ADVANCES IN BIORECTOR DESIGN, DEVELOPMENT & SCALE UP (BIOT5204)

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 alternatives for the following: 10 × 1 = 10

(i)   In the turbulent flow regime the relation between power number (P), impeller rotation rate (N_i) and impeller diameter (D_i) is
(a) $P \alpha N_i^3 D_i^5$ (b) $P \alpha N_i^2 D_i^4$ (c) $P \alpha N_i^4 D_i^3$ (d) $P \alpha N_i^2 D_i^4$

(ii)   In laminar flow regime the relation between power number (P), impeller rotation rate (N_i) and impeller diameter (D_i) is
(a) $P \alpha N_i^2 D_i^3$ (b) $P \alpha N_i^2 D_i^4$ (c) $P \alpha N_i^2 D_i^2$ (d) $P \alpha N_i^2 D_i^5$

(iii)   Margarine is a non-Newtonian fluid of the type
(a) Bingham plastic   (b) Casson plastic
(c) Pseudoplastic   (d) Dilatant

(iv)   The ratio of momentum and thermal diffusivity is called as
(a) Prandlt number   (b) Nusselt number
(c) Peclet number   (e) Schmidt number

(v)   Which law states mass flux is proportional to the concentration gradient?
(a) Newton's law   (b) Fick's law
(c) Fourier's law   (d) Planck's law

(vi)   Which of the reactor is a steady state reactor?
(a) Batch   (b) CSTR   (c) PFR   (d) Both (b) and (c)

(vii) The Monod equation explains
    (a) enzyme kinetics   (b) microbial growth kinetics
    (c) inhibition kinetics   (d) all of the above

(viii) In a CSTR, at steady state and for sterile feed,
    (a) $D = Y_{x/s}$ (b) $D = \mu_{max}$ (c) $D = K_s$ (d) $D = \mu$

(ix) Perfusion system is used in
    (a) plant tissue culture   (b) animal cell culture
    (c) bacterial culture   (d) fungal culture

(x) Dimension of mass transfer coefficient
    (a) LT^{-1} (b) T^{-1} (c) MLT^{-1} (d) MT^{-1}

Group – B

2. (a) Define Schmidt number and Prandtl number and prove both are dimensionless.
   (b) A 20 Lt. stirred fermenter containing a culture at 30 $^\circ$C is used for production of microbial insecticide. K_La is determined using the dynamic method. Air flow is shut off for a few minutes and the dissolved oxygen level drops, the air supply is then reconnected. When steady state is established, the dissolved-oxygen tension is 78% air saturation. The following results are obtained:

Time (Sec)	5	15
Oxygen tension (% air saturation)	50	66

    (i) Estimate K_La
    (ii) An error is made in determining the steady-state oxygen level which, instead of 78% is taken as 70%. What is the percentage error in K_La resulting from this 8% error in $\bar{C}_{AL}$?

                                                         6 + 6 = 12

3. A small reaction bomb fitted with a sensitive pressure-measuring device is flushed out and then filled with pure reactant "A" at one atm pressure. The operation is carried out at 25°C, a temperature low enough that the reaction does not proceed to any appreciable extent. The temperature is then raised rapidly to 100°C. The reaction is 2A⟶ B. The experimental data are given below :

T(min)	1	2	3	4	5	6	7	8	9	10	15	20
Pressure (atms)	1.14	1.04	0.98	0.94	0.90	0.87	0.85	0.83	0.82	0.80	0.75	0.73

Find rate equation which will satisfactorily fit the data.

                                                                      12

Group – C

4. (a) For the decomposition A→ R, $C_{A0} = 1$ mol/lit. , in a batch reactor conversion is 75% after one hour, and just complete after two hours. Find a rate equation to represent these kinetics.

(b) Find the conversion after one hour in a batch reactor for A→ R, $C_{A0} = 1$ mol/lit
$-r_A = 3 C_{A0}^{0.5}$ mol/lit. hr.

6 + 6 = 12

5. (a) In a fed-batch culture, 200 g/L glucose solution is added at a flow rate of 50 L/h. The initial culture volume (at quasi steady state) and the initial cell concentration are 600 L and 20 g/L, respectively. The yield coefficient (Yx/s) is 0.5 g cell mass/g substrate. What will be the cell concentration (g/L) at quasi steady state at t=8 h.

(b) A batch bioreactor is to be scaled up from 10 to 10,000 liters. The diameter of the large bioreactor is 10 times that of the small bioreactor. The agitator speed in the small bioreactor is 450 rpm. Determine the agitator speed (rpm) of the large bioreactor with same impeller tip speed as that of the small bioreactor.

6 + 6 = 12

Group – D

6. Write a short note on:
   (a) SSF bioreactor

   (b) Perfusion system

6 + 6 = 12

7. (a) Why bioreactors are used in animal cell culture?

(b) Describe different types of bioreactors used in animal cell culture.

2 + 10 = 12

Group – E

8. (a) Define pH,

(b) Explain operating principles of pH electrode.

(c)   What changes are required in a normal pH electrode if it is to be used for insitu sterilization and explain why changes are necessary?

2 + 6 + 4 = 12

9. (a)   Explain different types of controller used in bioprocesses.

(b)   Discuss the operating principles of each controller.

6 + 6 = 12