



First Semester 2022– 2023
Mid Semester Examination (Open Book)

Course No: CE F323

Course Name: Introduction to Environmental Engineering

Max. Marks: 60

Date: 31-10-2022 FN

Weightage: 30 %

Duration: 90 Minutes

Instructions: Assume any data judiciously only if needed with reasoning.

1. Polyvinyl chloride (PVC), a common form of plastic found in construction and many household goods. It is almost always get to the municipal solid waste and some time is burned in landfills. PVC is a polymeric chain repeating the monomer C_2H_3Cl . The following reaction describes the high-temperature combustion of the typical PVC monomer:
$$C_2H_3Cl + a O_2 \rightarrow b CO_2 + c H_2O + d ClO_2$$
 - 1.1. Determine the values of the stoichiometric coefficients for this reaction (Balance the equation). **(1M)**
 - 1.2. Calculate the volume of oxygen at $T = 20^\circ C$ and $P = 1$ atm required to incinerate one mole of the monomer. Express your answer in liters. **(2M)**
 - 1.3. Calculate the volume of air at $T = 20^\circ C$ and $P = 1$ atm required to incinerate 2 kg of PVC. Express your answer in liters. Assume Oxygen is 21% of volume of air **(3M)**
 - 1.4. If the fumes exit the stack at $240^\circ C$ and 1 atm, how many m^3 of CO_2 , H_2O (vapor), ClO_2 and total are being released for every 10 kg of PVC burned? **(4M)**
2. A wastewater is to be treated in a complete-mix reactor. Assuming that the reaction is irreversible and first-order ($r = -kC$) with a reaction rate coefficient equal to 0.15/day, determine the flowrate that can be treated if the reactor has a volume of $20 m^3$ and 98 percent treatment efficiency is required. What volume would be required to treat the flowrate determined above if the required treatment efficiency is 92 percent? **(6M)**
3. The following test results were obtained for a wastewater sample taken at the headworks to a wastewater treatment plant. All of the tests were performed using a sample size of 50 mL. Determine the concentration of **total solids, total volatile solids, total suspended solids, volatile suspended solids, and dissolved solids** for sample # 2 **(5 M)**

Item	Weight, g
	Sample number
	2
Tare mass of evaporating dish	53.5434
Mass of evaporating dish plus residue after evaporation at $105^\circ C$	53.5693
Mass of evaporating dish plus residue after ignition at $550^\circ C$	53.5489
Tare mass of Whatman GF/C filter	1.5435
Mass of Whatman GF/C filter plus residue after drying at $105^\circ C$	1.5521
Mass of Whatman GF/C filter plus residue after ignition at $550^\circ C$	1.5455



4. Determine the UBOD and BOD₅ (in mg/L) of a mixture of 150 mg/L glucose (C₆H₁₂O₆) and 150 mg/L glutamic acid (C₅H₁₀N₂O₃). Assume the value of the BOD₅ first-order reaction rate constant is 0.23 d⁻¹ (base e), at 20°C. **Hint:** The moles of oxygen required to convert each compound into CO₂, H₂O (former) and also NH₃ (latter) is the theoretical UBOD (same as COD since molecular composition as organic waste is known). (6M)
5. If the BOD value at 20°C of a wastewater measured at 3 and 10 days was found to be 125 and 225 mg/L, respectively, determine the 5-d value using the first-order rate model. (3M)
6. As part of an evaluation, you have been asked to determine the effect of the wastewater discharge on the dissolved oxygen of a river for **only summer conditions** as shown below. Calculate the DO at the critical point and time at which DO will be critical. (15M)

Parameter	wastewater	River	
		Winter	Summer
Flow, m ³ /s	0.200	0.483	0.241
BOD ₅ , mg/L	100	N/A	N/A
k at 20°C, d ⁻¹	0.3685	N/A	N/A
BOD _U , mg/L	N/A	7.66	7.66
Temperature, °C	28	4	28
DO, mg/L	0.0	8.0	8.0
Speed, m/s	N/A	0.150	0.150
Depth, m	N/A	2.0	1.0
Bed Activity Coefficient	N/A	0.3	0.3

7. Write short notes: (5 x 3 =15M)
- 7.1. Estimation of presence of pathogens in a water sample using any method.
- 7.2. Stressors and Pollutants in GW.
- 7.3. Write a summary of your topic chosen for term paper.