Ref No. –Ex/PG/CIV/PE/T/121A/2025

M.E.C.E. 1st YEAR EXAMINATION, 2025
(2nd Semester)
SUBJECT: Process Design in Environmental Engineering

Full Marks 100

Time: Three hours

Use a separate Answer-Script for each part

No. of Questions	Part I(60 Marks for This Part)	Marks
	Answer Question 1 (compulsory) and any two from the rest. Assume any data if not provided. <u>All the drawings should be in pencil.</u>	
Q1. (A)	Discuss the mechanism of algae bacteria symbiosis with a neat sketch in wastewater treatment for a facultative stabilisation pond.	5+2
(B)	What is the basic difference between rotating biological contractor and aerated lagoon. Draw a labelled complete flowsheet of wastewater treatment using oxidation ditch.	3+4
(C)	Writing justification choose which type of reactor you will recommend for these situations: (i) Treatment of municipal wastewater (ii) Treatment of industrial wastewater (iii) Waste with high value of degradation coefficients and above zero-order kinetics (iv) For treatment of wastewater with heterogeneous substrates	1.5×4
Q2. (A)	Determine graphically the rate of reaction for the decomposition of the following pollutant in a batch reactor. Also determine half-life for that pollutant.	8+2

Time (d)	0	1	2	3	4	5	6	7	8
Concentration (mole/L)	250	70	42	30	23	18	16	13	12

(B)	For a waste stabilization pond for 30000 people the following data are given: i. Waste water flow=150lit/capita-day ii. BOD_5 contribution at 20°C=50g/capita-day iii. Final BOD_5 in the effluent should be less than 30mg/L iv. Latitude of the place 23°N v. Maximum solar radiation=126cal/cm^2-day, Minimum solar radiation=70cal/cm^2-day, sky clearance factor =70% and conversion efficiency =6%, Oxygenation factor=1.3 vi. Pond temperature=15°C vii. Kp at 20°C=0.132×log (BOD_u)-0.169 viii. $Kp(t)=Kp(20°C)\times(1.035)^{t-20}$ ix. Sulphate concentration =115mg/L Determine: (a) the oxygen production (b) detention time for plug flow system (c) pond area (d) Sulphide concentration	10

[Turn over

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No. of Questions	Part I(60 Marks for This Part)	Marks
Q3. (A)	Determine the energy required to supply the necessary oxygen for an aerated lagoon to treat a wastewater flow of 4500m^3/day with the following data: i. Influent SBOD=200g/m^3 ii. Effluent SBOD=30g/m^3 iii. Kinetic coefficients at 20-25°C: Y=0.6g/g, k_s=80g/m^3, k_d=0.06d^{-1}, k=5g/g-d iv. Influent TSS=200g/m^3 v. Lagoon water temperature 25°C vi. Aerator O_2 transfer rate=1.5kgO_2/KWh vii. Elevation= 300m and elevation correction factor = 0.975 viii. Design hydraulic retention time=4days ix. Aeration constants: α=0.85, β=1 x. O_2 concentration to be maintained in liquid = 1.5 g/m^3 xi. Saturated oxygen concentration at: 25°C= 8.38 mg/L and at 25°C = 8.22 mg/L	10
Q3.(B)	Determine the liquid volume and total oxygen requirement for an oxidation ditch for the following conditions: i)Population to be served=45000 @ 150 lcapita^{-1}day^{-1} wastewater, $BOD_{5,20°C}$=40 gcapita^{-1}day^{-1} and TKN = 8 gcapita^{-1}day^{-1} ii)Desired effluent BOD_5 at 20°C=30mg/l iii) Suspended solid in the wastewater = 20 mg/l and 65% of this solid is biodegradable iv)Organic loading=0.25kgBOD_5day^{-1}kgMLVSS^{-1} v)MLSS concentration=3500mg/l vi)Volatile fraction of MLSS=0.6 vii)Sludge yield coefficient=0.6 viii) Sludge decay coefficient=0.12d^{-1}	10
4. (A)	With the following data develop the process design of a staged rotating biological contactor system and check for organic and hydraulic loadings. Assume 1st stage sBOD=25g/m^3. Use 9300 m^2 area per shaft.	10
(B)	Design a septic tank for a residential building [as per code IS 2470 (Part-I):1985] of 20 persons having following fixtures: 1 WC/4person, 1 kitchen sink, 2 wash basins, 2 shower baths and 1 drinking fountain. Probable number of FUs are based on 70% FU discharging simultaneously. Each unit is assumed to flow 9 LPM.	10

Parameter	Unit	Primary Effluent	Target Effluent
Flow rate	m^3/d	5000	--
Total BOD_5	g/m^3	200	30
$SBOD_5$	g/m^3	100	15
TSS	g/m^3	85	25

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SUBJECT: Process Design in Environmental Engineering

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Time: Three hours

Use a separate Answer-Script for each part

No. of Questions	Part I(60 Marks for This Part)	Marks

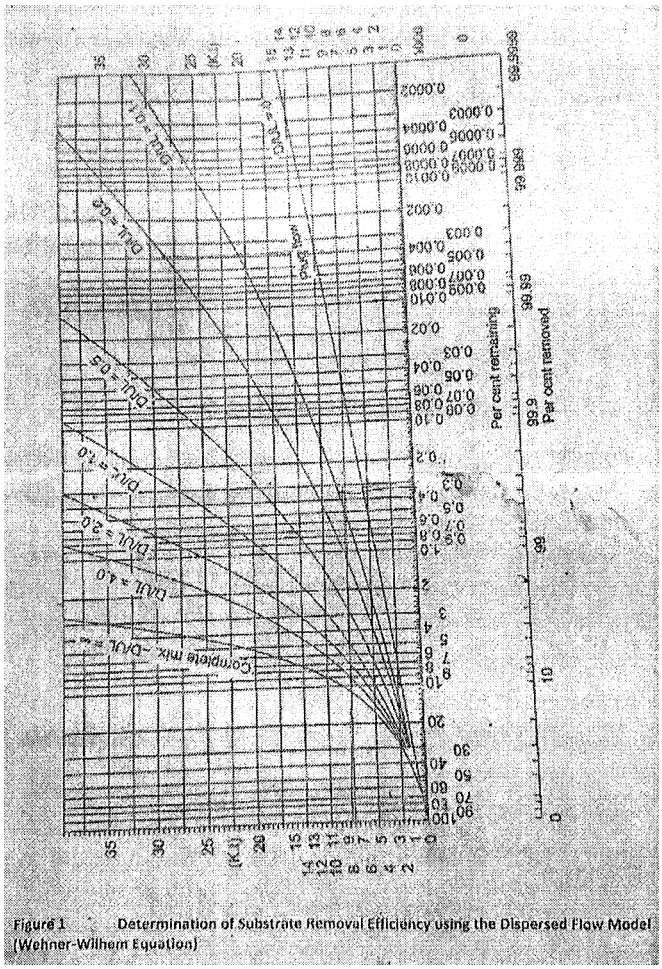

Figure 1 Determination of Substrate Removal Efficiency using the Dispersed Flow Model (Wehner-Wilhem Equation)

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M.E. CIVIL ENGINEERING FIRST YEAR SECOND SEMESTER EXAM 2025
Subject: PROCESS DESIGN IN ENVIRONMENTAL ENGINEERING
Part - II
(40)

Use a separate Answer-Script for each part

No. of Questions	Answer Question No. 1 and any *Two* from the rest	Marks
1	Water having a total organic carbon (TOC) of 200 mg/L is to be treated by a granular carbon column at a water flow, $Q = 150$ m^3/day. The minimum TOC removal should not be less than 95%. The data obtained from a pilot column breakthrough test is as follows:	[20]

Total volume, V (L)	TOC concentration (mg/L)
400	9
1,000	11
1,300	8
1,900	9
2,300	30
2,500	100
2,700	165
2,930	190
3,120	200

The size and water flow rate for the pilot column are as follows:
Inside diameter, 9.50 cm
Height of carbon bed, 1.04 m
Mass of carbon, 2.98 kg
Water flow rate, 12.39 L/h
Unit flow rate, 0.486 L/s-m^2
Packed carbon density, 400 kg/m^3
Determine the following:
a. The design reaction constant k_1
b.The design maximum solid-phase concentration q_0
c. The breakthrough time T_B
d. The breakthrough volume V_B
e. The mass of carbon M
f. Diameter and length of carbon bed
g. Weight of carbon required per unit volume treated

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M.E. CIVIL ENGINEERING FIRST YEAR SECOND SEMESTER EXAM 2025
Subject: PROCESS DESIGN IN ENVIRONMENTAL ENGINEERING
Part - II
(40)

2 (a)	Discuss Breakpoint Chlorination with the help of a neat sketch.	[5+5]
(b)	0.7 mg/L of total chlorine is required for satisfactory disinfection at pH = 8. If it is Given that initially 12 min contact time is required at pH = 7 Find the contact time required at pH = 8. Take n = 1.5 and k_i = 2.7 x10^{-8} moles/L.	
3 (a)	Discuss the four steps in the adsorption with a sketch.	[5+5]
(b)	Discuss the formation of DBPs and their negative effects.	
4(a)	Discuss the process of Reverse Osmosis with a neat sketch.	[5+5]
(b)	Estimate quantity and quality of the waste stream, and the total quantity of water that must be processed from a reverse osmosis facility that is to produce 5000 m^3/d of water to be used for industrial cooling operations. Assume that the recovery and rejection rates are equal to 80% and 75% respectively and that the concentration of the feed stream is 500 g/m^3.	