(v) Immobilized cell reactors for wastewater treatment have the advantage of having/being

(a) higher cell concentration
(b) more stable prevents washout
(c) higher dilution rate before the cells washout
(d) all of the above.

(vi) The oxygen transfer rate is a bioreactor will increase if

(a) oil is added
(b) antifoam is added
(c) detergent like molecules are added
(d) the reactor temperature is increased.

(vii) The kinetics of monoclonal antibodies are described by the kinetics of the type

(a) growth associated (b) non- growth associated
(c) Monod model (d) combination of (a) & (b).

(viii) A fluid in which the viscosity decreases with increasing stirrer speed and mixing time, can be represented as

(a) newtonian fluid
(b) pseudoplastic, thixotropic fluid
(c) dilatant, rheopectic fluid
(d) dilatant, pseudoplastic fluid.

(ix) Damkohler No. (Da) is a measure of

(a) pore diffusion (b) film diffusion
(c) combination of (a) & (b) (d) reaction kinetics.

(x) Thiele parameter predicts the effect of

(a) molecular diffusion (b) chemical reaction
(c) pore diffusion (d) combination of (a) & (b).

Group – B

2. (a) What is volumetric mass transfer coefficient? What are the factors that affect volumetric mass transfer coefficient? Draw the concentration profile at air-bubble – medium interface.

Run	1	2	3	4
v_0 liter/hr	30.0	9.0	3.6	1.5
C_{Af}, millimol/liter	85.7	66.7	50	33.4

(b) A 10 litre (H/D = 1.4) reactor having its stirrer rotating at 500 rpm is fed with air at a rate of 1 v u m is to be scaled up to 10,000 litre on similar geometry for equal aeration. Compute the speed of agitation in the scaled up vessel.

6 + 6 = 12

B.TECH/BT/6TH SEM/BIOT 3203/2017

BIOREACTOR DESIGN AND ANALYSIS
(BIOT 3203)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) If the reaction rate doubles as the concentration of the reactant A increases by a factor of 2, what is the order of the reaction with respect to A?

(a) First order (b) Zero order
(c) Pseudo first order (d) None of these.

(ii) Swirling and vortex formation can be prevented by

(a) using baffles (b) using diffusion ring with turbines
(c) both (a) and (b) (d) none of these.

(iii) Yield coefficient represents

(a) total biomass or product produced
(b) conversion efficiency of a substrate into product
(c) conversion rate of a substrate into biomass or product
(d) production time of biomass or product.

(iv) The rate limiting step in the movement of oxygen from the gas phase in a bubble to the medium is the movement of oxygen molecules through

(a) gas-liquid interface (b) bulk liquid
(c) gas phase (d) none of these.

(b) A bioreactor has an oxygen mass transfer coefficient capabilities of 400 h^{-1}. What is the maximum cell concentration of E. coli that can be grown aerobically in this reactor? Respiration rate of E. Coli is 0.35 g O_2 (g cell)$^{-1}$ h^{-1}. Critical oxygen concentration is 0.2 mg/L. Assume oxygen saturation with air to be 6.7 mg/L.

(2 + 2 + 2) + 6 = 12

3. (a) Derive washout condition from Monod chemostat model.

(b) An aerobic batch fermentation is carried out using methanol as substrate. Calculate the following μ_{max}, $Y_{X/S}$, K_S, t (doubling time) and Sp. Growth rate at 10 hrs. from given experimental data.

Time (hr.)	0	2	4	8	10	12	14	16	18
x(gm/lit.)	0.2	0.211	0.305	0.98	1.77	3.2	5.6	6.15	6.2
S(gm/lit.)	9.23	9.21	9.07	8.03	6.8	4.6	0.92	0.077	0.0

4 + 8 = 12

Group – C

4. (a) Explain how concentration, temperature and pressure affect reaction rate.

(b) A mixed flow reactor (2 m^3) processes and aqueous feed (100 lit./min) containing reactant A (C_{A0} =100m mol/lit). The reaction is reversible and represented by A $\leftrightarrow$ R, $-rA = 0.04\ C_A - 0.01\ C_R$, What is the equilibrium conversion and the actual conversion in the reactor?

6 + 6 = 12

5. (a) The reaction of sulphuric acid with diethylsulfate in aqueous solution at 23^{0}C is given below :

$H_2So_4 + (C_2H_5)_2\ SO_4 \rightarrow 2C_2H_5SO_4\ H$

Initial conc. of H_2SO_4 and $(C_2H_5)_2\ SO_4$ are each 5.5 mol/lit. Find a rate equation for this reaction with the help of data given below:

Time (min)	0	41	55	96	146	194	267	368	410	infinite
$2C_2H_5SO_4\ H$ (mol/lit.)	0	1.18	1.63	2.75	3.76	4.31	4.86	5.32	5.42	5.8

(b) At 650 ^{0}C phosphine vapor decomposes as follows :

$4PH_3 \rightarrow P_4\ (g) + 6H_2$, $-r_{phos} = (10\ hr.^{-1})\ C_{phos}$

What size of P F R operating at 650^{0}C and 11.4 atm is needed for 75 % conversion of 10 mol/hr. of a feed containing $\frac{2}{3}$ phosphine and $\frac{1}{3}$ inert.

6 + 6 = 12

Group – D

6. (a) A sample of tracer was injected as pulse to a reactor and the effluent concentration measured as a function of time. The results are in the following table. Construct C and E curves.

T (min)	0	1	2	3	4	5	6	7	8	9	10	12	14
C (g/cum)	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

(b) Explain the relation between F and E curves.

8 + 4 = 12

7. (a) Explain axial dispersion and degree of back mixing.

(b) Tracer data Given :-

T (min)	0	1	3	4	7	9	12	14
C (gm/m^3)	0	1	8	10	4	2.2	0.6	0.0

Determine the fraction of material leaving the reactor that has spent between 3 to 6 minutes in the vessel.

3 + 9 = 12

Group – E

8. (a) What are the different thumb rules for scale-up of reactors? What are their limitations and failures?

(b) Briefly describe about the working principles and applications of membrane bioreactor and photo bioreactor with schematic diagram.

(3 + 3) + 6 = 12

9. (a) Pure gaseous reactant A (C_{A0} = 100 millimol/liter) is fed at a steady rate into a mixed flow reactor (V = 0.1 liter) where it dimerizes (2A $\rightarrow$ R). For different gas rates the following data are obtained. Find a rate equation for this reaction.