Ref. No.: Ex/PG/CE/T/111D/2024

M.E. CIVIL ENGINEERING FIRST YEAR FIRST SEMESTER EXAM 2024
Subject: WATER SUPPLY AND TREATMENT (EE)

Time : Three hours Full Marks : 100

(Use sepatate Answer Script for each Part)

PART I (60 Marks)

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 = 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 = 40° Diameter of particles to be removed 100% = 0.025 mm Specific gravity of particles = 2.60 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)	Describe different types of sedimentation with their application.	[5]
(b)	Compute the terminal settling velocity of a spherical particle with diameter 0.6 mm and specific gravity 2.5 settling through water at 22°C temperature. Given: Kinematic viscosity of water = 0.962 centistoke. Show detailed calculation upto and including 3rd iteration.	[6]
(c)	Deduce an expression for 'critical fall velocity' for the flow through an inclined circular tube settler in terms of known variables using Hagen-Poiseuille equation for flow $$Q = \frac{\pi h \rho g R^4}{8 \mu l}$$ the terms having their usual meanings.	[9]

[Turn over

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Part - I
(60)

3 (a)	In an experiment on the removal of CO_2 from water sprayed into the air in spherical droplets of 0.5cm in diameter. The initial super-saturation of the water with CO_2 was 25.8 mg/L. After 1.2 sec of exposure, this was reduced to 11 mg/L. Find the co-efficient of gas transfer (k_g) and proportionality factor (k_La).	[10]
(b)	Derive the expressions for rate of free fall for single descent and multiple descents in gravity aerators. Find the time of exposure of water in gravity aerators falling through a height of 3.3m in four descents.	[10]

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M.E. CIVIL ENGINEERING 1st YEAR 1st SEMESTER EXAMINATION, 2024

WATER SUPPLY AND TREATMENT (EE)

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 (5×4) = 20

I. What are the factors affecting the behaviours of ions in solutions? What is activity?

II. What is adsorption isotherm? Discuss the difference between the assumptions of four basic types of adsorption isotherm?

III. What are the different forms of nitrogen may present in the contaminated river water? Show their distribution with time.

IV. What are the advantages of considering coliform bacteria as a pathogen indicator in drinking water? How MPN table is used for determination of most probable number of coliforms per 100 ml of sample? If expected MPN of coliforms per 100 ml of sample is around 2700 then what will be the serial sample volumes?

2.

a) Develop appropriate half reactions for the given two pairs of compounds, and from these construct the complete oxidation-reduction equation considering oxidation between [CH_3COO^- + CO_2] and [$CH_3CH_2COO^-$] compounds and reduction between [NO_2^-] and [NO_3^-] compounds.

5

b) Tests for common ions are run on a sample of water and the results are shown below. Draw the bar diagram and calculate total hardness, calcium hardness, magnesium hardness, temporary hardness, permanent hardness, carbonate hardness, non-carbonate hardness.

Constituents: Ca^{2+} = 60.5 mg/L ; HCO_3^- = 180 mg/L ; Mg^{2+} = 25 mg/L ;

SO_4^{2-} = 63.4 mg/L ; Na^+ = 63.5 mg/L ; Cl^- = 90.5 mg/L ; pH = 7.8.

5

a) Compute the ionic strength of a solution containing 0.10 M $MgCl_2$ and 0.20 M $Al_2(SO_4)_3$. Also calculate the activity coefficient and activity of Mg^{++} and Al^{+++} ions in the solution using the Guntelberg relationship.

4

b) How many moles of KIO_3 must be added per liter of solution containing 0.1M Ba^{++} to bring about 99.9% precipitation of Ba^{++} as $Ba(IO_3)_2$? Given K_{sp} of $Ba(IO_3)_2$ is 1.5×10^{-9}.

6

4.

a) Find the amount of $[H^+]$ and pH of a 0.2 M HAc solution when K_A of HAc is 1.8×10^{-5}. By what amount is the $[H^+]$ decreased after adding 0.1M NaAc in the solution?

4

b) Granular activated carbon (GAC) was tested for its ability to remove soluble organic nitrogen from treated wastewater. Different masses of GAC were added to 2 liters of wastewater having 0.91mg/l initial concentration of soluble organic nitrogen and contacted for 2.5h at 25°C and 7.5 pH. Using the data given in the table determine (i) the maximum capacity of GAC for soluble organic nitrogen (q_m) and (ii) measure of affinity of soluble organic nitrogen for GAC (K_{ads}) based on Langmuir Isotherm.

Sl. No.	Mass of GAC added (g)	C, mg/l of soluble organic nitrogen remaining
1	0.4	0.78
2	1.0	0.66
3	4.0	0.33
4	10.0	0.20
5	20.0	0.15
6	40.0	0.10
7	100.0	0.07

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