Ref. No.: Ex/PG/CIV/PC/T/111A/2025

M.E. CIVIL ENGINEERING FIRST YEAR FIRST SEMESTER EXAM 2025
Subject: WATER SUPPLY AND TREATMENT (EE)
Part - I
(60)

Time: 3 Hours **Full Marks: 100**

Use a separate Answer-Script for each part

No. of Questions	Answer all the Questions	Marks
1 (a)	Design a tube settler module of square cross section with the following data: Average design flow = 200 m^3/hr Cross section of square tubes = 40 mm x 40 mm Length of tubes = 0.80 m Thickness of tubes = 1.0 mm Angle of Inclination of tubes with horizontal = 50° Diameter of particles to be removed 100% = 0.05 mm Specific gravity of particles = 2.65 Kinematic viscosity of water = 1.02 centistoke. Also find sizes for an equivalent rectangular sedimentation tank which will provide same removal efficiency as given by the tube settler module.	[20]
2 (a)	Derive the expressions for rate of free fall for single descent and multiple descents in gravity aerators.	[5]
(b)	Find the time of exposure of water in gravity aerators falling through a height of 3.3m (i) in single descent and (ii) in four descents.	[5]
(c)	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 ?	[10]

Time (min)	0	30	60	90	120	150	200	300
Conentration (mg/L)	400	220	170	153	147	122	84	29

[Turn over

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3 (a)	Compute the terminal settling velocity of a spherical particle with diameter 1.2mm and specific gravity 2.6 settling through water at 2°C temperature. Given: Kinematic viscosity of water = 0.95 centistoke. Show detailed calculation upto and including 3rd iteration.	[7]
(b)	Discuss the lime-soda softening process with the pertinent reactions.	[6]
(c)	From the water analysis presented below, determine the amount of lime and soda (in mg/L as $CaCO_3$) necessary to soften the water to 90.00 mg/L hardness as $CaCO_3$. **Water Composition (mg/L)** Ca^{2+}: 95.20 CO_2: 19.36 HCO_3^-: 241.46 Mg^{2+}: 13.44 SO_4^{2-}: 53.77 Na^+: 25.76 Cl^-: 67.81	[7]

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M.E. CIVIL ENGINEERING 1st YEAR 1st SEMESTER EXAMINATION, 2025

WATER SUPPLY AND TREATMENT

Time: Three hours

Full Marks 100
(40 marks for part II)

Use a separate Answer-Script for each part

Part-II

Question no. **1** is compulsory
Answer any **two** from the rest
(Assume any data, if required, reasonably)

1. Answer the following questions (3+5+3+5) = 16

I. Describe the Indian standards for drinking water and health hazards of – (a) Arsenic; (b) Fluoride; and (c) Nitrate.

II. What is adsorption isotherm? What are the differences between Langmuir Isotherm and Freundlich Isotherm? What is break-through curve in adsorption?

III. What is half reaction? Discuss the importance of redox potential in half reaction.

IV. Illustrate the effect of common ion in fractional precipitation when 10^{-4} mole of $BaCl_2$ is added in 1 liter of saturated $BaSO_4$ solution. Solubility of $BaSO_4$ is 1.1×10^{-5} mole/l.

2.

a) Develop appropriate half reactions, and from these construct the complete oxidation-reduction equation. Oxidation of CH_3COO^- to CO_2 and reduction of $Cr_2O_7^{2-}$ to Cr^{3+}. 5

b) 1.5×10^{-2} mole mass of acetic acid is added to sufficient water to make 1.5 liter of solution at 25°C. Indicating the different stapes find out the equilibrium concentration of all species involved? Ignore activity corrections. Given $K_A = 1.8 \times 10^{-5}$ at 25°C.

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3.

a) A water contains 100 mg/l $CO_3^{=}$ and 75 mg/l HCO_3^{-} at a pH of 10. Calculate the exact alkalinity. Also find approximate the alkalinity by ignoring $[OH^-]$ and $[H^+]$. 5

b) Two-liter solution is prepared by dissolving 0.20 mole of H_2S and 0.10 mole of H_2SO_4 (consider 100% dissolution) in water. Calculate the $[H^+]$, $[HS^-]$ and $[S^{=}]$ in the solution and also calculate pH of the solution. ($K_1 = 1.1 \times 10^{-7}$, $K_2 = 1 \times 10^{-14}$). 7

4.

a) Compute the ionic strength of a solution containing 35 mg/l NaCl, 60 mg/l Na_2SO_4 and 20 mg/l $Mg(NO_3)_2$. Also calculate the activity coefficient and activity of Na^+ and $SO_4^{=}$ ions in the solution. 5

b) The concentrations of $[Cl^-]$ and $[I^-]$ ions in 1L of solution are 1×10^{-3} M and 1×10^{-3} M respectively. $[Ag^+]$ is added into the solution as $AgNO_3$ compound [having 90% purity] in small increments. Find the followings:

(i) At what $[Ag^+]$ concentration in the solution will AgI start to precipitate?

(ii) At what $[Ag^+]$ concentration in the solution will AgCl start to precipitate?

(iii) What is the $[I^-]$ concentration in solution when AgCl start to precipitate?

(iv) What is the total amount of $AgNO_3$ compound needed when AgCl start to precipitate?

(v) Over what $[Ag^+]$ range can $[I^-]$ be separated quantitatively from $[Cl^-]$?

Given: K_{sp} of AgI at 25°C = 8.3×10^{-17}

K_{sp} of AgCl at 25°C = 1.8×10^{-10}

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