approximately 5 years.*

- i. What is the purpose of the LCA?
- ii. What can the results be used for?
- iii. What are the temporal limitations of the study?
- iv. What are the spatial limitations of the study?

## List of formulas

### 1. Overflow rate

$$v_o = \frac{Q}{LW} = \frac{Q}{A}$$

where Q is the flow rate and A is the surface area of the tank

### 2. Monod Equation

$$\mu = \mu_m \frac{S}{S + K_s}$$

$$X = \frac{Y(S_o - S)}{1 + k_d \theta}$$

$$\frac{\mu_m}{Y} = k$$

$$\frac{1}{\theta} + k_d = \frac{k Y S}{S + K_s}$$

$$S = \frac{K_s(1 + k_d \theta)}{\theta(Yk - k_d) - 1}$$

$\theta$  = Hydraulic Retention Time (HRT)

### 3. Units and conversion

$$1 \text{ ha} = 100 \text{ m} \times 100 \text{ m}$$

$$1 \text{ MLD} = 1 \times 10^6 \text{ Liters per day}$$

$$1 \text{ m}^3 = 1000 \text{ L}$$

$$1 \text{ m} = 100 \text{ cm} = 1000 \text{ mm}$$

$$1 \text{ g} = 1000 \text{ mg}$$

