REG. NO.:

Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ADVANCED SCIENCES
CONTINUOUS ASSESSMENT TEST - I
FALL SEMESTER 2025-2026

SLOT: C1+TC1

Programme Name & Branch : **B.Tech- Chemical Engineering**
Course Code and Course Name : **BACHY104 - Engineering Chemistry**
Faculty Name(s) : **Dr. Ethiraj KR, Dr. Atanu Chakraborty**
Class Number(s) : **6416, 6422**
Date of Examination : **19/08/2025**
Exam Duration : **90 minutes** **Maximum Marks: 50**

General instruction(s):

- Answer All Questions
- M - Max mark; CO – Course Outcome; BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)
- Course Outcomes: xxxx

Q. No	Question	M	CO	BL
1.	Discuss the principle involved in the estimation of dissolved oxygen in a water sample with appropriate equations. What are the methods to remove the dissolved oxygen from boiler feed water? Winkler's Method; Principle- Winkler's method essentially converts dissolved oxygen into an equivalent amount of iodine, which is then determined by titration. Manganese(II) sulfate ($MnSO_4$) is added to the water sample under alkaline conditions (using alkali-iodide solution). Dissolved oxygen oxidises $Mn^{2+}$to a higher valent manganese hydroxide, $MnO(OH)_2$ (brown precipitate). **Liberation of Iodine:** On acidification with sulfuric acid, the oxidised manganese reacts with iodide ions (I^-), liberating free iodine (I_2). The liberated iodine is titrated with standard sodium thiosulfate $Na_2S_2O_3$ solution, using starch as an indicator. The amount of thiosulfate used is directly proportional to the concentration of dissolved oxygen (DO) in the sample. ------3M Equations – 3M Application of Sod. Sulphite, Sod. Sulphide and hydrazine – Equations for all three and justification for the hydrazine treatment since the byproducts are not contaminating the water ---3M With equations -1M	10	4	2
2.	What are the various filtration methods used for the disinfection of water, and how is reverse osmosis superior to all other processes? Discuss the Principle and list out the advantages of the Reverse Osmosis process.	10	4	3

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	Ultra, mico, nano filtrations – brief discussion (3M) and reverse osmosis. -figure principle .(5M), Applications – 2M Can consider if students write about the carbon filter too			
3.	a) Calculate the calcium carbonate equivalence of the following impurities present in 1 L of water sample and find the temporary hardness present in the given water sample $CaCl_2$: 23mg/L, $MgSO_4$: 120mg/L, $Mg(HCO_3)_2$: 146mg/L, $CaSO_4$: 34mg/L. (Mol wt. of $CaCl_2$: 111, $MgSO_4$: 120, $Mg(HCO_3)_2$: 146 and $CaSO_4$: 136) Calcium carbonate equivalence of $CaCl_2$: 23 – 20.72, $MgSO_4$: 120mg/L- 120/120 x100 = 100, $Mg(HCO_3)_2$: 146mg/L – 146/146 x100 = 100, $CaSO_4$: 34mg/L. – 34/136 x100 = 25 Tempo. Hardness = 100 PPM	5	4	3
	b) A small quantity of magnesium salts can create a large amount of boiler troubles. Give the reason behind this. Dissolved magnesium salts are hydrolyzed to form acids $MgCl_2 + 2\,H_2O \longrightarrow Mg(OH)_2 + 2\,HCl$ This acid reacts with boiler and corrodes: $Fe + 2\,HCl \longrightarrow FeCl_2 + H_2$ | $FeCl_2 + 2\,H_2O \longrightarrow Fe(OH)_2 + 2\,HCl$ Explanation – 2.5 M Equation -2.5 M	5		
4.	a) Discuss the principle involved in the estimation of hardness by the EDTA titration method. Principle of Complexometric Titration- 2.5M Equations - 1M Colour change -reason- 0.5 M, Why Disodium EDTA - 1M The principle lies in the **stoichiometric reaction** of metal ions with EDTA (1:1 ratio) to form a stable, colorless, and soluble chelate, with the endpoint detected by a suitable indicator Complexometric titration is based on the formation of a **stable, water-soluble complex** between a metal ion (the analyte) and a complexing agent (the titrant). • The most common titrant used is **EDTA (ethylenediaminetetraacetic acid)**, a hexadentate ligand that can bind to metal ions through six donor atoms, forming very stable **chelate complexes**. $Mn^{++} + EDTA^{4-} \longrightarrow [M\text{–}EDTA]^{(n-4)}$ • When EDTA is added to a solution containing metal ions, it binds in a **1:1 molar ratio** with almost all polyvalent metal ions, irrespective of their	5	4	2

	charge: The **endpoint** of the titration is usually detected using a **metal ion indicator** (e.g., Eriochrome Black T, Murexide). These indicators form a less stable complex with the metal ion and change color when displaced by EDTA at the equivalence point.			
	b) 1 g of $CaCO_3$ was dissolved in HCl and made up to 1 L for titration; 50 mL of this solution required 36 mL of EDTA, and 50 mL of sample hard water required 26 mL of EDTA. 50 mL of boiled, cooled water consumed 10 mL of EDTA. Calculate Carbonate and Non-carbonate hardness and express in ppm. 50 mL of sample hard water- 36 mL of EDTA 50mg of Ca2+ reacted with 36 mL of EDTA 1mL of EDTA reacts with 50/36= 1.3889 mg of Ca2+ 50mL of sample hard water consumed 26mL of EDTA 26 mL of EDTA reacted with 1.3889x 26= 36.114mg of Ca2+ 50 mL of water contains 36.114 mg 1000mL -----36.114x 1000/50 = 722.22 **Total Hardness: 722.22 mg of Ca2+** 50 mL of boiled, cooled water – 10mL of EDTA 1000ml of boiled, cooled water reacted with v3/v1 x1000 = 10/36 x 1000 = 277.78 Tempo. Hardness = 722.22- 277.78 = 444.4 **Carbonate (444.44) and Non-carbonate hardness (277.78)**	5		
5.	Compare the ion exchange resin method and the zeolite process for water purification. Highlight the differences in their working principles, ion selectivity, and regeneration method. Give the comparison process, equations regeneration and any two advantages and disadvantages and a schematic diagram – 5 Marks for each process	10	4	1