Ref No. –Ex/PG/CIV/PE/T/128E/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.	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

Assume 1st stage sBOD=25g/m^3. Use 9300 m^2 area per shaft.

(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

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

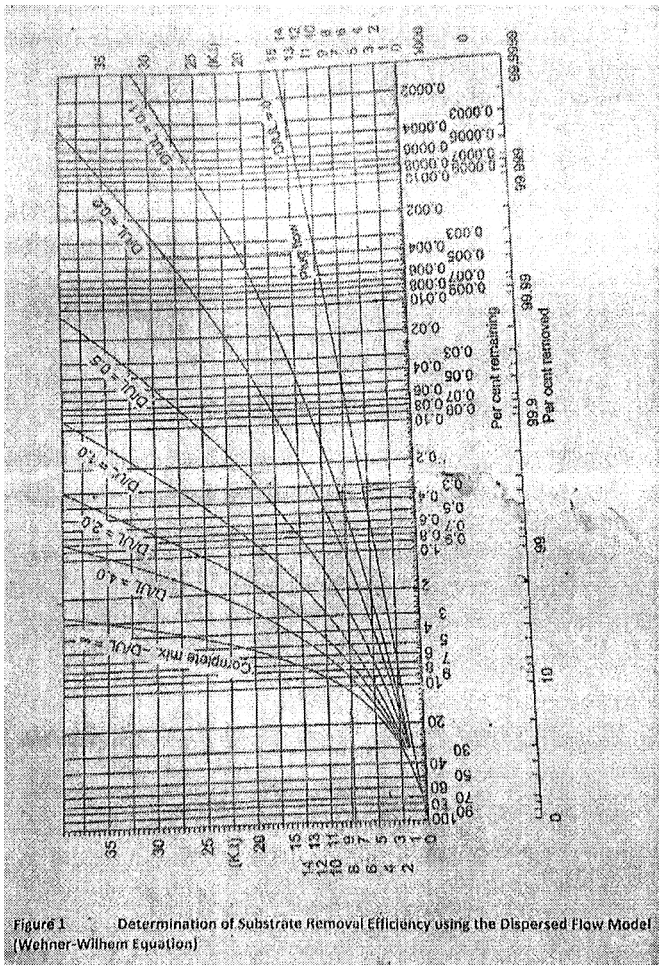

Figure 1 Determination of Substrate Removal Efficiency using the Dispersed Flow Model (Wehner-Wilhem Equation)

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M.E. CIVIL ENGINEERING FIRST YEAR SECOND SEMESTER EXAM 2025
Subject: PROCESS DESIGN IN ENVIRONMENTAL ENGINEERING (EE)
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	Design a Trickling Filter (TF) and rotary distributors for the following data: Average flow = 55 MLD BOD_5 in influent = 250 mg/L BOD_5 in effluent ≤ 15 mg/L Depth of filter = 1.6-2.5m Diameter of TF ≤ 60m Organic Loading ≈ 0.8Kg/m^3.day Hydraulic Loading = 10-40 m^3/m^2.day For central column, Flow velocity ≥ 0.9m/sec for average flow condition and 1.5-2.2 m/sec for peak flow condition Peak Factor = 2.25 Adapt a multiple diameter section for the arms Diameter of orifice = 20-30mm Spacing of orifice ≥ 35mm	[20]
2	Laboratory test data shows that 99% kill of organisms in a sample of water could be obtained at a chlorine concentration of 6mg/L with a contact time 25 min. Assuming coefficient of dilution = 1.2, find out: (i) Contact time at 6mg/L concentration for 99.95% kill (ii) Concentration for 99% kill at 20 min contact time (iii) Chlorine concentration for 99.95% kill at 20 min contact time.	[10]
3 (a)	What are the different pressure-driven membrane processes? Describe any one.	[5]
(b)	Describe the process of Electrodialysis with a neat sketch.	[5]

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Part - II
(40)

4	Determine the area and power required to demineralize 4500 m^3/d of treated wastewater to be used for industrial cooling water using an electrodialysis unit comprised of 280 cells. Assume the following data apply: TDS concentration = 2600 mg/L^2. Cation and anion concentration = 0.012 g-eq/L Efficiency of salt removal = 65 % Current efficiency= 80 % CD/N ratio = 400 Resistance = 4 Ω Faraday's constant= 96,485 Amp-s/gram equivalent	[10]