ENVIRONMENTAL ENGINEERING
(CIVL 3103)

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) The flow velocity in a sewer does not depend on
(a) its grade (b) its length
(c) its hydraulic mean depth (d) its roughness.

(ii) The correct relationship between TOD, BOD & COD is given by
(a) TOD>BOD>COD (b) TOD>COD>BOD
(c) BOD>COD>TOD (d) COD>BOD>TOD.

(iii) Standard 5-day BOD at 20°C, when compared to ultimate BOD, is about
(a) 58% (b) 68% (c) 98% (d) none of these.

(iv) Activated sludge is the
(a) aerated sludge in the aeration unit
(b) sludge settled in the humus tank
(c) sludge in the secondary tank after aeration and rich in microbial mass
(d) sludge in the secondary tank after aeration and rich in nutrients.

(v) Total Kjeldahl nitrogen is a measure of
(a) total organic nitrogen (b) total organic & ammonia nitrogen
(c) total ammonia nitrogen (d) total inorganic & ammonia nitrogen.

(vi) Disinfection of water results in
(a) Removal of turbidity (b) Removal of hardness
(c) Killing of pathogenic bacteria (d) Complete sterilisation.

(vii) According to the Indian Standard recommendations, water requirement per capita per day in a residential building is
(a) 50 litres (b) 115 litres (c) 135 litres (d) 160 litres.

(viii) Crown corrosion in a reinforced concrete sewer is caused by
(a) H_2S (b) CO_2 (c) CH_4 (d) NH_3.

(ix) The most suitable section of a sewer in a combined sewerage system is
(a) rectangular (b) circular (c) parabolic (d) new egg shape.

(x) Minimum D.O. prescribed for a river stream, to avoid fish kills, is
(a) 2 ppm (b) 4 ppm (c) 8 ppm (d) 10 ppm.

Group – B

2. In two periods of each of 20 years, a city has grown from 30,000 to 1,70,000 and then 3,00,000. Determine (i) the saturation population; (ii) the equation of the logistic curve; (iii) the expected population after the next 20 years. [(CO2)(Evaluate/HOCQ)]
12

3. (a) What is meant by the term "per capita demand"? How is it estimated? What values of per capita demand would you recommend for:
(i) A small town with a population of 50,000.
(ii) A small city with population of 1-2 lakhs.
(iii) A large city with a population of 5 lakhs.
State reasons in support of your answers. [(CO2)(Remember/IOCQ)]
(b) What are the different sources of ground water? [(CO6)(Understand/LOCQ)]
8 + 4 = 12

Group – C

4. (a) Enumerate the chemicals which are used for coagulation. Discuss their comparative merits and demerits. [(CO3)(Remember/IOCQ)]
(b) A filter unit is 4.5 m by 9.0 m. After filtering 10,000 cubic meter per day in 24 hrs period, the filter back washed at a rate of 10 l/sq m/sec. for 15 min. Compute the average filtration rate, quantity and percentage of treated water used in washing and the rate of wash water flow in each trough. Assume 4 troughs.
[(CO3)(Analyze/HOCQ)]
5 + 7 = 12

5. (a) Find the settling velocity of a discrete particle in water under conditions when Reynold's number is less than 0.5 . The diameter and specific gravity of the particle is 6 × 10^-3 cm and 2.65 respectively. Water temperature is 20° C. (Kinematic viscosity v of water at 20° C = 1.01 × 10^-2). [(CO3)(Analyze/HOCQ)]
(b) Define "flowing through period" and "detention period" in a sedimentation tank.
[(CO3)(Understand/LOCQ)]
7 + 5 = 12

Group – D

6. (a) What do you mean by variation in flow of sewage? Explain average flow, dry weather flow, and maximum flow. [(CO4)(Understand/IOCQ)]
(b) Write a short note on following terms:
(i) Self cleansing velocity
(ii) Non-scouring velocity. [(CO6)(Remember/LOCQ)]
6 + 6 = 12

7. (a) A 40 cm dia sewer is to flow at 0.3 depth on a grade ensuring a degree of self cleansing equivalent to that obtained at full depth at a velocity of 80 cm/sec. Find:
(i) The required grade
(ii) Associated velocity
(iii) The rate of discharge at this depth.
Given: Mannings rugosity coefficient = 0.014, Proportionate area = 0.252, Proportionate HMD (r/R) = 0.684 [(CO5)(Analyze/LOCQ)]

(b) Enlist the factors that must be considered while choosing a sewer material. [(CO5)(Understand/LOCQ)]

7 + 5 = 12

Group – E

8. (a) 5 ml of raw sewage was diluted by specially prepared water, in a 300 ml capacity BOD bottle. The D.O. concentration of the diluted sample at the beginning of the test was 9 mg/L and 6 mg/L after 5 day incubation at 20°C. Find the BOD of the raw sewage. [(CO1)(Analyze/LOCQ)]

(b) Design a high rate single stage trickling filter for treating the following wastewater of a town having a population of 40,000 persons:
(i) Domestic sewage @150 lpcd having 200 mg/L of BOD.
(ii) Industrial wastewater @ 0.25 million litres per day having 600 mg/L of BOD.
Assume the following:
BOD removal in primary clarifier = 35%
Permissible organic loading of filter = 8000 kg/hec-m/day (excluding sewage recirculation)
Recirculation ratio = 1.0
Permissible surface loading = 160 mL/hec/day (including re-circulated sewage)
Also determine the efficiency of the filter and BOD of the effluent. [(CO4)(Analyze/HOCQ)]

2 + 10 = 12

9. (a) An average operating data for conventional activated sludge treatment plant is as follows:
Wastewater flow = 35000 m^3 /d
Volume of aeration tank = 10900 m^3
Influent B.O.D. = 250 mg/l
Effluent B.O.D. = 20 mg/l
Mix Liquor Suspended Solid (MLSS) = 2500 mg/l
Effluent suspended solid = 30 mg/l
Waste sludge suspended solids= 9700 mg/l
Quantity of waste sludge = 220 m^3/d.
Based on the above information, determine
(i) Aeration period (hrs)
(ii) Food to microorganism ratio (F/M) (kg B.O.D. per day/kg MLSS)
(iii) Percentage efficiency of B.O.D. removal
(iv) Sludge age (days). [(CO4)(Analyse/HOCQ)]

(b) Explain Grit chamber. [(CO4)(Understand/LOCQ)]

9 + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	33.33	19.8	46.87

Course Outcome (CO):

After the completion of the course students will be able to

1. Identify the nature and quality of water & waste water as per its characteristics like physical, chemical & biological.
2. Estimate the future water demand by using various population forecasting methods.
3. Define and design in detail about the various water treatment units.
4. Define and design in detail about the various waste water treatment units.
5. Estimate the quantity of sewage produced and design the sewerage system.
6. Analysis and design of water distribution networks.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.