Ref No. –Ex/PG/CE/T/128E/2024

M.E.C.E. 1st YEAR EXAMINATION, 2024
(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 relevant 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)	Draw labelled complete flowsheets of wastewater treatment using rotating biological disc for different flows and different feed systems.	3+4
(C)	Writing justification choose which type of reactor you will recommend for these situations: (i) Treatment of municipal waste water (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)	Writing the basic mass balance equation derive the first order pollution removal kinetic equations for plug-flow reactor (PFR). Defining the dispersion number write the value of dispersion number for ideal CSTR. In a CSTR the chemical rate of reaction is given as r_C=-0.1[C]. K value is in d^{-1}. For 80% removal determine the volume of the reactor for a volumetric flow rate of 100L/s if initial concentration is 0.15mol/L for completely mixed stirred tank reactor (CSTR).	3×2+4
(B)	It has been found that the observed die off coefficient for E-coli in waste stabilization pond can be described adequately by first order kinetics. Assume that the bacteria die off rate is 1.5 per day at 20°C. Check whether the effluent obtained from the stabilization pond is suitable for irrigation (1000/100ml) with initial concentration 10^6/100ml at 25°C. The surface area of the pond is 4 ha, depth is 1.5m and daily flow rate is 6000 m^3/day. Assume dispersion number is 0.5. Use the figure attached. If the coliform concentration is required to reduce further what measures you will recommend?	6+4
Q3. (A)	Design an earthen sedimentation basin for an aerated lagoon to separate solids for the given information: (i) Flow to the sedimentation basin = 3500 m^3/day (ii) Suspended solids in the influent to the basin which are not degraded biologically = 200mg/L (iii) Volatile solids produced due to biological reactions in the reactor =100 mg/L (iv) Suspended solids produced is equal to volatile solids produced divided by 0.8 (v) Suspended solids in the effluent from the basin = 25mg/L	10

[Turn over

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	(vi) Volatile fraction of the total solids discharged to the sedimentation basin =75% (vii) The cleaning interval of the basin = 5years (viii) The volatile solids available at the end of the t years of operation assuming linear decomposition of the volatile solid and 70% reduction per year, VSS_t=[0.7+(1-% of reduction per year)(t-1)]×VSS deposited per year (ix) Hydraulic detention time = 2 days (x) The liquid level above the sludge layer at its maximum layer of accumulation = 1.5 m Assuming the deposited solids will compact to an average value of 15%, with the specific density of the accumulated solids 1.05, determine: ▪ Volume of the sedimentation basin ▪ Surface area of the sedimentation basin ▪ Total depth of the sedimentation basin along with depth required for storage of sludge	
Q3.(B)	Determine the oxygenation capacity required for a cage rotor of an oxidation ditch in kg per day with the following information: (i) Population served = 50,000 (ii) Waste water flow = 200L/capita per day (iii) Percapita BOD_5, 20°C contribution = 40g/capita per day (iv) Desired effluent BOD_5, 20°C =20 mg/L (v) TKN concentration in the influent = 45mg/L (vi) Mixed liquor suspended solid concentration = 3500mg/L (vii)Volatile fraction of MLSS = 0.6 (viii)Suspended solid in the effluent = 20mg/L (ix) 65% of the suspended solid of the effluent is biodegradable (x)Sludge yield coefficient = 0.6 (xi) Sludge decay coefficient = 0.12/day (xii)Food to micro-organism ratio=0.25 (xiii) Liquid temperature in the lagoon =10°C (xiv)Elevation of the area = 1000m (xv) α = 0.98; β= 1 (xvi) C_s = 9.17mg/L at 20°C (xvii) C_w at 10°C = 11.27mg/L (xviii) C_L =1.5mg/L (xix) Altitude correction factor for 1000m elevation = 0.95	10

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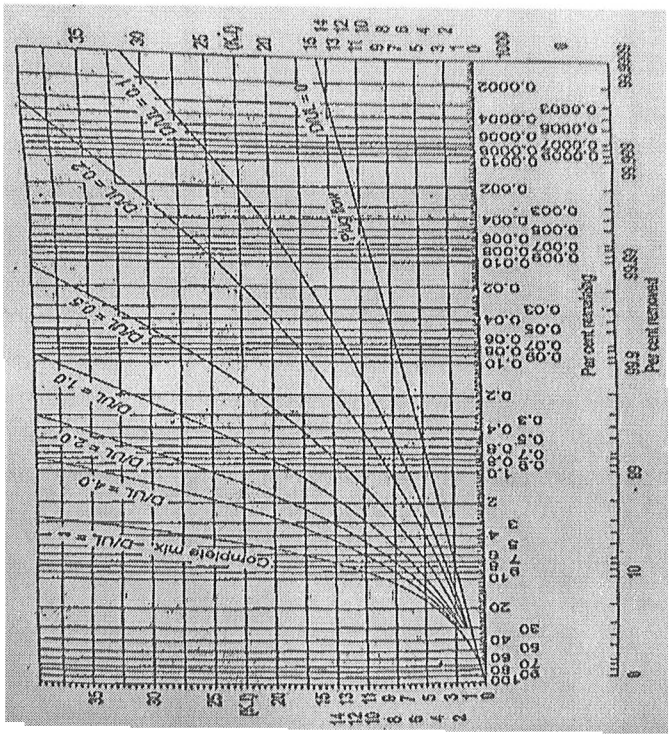
Part I (60 Marks for This Part)

No. of Questions		Marks
4. (A)	With the following data develop the process design of a staged rotating biological contactractor system and check for organic and hydraulic loadings.	10

Parameter	Unit	Primary Effluent	Target Effluent
Flow rate	m^3/d	6000	--
Total BOD_5	g/m^3	250	30
$SBOD_5$	g/m^3	100	15
TSS	g/m^3	80	30

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/5person, 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. Cleaning interval 2 years. 10



Ref. No.: Ex/PG/CE/T/128E/2024

M.E. CIVIL ENGINEERING FIRST YEAR SECOND SEMESTER EXAM 2024
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 $\leq$ 15 mg/L Depth of filter = 1.6-2.5m Diameter of TF $\leq$ 60m Organic Loading $\approx$ 0.8Kg/m^3.day Hydraulic Loading = 10-40 m^3/m^2.day For central column, Flow velocity $\geq$ 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 $\geq$ 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]