

**ENVIRONMENTAL ENGINEERING
(CIVL 3104)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

**Group - A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
 - (i) Which of the following cations imparts pseudo-hardness?

(a) Calcium only	(b) Magnesium only
(c) Calcium and Magnesium	(d) Sodium.
 - (ii) The maximum permissible limit of fluoride in drinking water is

(a) 0.5 mg/l	(b) 1.5 mg/l
(c) 0.75 mg/l	(d) 5 mg/l.
 - (iii) Alum forms effective flocs in the pH range of

(a) 5.5 to 7.3	(b) 6.5 to 8.5
(c) 7.5 to 9.3	(d) 9.4 to 10.0.
 - (iv) After which of the following treatment units the turbidity is maximum?

(a) Chlorination	(b) Flocculation basin
(c) Secondary sedimentation	(d) Primary sedimentation.
 - (v) Free available chlorine is

(a) OCl ⁻	(b) HOCL	(c) OCl ⁻ + HOCL	(d) Ca(OCl) ₂ .
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 - (vi) A combined sewer is one which transports

(a) Domestic sewage and storm water
(b) Domestic sewage and industrial waste
(c) Domestic sewage
(d) Domestic sewage, industrial waste and storm water.
 - (vii) The drop manholes are provided in a sewerage system when there is

(a) Change in alignment in the sewer lines
(b) Change in size of sewers
(c) Change in elevation of ground level
(d) Change from gravity system to pressure system.

- (viii) Kjeldahl Nitrogen is the combination of

(a) Free ammonia + organic nitrogen	(b) Nitrate + free nitrogen
(c) Nitrite + organic nitrogen	(d) Free ammonia + Nitrite.
- (ix) Chemical Oxygen Demand (COD) of a sample is always greater than Biochemical Oxygen Demand (BOD) since it represents

(a) Biodegradable organic matter only
(b) Biodegradable and non-biodegradable organic matter
(c) Non-Biodegradable organic matter
(d) Inorganic matter.
- (x) In a BOD test, 5 ml of waste water is added to 295 ml of aerated pure water. Initial dissolved oxygen (DO) of the diluted sample is 7.8 mg/l. After 5 days of incubation at 20°C the DO content of the sample is reduced to 4.4 mg/l. The BOD of the waste water is

(a) 196 mg/l	(b) 200 mg/l
(c) 204 mg/l	(d) 208 mg/l.

Group - B

2. (a) What are the different forms of Nitrogen? Describe each and state the permissible limits of each? What is the disease caused by the consumption of excess amount of nitrate?

6 + (3 × 2) = 12
- (b) Write short notes on:

(i) B-coli
(ii) Turbidity.
3. (a) A 200 ml sample of water has initial pH of 10. 40 ml of 0.02(N) H₂SO₄ is required to titrate the sample to decrease the pH to 4.5. If OH⁻ concentration is 6mg/L as CaCO₃ and 12 ml of 0.02(N) H₂SO₄ is consumed to reach pH from original to 8.3, then find the concentration of different alkalinity causing species.

7 + (3 + 2) = 12
- (b) What is the total hardness (mg/l of CaCO₃) present in the water sample having 6 mg/l of Mg²⁺ and 100 mg/L of Ca²⁺? Write short note on Dissolved gasses.

Group - C

4. (a) What is peak hour demand and how does it affect the design of water supply system? Sketch the fluctuations in demand for typical Indian conditions.

- (b) Calculate the storage required to supply the demand shown in the following table if the inflow of water to the reservoir is maintained at a uniform rate throughout 24 hours.

Time	00-04	04-08	08-12	12-16	16-20	20-24
Demand in million litres	0.48	0.87	1.33	1.00	0.82	0.54

6 + 6 = 12

5. (a) Design slow sand filter beds for a population of 60,000 persons with per capita demand of 135 litres/head/day. Rate of filtration may be taken as 170 litres/ hr./sq.m. Assume the maximum demand as 1.8 times the average daily demand.
- (b) Write short note on:
 (i) Ring system
 (ii) Methods of distribution.

7 + 5 = 12

Group - D

6. (a) Explain in detail about the forces acting on a sewer pipe.
- (b) Explain the importance of the following in design of sewers:
 (i) Self Cleansing velocity
 (ii) Non-Scouring velocity

8 + 4 = 12

7. A 350mm diameter sewer is to flow at 0.35 depth on a grade ensuring a degree of self cleansing equivalent to that obtained at full depth at a velocity of 0.8m/sec. Find:

- (i) The required grade
 (ii) Associated velocity
 (iii) The rate of discharge at this depth

Given:

Manning's Rugosity Coefficient = 0.014

Proportionate area = 0.315

Proportionate wetted perimeter = 0.472

Proportionate HMD (r/R) = 0.7705.

(3 × 4) = 12

Group - E

8. (a) Calculate the diameter required for a single stage trickling filter which is to yield as effluent BOD₅ of 20mg/l. When treating settled domestic

sewage with a BOD₅ of 120mg/l. The waste water flow is 2200 m³/day and the recirculation constant at 4000m³/day. The filter depth is 1.5m.

- (b) Give the complete flow diagram for treating sewage in a conventional sewage treatment plant.

8 + 4 = 12

9. (a) An average operating data for conventional activated sludge treatment plant is as follows:

Wastewater Flow = 35000m³/day

Volume of aeration tank = 10900m³

Influent BOD = 250 mg/l

Effluent BOD = 20 mg/l

Mixed Liquor Suspended Solids = 2500mg/l

Effluent Suspended Solids = 30mg/l

Waste Sludge Suspended solids = 9700mg/l

Quantity of waste sludge = 220m³/d

Based on the information above, determine:

- (i) Aeration Period (in hrs)
 (ii) Food to Micro-organisms ratio
 (iii) Percentage efficiency of BOD removal
 (iv) Sludge age (days).

- (b) Solve the above problem by illustrating the flowchart of a conventional activated sludge plant with the parameters found.

10 + 2 = 12