

KATHMANDU UNIVERSITY  
End Semester Examination  
August, 2018

Marks scored:

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

Course : ENVE 101  
Semester: II

Exam Roll No. :

Time: 30 mins.

F. M. : 20

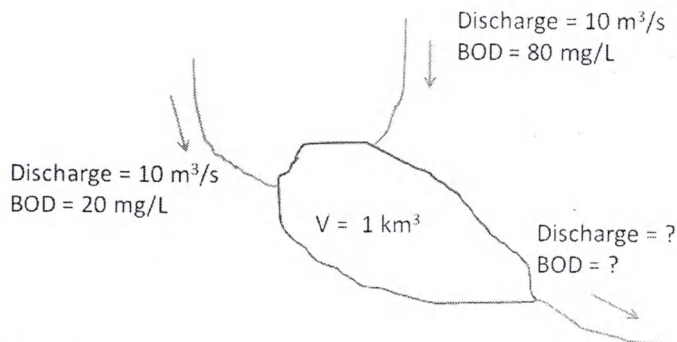
Registration No.:

Date **AUG 10 2018**

SECTION "A"  
[10 Q.×1=10 marks]

Select the correct answers from the choices. Attempt all the questions.

1. A fine particle settles at a terminal velocity of 0.1m/s in a water tank of depth 1m. What is the settling time of the particle?  
a) 1 s                      b) 0.1 s                      c) 10 s                      d) 100 s
2. A 1 kg sample of soil is analyzed for the chemical solvent TCE. The analysis indicates that the sample contains 5 mg of TCE. The TCE concentration in ppb is .....  
a)  $5 \times 10^6$                       b)  $5 \times 10^3$                       c)  $5 \times 10^{-3}$                       d)  $5 \times 10^0$
3. The part of the precipitation that flows on the surface of the earth or just immediately beneath the surface of the earth is called.....  
a) spillway                      b) infiltration                      c) transpiration                      d) runoff
4. A city has population of 5000 and the daily per capita waste water generation is 100 L/day. What is the waste water generation rate of the city?  
a)  $500 \text{ m}^3/\text{hr}$                       b)  $0.5 \text{ m}^3/\text{hr}$                       c)  $20833.3 \text{ m}^3/\text{hr}$                       d)  $20.83 \text{ m}^3/\text{hr}$
5. The BOD in the lake output in the figure shown below is:  
a) 50 mg/L                      b) 5 mg/L                      c) 60 mg/L                      d) 100 mg/L



6. Which of the following systems is represented by the equation given below?

$$\mu - k_d = \frac{1}{T}$$

- |                  |                       |
|------------------|-----------------------|
| a) Batch Culture | b) Continuous Culture |
| c) Monod Culture | d) Complex Culture    |



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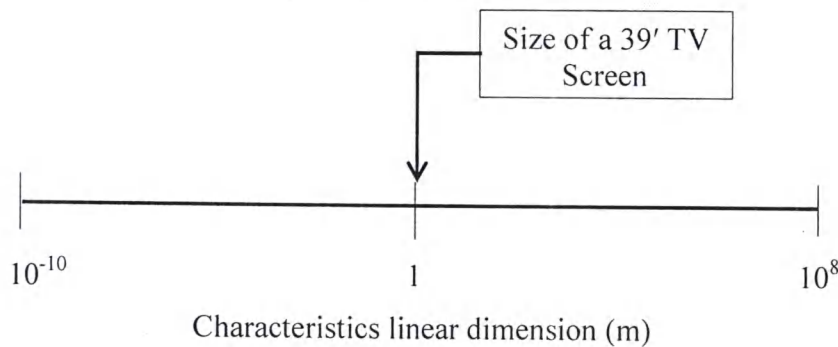
Level : B.E./B.Sc./B.Tech.  
Year : I  
Time : 2 hrs. 30 mins.

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

SECTION "C"

*Make logical assumption for any missing data or information. Attempt all questions. Relevant information are given in Annexes.*

- 1.a) Define an engineering project. What are the major aspects to be considered while undertaking the engineering decisions? [1+2]
- b) A range of  $10^{-10}$  m to  $10^8$  m is given on the figure below. Draw length scales of the following objects by dividing the given range appropriately and indicating the size of the objects by an arrow.  
Height of Mt. Everest, Sand particle, Width of Trisuli River, Average human height, Length of your calculator.  
An example is also shown. Size of 39' TV Screen (1m) [5]



- 2.a) How can you apply the knowledge of natural elemental recycling of nitrogen and phosphorus in Environmental Engineering applications? [3]
- b) According to Department of Hydrology and Meteorology (DHM), a hydrological system with surface area of 120 ha has average monthly precipitation of 1.3 in. Determine the average monthly evaporation (m) on the same system where runoff toward the system is  $0.42 \text{ m}^3/\text{s}$  and runoff away from the system is  $0.36 \text{ m}^3/\text{s}$ . The net change in water storage in the system is  $20000 \text{ m}^3$  in a month. Assume that there is no seepage from the system. [4]
3. Define a non-conservative substance. Estimate the concentration of  $\text{SO}_2$  in the urban air above Kathmandu University premises at Dhulikhel. The mixing height above Kathmandu Valley and Banepa urban areas is 1 km. The length and width of the box representing the mixing zone is 50 km by 30 km. The average annual wind speed is 10,000 m/hr.  $\text{SO}_2$  release rate is 0.2 kg/brick produced and the annual brick production rate is 10 million bricks /year. [1+6]

4. Two streams enter a lake in the system. The main stream has a flow of  $10 \text{ m}^3/\text{s}$  and a chloride concentration of  $10 \text{ mg/L}$ . The tributary stream has a flow of  $5 \text{ m}^3/\text{s}$  and chloride concentration of  $40 \text{ mg/L}$ . What is the chloride concentration in the flow that is leaving the lake system? Note that chloride is a conservative pollutant. [4]
- 5.a) Find the dimension (with proper drawing) of a rectangular settling tank to treat  $45 \text{ m}^3$  of a raw water per hour when the overflow rate is  $0.5 \text{ m/hr}$ , and detention time is 3 hours. [4]
- b) A completely mixed continuous culture system has got the following data with usual meanings of the symbols. [4]  
 $\mu_m = 12 \text{ day}^{-1}$ ,  $K_s = 75 \text{ mg/L}$ ,  $Y = 0.65 \text{ kg/kg}$   
 $k_d = 0.1 \text{ day}^{-1}$ ,  $S_0 = 500 \text{ mg/L}$ ,  $\text{HRT} = \frac{1}{2} \text{ day}$   
 where, HRT is the hydraulic residence time of the reactor.  
 (i) Find the values of  $S$  and  $X$ . Discuss the difference between these two variables.  
 (ii) If the flow of the system is  $1000 \text{ m}^3/\text{day}$ , find the volume, length and width (show the dimension in the drawing) of the reactor (Take depth =  $3 \text{ m}$  and  $L:W = 5$ ).
- 6.a) The following table has been prepared to differentiate between EIA and LCA. An example of an attribute is given. Fill the table providing the remaining three attributes in column 1 and the appropriate statements in column 2 and column 3. [4]

Attribute	EIA	LCA
1. Definition		
2.		
3.		
4.		

- b) With the approaching rainy season, the owner of the KU Canteen is worried about the poor roofing material in the canteen. He requested KU administration to change the roofing material in the canteen. The administration made a market survey and found three possible different types of materials of roof: steel, plastic and wheatstraw. Your task is to analyze the environmental properties of three different type of roof materials in a lifecycle perspective, and recommend a best roofing option. **(Refer Annexes for required information)**  
 The functional unit of roof is  $10 \text{ m}^2$  for 10 years.  
 The followings steps are recommended for the analysis.
- (i) For each type of roof materials, calculate the number of roofs required to provide the functional unit. [3]  
 (ii) For each types of roof, fill a MECO matrix (given in Annex B) with relevant information. Relevant data are given in Annex C. [6]  
 (iii) Which of the three roofs can provide functional units with lowest environmental impacts? [1]
- 7.a) Describe pollution prevention hierarchy. What is the importance of approaching green engineering from a design perspective? [2+2]
- b) Explain the principles and environmental benefits of smart growth. [3]

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**Annex A: FACTS ABOUT EACH TYPE OF ROOF IS GIVEN BELOW**

*Steel roof*

Material: steel

Weight: 3 kg/m<sup>2</sup>

Surface treatment: Painted with a lacquer based on volatile organic compound

Mounted with: screws made of iron

Average life time: 5 years

End of life scenario: 40 % re-cycling, 40% landfill (20% steel is lost due to corrosion in the use phase)

*Plastic roof*

Material: Polyethylene (PE)

Weight: 1.2 kg/m<sup>2</sup>

Surface treatment: none

Mounted with: screws made of iron

Average life time: 8 years

End of life scenario: 100% landfill

*Wheat straw*

Material: Wheat straw

Weight 1 kg/m<sup>2</sup>

Surface treatment: none

Mounted with: bamboo and cord made of jute

Average life time: 2 years

End of life scenario: 100% rots away in the disposal area near Fast Food Center

Assumptions which can be made without further notice

- Each of the three types of roof materials can be mounted on the existing frame with no or only minor modifications. Hence, the frame can be excluded from the study.
- The environmental impacts from mounting materials are negligible compared with the roof materials.
- For steel and PE, the energy use in the production phase is 30% of the energy use in material extraction phase.
- Wheat straw roof are produced manually without energy consuming machinery in any phase except transportation
- Wheat straw is an abundant, renewable resource and the reserves of this resources is infinite (Known person reserves per person is infinity).
- Transportation processes are unimportant for the comparison and can be left out of the study.

Annex B: MECO Matrix

	Material phase	Production phase	Use phase	Disposal phase
Materials				
Energy				
Chemicals				
Others				

## Energy properties of various materials

Materials		Primary Energy (MJ/Kg)	Energy content (MJ/Kg)	Energy required for re-utilisation (MJ/Kg)	Energy credit due to re-utilisation (MJ/Kg)	Energy credit due to incineration with energy recovery (MJ/kg)
Metals	Steel	40	0	20	40	0
	Magnesium	150	0	0	150	0
	Aluminium	170	27	30	170	0 or -22
	Copper	90	0	50	-90	0
	Stainless steel	40	0	40	-40	0
	Zinc	70	0	na	-70	0
Plastics	Poly propylene (PP)	80	40	5-10	-80	-30
	Styrene acrylonitril (SAN)	90	40	5-10	-90	-30
	Polyethylene tetraphtalate (PET)	80	30	5-10	-80	-25
	Polyurethane-soft or hard (PUR)	110	30	5-10	-110	-25
	Acrylo butadiene styrene (ABS)	95	40	5-10	-95	-30
	Polyamine (PA) Nylon	140	30	5-10	-140	-15
	Polycarbonate (PC)	115	30	5-10	-115	-25
	Polyehtelne (PE)	75	40	5-10	-75	-30
	Polyvinylchloride (PVC)	65	20	5-10	-65	-15
	Polystyrene (PS)	90	40	5-10	-90	-30
	Polystyrene Exapandabel (EPS)	80	40	5-10	-80	-30
	Polymethylmetacrylane (PMMA)	110	40	5-10	-110	-30
Others	Cardboard paper	40	20	10	-40	-15
	Glass	10	0	7	-10	0

Supply horizons (based on known reserves) for various resources

Resource	Supply horizons Years	Known Global reserves per person, Kg/person
Plastic Oil	43	25,600
Coal	170	98,570
Brown Coal	390	98,130
Natural gas (m <sup>3</sup> /prs)	60	23,440
Aluminium	200	660
Iron (Steel)	120	12,200
Lead	20	13
Copper	36	60
Manganese	86	150
Nickel	50	9
Tin	27	1.1
Zinc	20	30
Silver	-	0.15
Gold	-	0.011
Palladium	-	0.008
Tantal	-	0.047
Antimonium	-	1
Cobalt	-	1
Molybdenum	-	4
Cadminum	-	0.23
Lanthanum	-	3.2
Cerium	-	5.9
Beryllium	-	0.038
Mercury	-	0.11
Platinum	-	0.008

## 1. Stokes Equation

$$v = \frac{1}{18} \frac{(\rho_s - \rho_l) g d_p^2}{\mu}$$

where,

$v$  = terminal velocity

$\rho_s$  = particle density

$\rho_l$  = fluid density

$d_p$  = diameter of the particle

$g$  = acceleration due to gravity

2. Reynolds's number ( $R_e$ ) =  $v d_p \rho_l / \mu$ 

$\mu$  = dynamic viscosity of fluid

Case I : Laminar flow ( $R_e < 1$ ), small particles at low velocity

Case II : Transitional flow ( $1 < R_e < 10000$ )

Case III : Turbulent flow ( $R_e > 10000$ )

## 3. 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

## 4. Monod Equation

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

$$S = \frac{K_s(1 + Tk_d)}{T(\mu_m - k_d) - 1}$$

$$X = \frac{Y(S_0 - S)}{1 + TK_d}$$

## 5. Units and conversion

1 ha = 100 m X 100 m

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

1 m<sup>3</sup> = 1000 L

1m = 100 cm = 1000 mm

