B.E. CIVIL ENGINEERING FOURTH YEAR SECOND SEMESTER EXAM 2025
SUBJECT: ADVANCED WATER AND WASTEWATER TREATMENT
Time: 3 hours **Full Marks: 100**

Sl. No.	Question	CO	Marks
1	i) What advantages does tube settlers provide during sedimentation over conventional settling tanks? ii) Design a tube settler module of square cross section with the following data: Average design flow = 150 m^3/hr Cross section of square tubes = 30 mm x 30 mm Length of tubes = 0.75 m Thickness of tubes = 1.5 mm Angle of Inclination of tubes with horizontal = 50° Diameter of particles to be removed 100% = 0.025 mm Specific gravity of particles = 2.60 Kinematic viscosity of water = 1.02 centistoke. Also compare the sizes of detention time of the above system with an ideal horizontal flow rectangular sedimentation tank which will provide the same removal efficiency as the tube settler module.	[CO1]	[5+15]
2	Design a velocity-controlled rectangular grit removal facility for peak design flow. The design average flow, peaking factor, and ratio of minimum to average flow are 0.5 m^3/s, 3.0, and 1/3, respectively. The horizontal and settling velocity, and detention time are 0.32 m/s, 1.3 m/min, and 80s, respectively. At this settling velocity, the minimum discrete particle of 0.18 mm diameter will be fully removed. Also find out the head over the weir, weir length, depth of flow and velocity in the channel corresponding to the peak flow, average flow, minimum flow when a proportional weir is provided at the downstream of the grit chamber. Assume that the weir length is less than the channel width and weir crest by 2 cm from channel bottom. **OR** Design a bar rack and screen chamber for fully cleaned condition. Also sketch a hydraulic profile through bar rack. Given the following data: Peak design flow = 120 MLD; Average sewage flow = 40 MLD; Diameter of incoming sewer = 1.40 m; Depth of flow in sewer at peak flow = 1.05 m; Velocity in sewer at peak design flow = 1.16 m/s; Drop of screen chamber floor to invert of incoming sewer = 0.08 m; Bar size = 10 mm x 50 mm; Clear spacing between bars = 25 mm; Bar Shape factor=2.42; Velocity of flow through screen = 0.9 m/s; Angle of screen = 75°. Assume any other suitable data as necessary.	[CO2]	[20]
3	i) Design the approximate dimension of a set of rapid gravity filters for treating water required for a population of 70,000; the rate of supply of 180 litres per day per person. The filters are rated to work 5500 litres per hour per sq. m. Assume whatever data are necessary, and not given. ii) Derive the Carman-Kozney equation for head loss through a clean bed of single sized sand particles in a filtration unit.	[C03]	[10+10]
4	i) Derive Stoke's equation for settling velocity of a spherical discrete particle.	[C01]	[10+10]

Ref. No.: **Ex/CE/PE/B/T/421F/2025**

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<tr><td></td><td>ii) A settling column analysis is done for discrete particles in dilute suspension. The column is 2m deep and data is given below. What will be the theoretical removal efficiency in an ideal horizontal flow settling basin operating at surface loading rate of 30 $m^3/d.\ m^2$? Plot p vs. v_s on a graph paper.
<table>
<tr><td>Time (min)</td><td>0</td><td>30</td><td>60</td><td>90</td><td>120</td><td>150</td><td>200</td><td>300</td></tr>
<tr><td>Conentration (mg/L)</td><td>400</td><td>220</td><td>170</td><td>153</td><td>147</td><td>122</td><td>84</td><td>29</td></tr>
</table></td><td></td><td></td></tr>
<tr><td>5</td><td>i) Write short notes on: (a) Food-to-microorganism ratio; (b) Mean cell residence time; (c) Sludge volume index (SVI) (d) Hydraulic retention time; and (e) Biomass yield.

ii) An aeration basin receives 23,000m^3/d flow, and influent BOD_5 concentration is170mg/L. The volume of aeration basin is 6000m^3 and MLSS concentration is 3000mg/L. The effluent soluble BOD_5 and TSS concentrations are 10 mg/L and 20mg/L, respectively. The suspended solids concentration in the underflow (TSS_{uf}) is12,000mg/L, and volume of waste activated sludge (WAS) Q_{wr}=180m^3/d. The VSS portion is 73% of TSS in the biosolids. Conduct mass balance and calculate the following: (a)aeration period; (b) return flow and ratio; (c) mass organic loading; (d) volumetric organic loading; (e) mean cell residence time; and (f) observed biomass yield.</td><td>[C04]</td><td>[10+10]</td></tr>
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