Ref. No. Ex/PG/EBT/T/113/2024

Name of the Examination: M.TECH. ENVIRONMENTAL BIOTECHNOLOGY FIRST YEAR FIRST SEMESTER - 2024

Subject: POLLUTION CONTROL STRATEGIES **Time: Three Hours** **Full Marks: 100**

Part: FULL

Answer any 4 (Four) questions

1. (a) With a neat diagram describe the theory of type-I settling. 10

1. (b) A settling analysis is run on a type-I suspension. The column is 2.0m deep, and the data is shown below. What will be the theoretical removal efficiency in a settling basin with a loading rate of $50 m^3/m^2$-day? 15

Time, min	0	60	80	100	130	200	240	420
Concentration, mg/L	300	189	180	168	156	111	78	27

2. (a) Describe the lime-soda ash process of water softening with necessary chemical reactions. 10

2. (b) A water sample with the ionic characteristics shown below is to be softened to the minimum possible hardness by the lime-soda ash-excess lime process. Calculate the required chemical quantities in milliequivalents per liter. Draw a bar diagram of the finished water. 15

	0.8	3.0	7.0	9.0
CO_2	Ca^{2+}	Mg^{2+}	Na^+	
	HCO_3^-	SO_4^{2-}		
		5.5		9.0

3. (a) Clean water at 20^oC ($\rho = 998.2 kg/m^3$, $\mu = 1.002 \times 10^{-3}$ N.s/m^2) is passed through a bed of uniform sand at a filtering velocity of 5.0m/h. The sand grains are 0.4mm in diameter with a shape factor of 0.85 and a specific gravity of 2.65. The depth of the bed is 0.67m and the porosity is 0.4. Determine the head loss through the bed. 12

3. (b) The filter medium as described in question (Q.3 a) is to be expanded to a porosity of 0.7 by hydraulic backwash. Determine the required backwash velocity and the resulting expanded depth. 13

4. (a) Derive the expressions of different design parameters for a complete mix activated sludge system applying the mass balance approach. Explain with a neat diagram. 10

4. (b) A complete mix-activated sludge system is to be designed for secondary treatment of $12000 m^3$/day of municipal wastewater. After primary clarification, the BOD is 200mg/L, and the effluent BOD should not exceed 5mg/L. The pilot plant analysis has established the following kinetic values: Y = 0.5kg/kg, k_d = $0.05 d^{-1}$. Assuming a MLSS = 3000mg/L and underflow concentration = 10000mg/L (from secondary clarifier), determine: (a) The volume of the reactor (b) The mass and volume of solids that must be wasted each day (c) The recycle ratio. 15

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5. (a)	Calculate the minimum size of the particle that will be removed with 100% efficiency from a settling chamber under the following conditions: Air: Horizontal Velocity = 0.3m/s, Temperature = 77^{o}C ($\mu = 2.1 \times 10^{-5}$ kg/m.s); Particle: Specific Gravity = 2.0; Chamber: Length = 7.5m, Height = 1.5m	10
5. (b)	An absorption tower is to be used to remove SO_2 from stack gas flowing at 10m^3/s at 1atm pressure and 25^{o}C temperature with a SO_2 content of 3.0% by volume. A removal of 90% is required, and water initially free from SO_2 is to be used as the solvent. The equilibrium line can be estimated as $y = 30x$. Determine the flow rate of water that represents 150% of the minimum liquid requirement.	15