



Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS/B.TECH (CE)/SEM-6/CE-603/2012**

**2012**

**ENVIRONMENTAL ENGINEERING-II**

*Time Allotted : 3 Hours*

*Full Marks : 70*

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words  
as far as practicable.*

**GROUP – A**

**( Multiple Choice Type Questions )**

1. Choose the correct alternatives for the following :

10 × 1 = 10

i) The waste from bathrooms, kitchen etc. is called

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|-----------|-------------|
| a) Refuse | b) Sullage  |
| c) Sewage | d) Garbage. |

ii) In combined sewers, the velocity of waste water at present peak flow should not be less than

- |              |             |
|--------------|-------------|
| a) 0.6 m/sec | b) 1 m/sec  |
| c) 3 m/sec   | d) 6 m/sec. |



- iii) The maximum efficiency of BOD removal is achieved in
- a) Trickling filters
  - b) Aerated lagoon
  - c) Oxidation ditch
  - d) Rotating biological contactors.
- iv) Bacteria which can survive with or without free oxygen is called
- a) aerobic bacteria                      b) anaerobic bacteria
  - c) facultative bacteria                d) none of these.
- v) The correct relationship among theoretical oxygen demand (ThOD), biochemical oxygen demand (BOD) and chemical oxygen demand COD is given by
- a)  $\text{ThOD} > \text{BOD} > \text{COD}$
  - b)  $\text{ThOD} > \text{COD} > \text{BOD}$
  - c)  $\text{COD} > \text{BOD} > \text{ThOD}$
  - d)  $\text{BOD} > \text{COD} > \text{Thod.}$
- vi) With increase in temperature the biochemical reaction rate
- a) decreases
  - b) increases
  - c) remains same
  - d) change is unpredictable.
- vii) 'Crown corrosion' in sewers is due to formation of
- a) Hydrochloric acid                      b) Nitric acid
  - c) Sulfuric acid                              d) Hydrofluoric acid.



viii) Hydraulic radius for a circular sewer (Dia. =  $D$ ) is

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|-------------------|------------------|
| a) $\frac{D}{2}$  | b) $\frac{D}{4}$ |
| c) $\frac{3D}{4}$ | d) $\sqrt{D}$ .  |

ix) A water having pH = 9 will have hydroxyl ion concentration

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|-------------------------|-------------------------|
| a) $10^9$ moles/ $l$    | b) $10^{-5}$ moles/ $l$ |
| c) $10^{-9}$ moles/ $l$ | d) $10^5$ moles/ $l$ .  |

x) The treatment units where only physical or gravitational forces are involved are known as

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|-------------------|--------------------|
| a) unit processes | b) unit operations |
| c) step units     | d) none of these.  |

### GROUP – B

#### ( Short Answer Type Questions )

Answer any *three* of the following.  $3 \times 5 = 15$

- Draw a schematic diagram of functioning of an attached growth system.
- What do you mean by activated sludge ? Discuss on the flow scheme and mixing regime of conventional activated sludge process.
- A catchment area of  $20 \text{ km}^2$  consists of two-third rural and one-third urban area. The rainfall intensity in the area is recorded as 25 mm/hr. Find the quantity of storm water run off in the area in litres / sec.  $k$  for rural area = 0.30 and  $k$  for urban area = 0.50.



5. Given  $Q = 80$  MLD,  $BOD_5 = 285$  mg/l. Calculate the total daily oxygen demand expressed as mass of  $BOD_5$  in kg and also the population equivalent of the waste water. Assume the per capita  $BOD_5$  contribution is 75 kg per day.
6. Estimate the quantity of secondary sludge produced by a secondary settling tank treating waste water discharge of 3.5 MLD. The sludge may be assumed to have a suspended solid concentration of 200 mg/l, removal efficiency of suspended solids as 90% and the solid content of sludge as 6%.

### GROUP – C

#### ( Long Answer Type Questions )

Answer any *three* of the following.  $3 \times 15 = 45$

7. a) Discuss what you mean by fresh, stale and septic sewage ?
- b) The density of population of a township having area 36 hectares is 250 per hectare and water supply is 225 litres / day. Calculate the quantity of waste water for which the sewers of a separate system should be designed. Assume waste water generation as 80% of water supply.
- c) Calculate the theoretical oxygen demand of the following chemical compounds :
- (i) Glucose ( $C_6H_{12}O_6$ ) = 200 mg/l
  - (ii) Lactose ( $C_{12}H_{22}O_{11}$ ,  $H_2O$ ) = 1000 mg/l
  - (iii) Benzene ( $C_6H_6$ ) = 25 mg/l .



8. a) Calculate the velocity of flow and the discharge through a sewer of diameter 1000 mm laid at a gradient of 1 in 500. Assume the sewer is running full. Use Manning's formula with  $n = 0.013$ . 5
- b) The  $BOD_5$  of a waste water is 280 mg/l and the ultimate BOD is reported as 410 mg/l. Find the biochemical reaction rate constant for the waste water. 5
- c) The following observations were made on a BOD test :
- (i) D.O. of original sample = 4.5 mg/l
  - (ii) D.O. of aerated water required for dilution = 6.4 mg/l
  - (iii) D.O. of diluted sample after 5 days incubation at  $20^\circ\text{C}$  = 2.3 mg/l
  - (iv) Diluted sample is 2 per cent mixture of waste water and the aerated water.
- Calculate the  $BOD_5$  and the ultimate BOD of the waste water sample considering BOD rate constant as 0.23 per day. 5
9. a) The waste water is flowing @ 4.5 MLD from primary clarifier to a standard rate trickling filter. The 5 days BOD of the influent to TF is 160 mg/l. The value of the adopted organic loading is  $160 \text{ gm/m}^3/\text{day}$  and surface loading is  $2000 \text{ litres/m}^2/\text{day}$ . Determine the volume of the filter and its depth. 5



- b) The waste water from a city having flow of  $85 \text{ m}^3/\text{s}$ ,  $\text{BOD}_5$   $325 \text{ mg/l}$  and D.O.  $4.8 \text{ mg/l}$  is discharged to a river having flow of  $930 \text{ litres/second}$ ,  $\text{BOD}_5 = \text{nil}$  and D.O.  $= 6.25 \text{ mg/l}$ . Find the  $\text{BOD}_5$  and D.O. of mix at the point of confluence. 5
- c) Write short notes on 'algae-bacteria symbiosis' with reference to a facultative stabilization pond. 5
10. a) An average operation data for a conventional activated sludge process is as follows :
- (i) Waste water flow  $= 50,000 \text{ m}^3/\text{d}$
  - (ii) Volume of aeration tank  $= 15,500 \text{ m}^3$
  - (iii) Influent  $\text{BOD}_5 = 200 \text{ mg/l}$
  - (iv) Effluent  $\text{BOD}_5 = 25 \text{ mg/l}$
  - (v) Mixed liquor suspended solids (MLSS)  $= 3000 \text{ mg/l}$ .
- Based on the above information, determine :
- A) Aeration period in hours
  - B) F/M in  $\text{kg BOD}_5$  per day per  $\text{kg MLSS}$ .
  - C) Percentage efficiency of BOD removal. 9
- b) What do you understand by Mean Cell Residence Time (MCRT) ? 2



- c) Prove that MCRT and HRT are same when there is no recycling of sludge to the aeration tank. 2
- d) Why is recycling of sludge to the aeration tank necessary ? 2
11. a) Write short notes on any *one* of the following : 5
- (i) Oxidation ditch
  - (ii) Aerated lagoon
  - (iii) Septic tank.
- b) Draw a complete flow sheet of a conventional activated sludge process. 5
- c) Discuss different methods of disposal of municipal solid wastes. 5
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