BACHELOR OF ENGINEERING (CIVIL ENGINEERING) FIFTH YEAR SECOND SEMESTER - 2025

SUBJECT: ADVANCED WATER & WASTE WATER TREATMENT (CE/5/T/505C)

Time: 3 hours **Full Marks: 100 [Part –I: 70 + Part –II: 30]**

Part - I

Instructions: Answer question no 1 and any three questions from the rest

Sl. No.	Question		Marks
1	a) Determine the % of HOCl in an aquous solution, OCl^- and $[HOCl]$ at a temperature 20°C, $pH = 8$, $K_{OCl} = 2.5 \times 10^{-8}$ b) ***Discuss with necessary equation***: De-mineralisation process of water softening		[10]
2	Design a two stage Trickling filter to treat a domestic sewage of flow 18 MLD having influent BOD_5 is 300 mg/l and desired effluent BOD strength is as per Indian standard. Also design the distribution system for the first stage TF. No need to design the under-drainage system. Assume any relevant data if needed.		[20]
3	A) Find the terminal velocity at 20°C of spherical particle of 1.1 mm diameter, 2.65 specific gravity. Flow is 10 MLD and kinematic viscosity at 20°C is 1.01 centistoke. B) Discuss electrical double layer theory in context of colloidal stability in water.		[15+5]
4	Find out capacity of storage reservoir to supply a flow of 200 m3/hr to a city by graphical method. City power is not available from 6 a.m. to 10 a.m. daily. 12 hrs of pumping is done during 4 am to 10 am and 12 noon to 6 pm. Peak water demand is during i) 6 a.m. to 10 a.m. , ii) 1 p.m. to 2 p.m., 5 p.m. to 6 p.m. Assume a peak factor of 2.25. Other than peak hours hourly demands are as follows: i. 20% of average hourly demand : 11 pm to 4 am ii. 40% of average hourly demand : 4 am to 5 am and 10 pm to 11 pm iii. 60% of average hourly demand : 12 noon to 1 pm iv. 70% of average hourly demand : 2 pm to 5 pm and 8 pm to 10 pm v. 80% of average hourly demand : 5 am to 6am vi. 90% of average hourly demand : 6 pm to 8 pm vii. 100% of average hourly demand: 10 am to 12 noon. Water supply is continuous.		[20]

5	Design a tube settler module of square cross section with following data: Average design flow: 260 m^3/hr; Cross-section of square tubes: 50 mm × 50 mm; Length of the tubes: 1 m; Thickness of the tube: 1.5 mm; Angle of inclination of the tube with horizontal: 60°; Dia of particle to be removed 100% is 0.04 mm; Specific gravity of particles: 2.65; Kinematic viscosity: 1.055 centistoke Also compare size and retention time for a rectangular tank with same efficiency.		[20]
6	Design a spray aerator given the following data: Design flow 250 m^3/hr, Iron present in the water: 1 mg/L, Manganese present in the water: 0.5 mg/L, saturation concentration of O_2: 7.92 mg/L, Aeration constant (base 10): 70 cm/hr. Wind velocity is 6 kmph.		[20]

Ref. No.: Ex/CE/5/T/505C/2025

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Time: 3 hours **Full Marks: 100**

Instructions: Question no. 1 is compulsory. Answer any two questions from the remaining ones. Assume any necessary data as per conventional norms.

Part - II

<table>
<tr><th>Sl. No.</th><th>Question</th><th>Marks</th></tr>
<tr><td>1</td><td>
A) Fill in the blank:
Size of a fine screen lies between _____ mm and _____ mm.
B) Tick the correct option:
An in-stream reducer of solid size is – screenings grinder/ comminutor/ macerator.
C) Pick the odd one out:
Vortex separator, Grit Chamber, DAF system, RO system.
D) True/ False:
Removal of volatile and semi-volatile organic compounds from wastewaters is carried out by gas stripper.
E) Consider a conventional sewage treatment facility of 100 MLD as average capacity. Complete the sequence of units to be placed at the plant.
Screens ➡ Grit chamber ➡ _____ ➡ Primary settling tank
F) Match the columns:
<table>
<tr><th>A</th><th>B</th></tr>
<tr><td>Flocculant Settling</td><td>Grit Chamber</td></tr>
<tr><td>Hindered Settling</td><td>Solids thickening facilities</td></tr>
<tr><td>Discrete Settling</td><td>Removal of chemical floc in settling tank</td></tr>
<tr><td>Compression Settling</td><td>Secondary settling facilities used in conjunction with biological treatment facilities</td></tr>
</table>
</td><td>[6 x 1 = 6]</td></tr>
<tr><td>2</td><td>A screen chamber exists in an STP treating 50 MLD as average flow. Determine head loss through the mechanically cleaned bar rack considering 35% clogged condition. Check whether it is within the allowable head loss value with respect to the design criteria under these conditions.
Given data:</td><td>[11 + 1 = 12]</td></tr>
</table>

	Assumed width of rectangular bars = 10 mm Clear spacing between bars = 25 mm No. of clear spacing = 73 Depth of flow in the screen chamber in the u/s of bar rack = 1.17 m		
3	Consider a grit chamber to treat average wastewater flow of 50 MLD to remove grit particles up to a size of 0.15 mm and of specific gravity of 2.65. The minimum temperature is 15°C. A) Compute the settling velocity. B) Compute the surface overflow rate considering very good performance. C) Check whether horizontal velocity of flow remains below the critical displacement velocity. D) Determine the hydraulic retention time and comment with respect to the standard design criteria. E) Determine the dimension of the grit chamber.		[3 + 3 + 1.5 + 1.5 + 3 = 12]
4	Consider a horizontal flow rectangular sedimentation tank with the following data: Maximum flow rate = 113, 500 m^3/ d, No. of basins: 4, Detention time: 4 hours, Length-to-width ratio: 2 to 3, Surface loading rate: 35 m^3/ m^2/ d, Maximum turbidity = 20 JTU, Maximum seasonal iron concentration = 0.7 mg/ L, Maximum seasonal manganese concentration = 0.4 mg/ L, Optimum coagulant, ferric sulfate [$Fe_2(SO_4)_3$] dosage = 20 mg/ L, Optimum coagulant aid, cationic polymer = 0.05 mg/ L, Hydrated lime [$Ca(OH)_2$] for pH adjustment = 15 mg/ L, Seasonal potassium permanganate [$KMnO_4$] dosage = 4 mg/ L, Seasonal powdered activated carbon [PAC], for taste and odor control = 5 mg/ L A) Determine the dimension of the tank using the abovementioned information. B) Determine the quantity of residuals removed under maximum day flow condition. Increase the theoretical solids production by 50% due to several uncertainties and consider the removal efficiency as 85%.		[4 + 8 = 12]