Group - E

8. (a) What do you understand by dissolved oxygen(D.O)?
   (b) Justify critical oxygen demand for aerobic fermentation.
   (c) Explain the basic science behind D.O measurement.

3 + 4 + 5 = 12

9. (a) What is bioprocess ? explain bioprocess with example.
   (b) Discuss the basic instrumentation required for a fermenter.

6 + 6 = 12

ADVANCES IN BIOREACTOR DESIGN,DEVELOPMENT & SCALE UP
(BIOT 5204)

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) For a sparingly soluble gas in an aerobic fermentation process the relation $\frac{1}{K_L} = \frac{1}{k_L} + \frac{1}{Mk_g}$ reduces to
   (a) $k_L=k_G$ (b) $K_L=0$
   (b) $K_L=k_L$ (d) $k_L=0$.

   (ii) The kinetics of vaccine production is based on the model of
   (a) growth associated (b) non-growth associated
   (c) a combination of (a) & (b) (d) Monod model.

   (iii) For mass transfer from air bubbles in aerobic fermentation, the relation $Sh = 2.0 + 0.60\ Re^{½}\ Sc^{1/3}$ is valid for
   (a) small Reynolds number (b) large Reynolds number
   (c) all Reynolds number (d) small Schmidt number.

   (iv) Cell suspension is a non-Newtonian fluid of the type
   (a) Bingham plastic (b) Pseudoplastic
   (c) Dilatant (d) Thixotropic.

   (v) For small substrate concentration Monod model behaves as a reaction of the type.
   (a) first order (b) zero order
   (c) second order (d) pseudo first order.

   (vi) Perfusion reactor is used for the production of
   (a) antibiotics (b) alcohol
   (c) monoclonal antibody (d) single cell protein.

(vii) The relative rates of bioconversion and diffusion in an immobilized cell system is given by
(a) Grashof number (b) Sherwood number
(c) Damkohler number (d) Peclet number.

(viii) The scale-up criteria for a CSTR to be used for animal cell culture is based on
(a) geometric similarity
(b) equal p/v ratio
(c) equal tip velocity
(d) equal impeller based Reynold's Number

(ix) The slowest specific growth rate (μ)has been observed for
(a) bacterial cells (b) fungi
(c) animal cells (d) plant cells.

(x) In the presence of diffusion limitation in immobilized cell systems
(a) $\eta>1$ (b) $\eta=1$
(c) $\eta=0$ (d) $\eta<1$.

Group - B

2. (a) The first-order reversible liquid reaction $A \rightarrow R$, $C_{A0} = 0.5$ mol/L, $C_{R0} = 0.0$ takes place in a batch reactor. After 8 minutes, conversion of A is 33.3 % while equilibrium Conversion is 66.7 % . Find the rate equation for this reaction.

(b) Derive rate equation for competitive inhibition (enzyme reaction) and show the result graphically.

6 + 6 = 12

3. (a) Derive an expression for cell concentration for a continuous culture in a chemostat operating at steady state and when $k_d=0$ and $q_P=0$.

(b) Pseudomonas sp has a mass doubling time of 2.4 hr when grown on acetate. The saturation constant using this substrate is 1.3g/L and cell yield on acetate is 0.46 g cell/g acetate. If we operate a chemostat on a feed stream containing 38 g/L acetate find the following:
(i) Maximum dilution rate
(ii) Cell concentration when the dilution rate is one-half of the maximum
(iii) Cell productivity when dilution rate is 0.8Dmax

5 + 7 = 12

Group – C

4. (a) Derive rate equation for nth. order reaction

(b) An aqueous feed of A and B (400 L/min, 100m mol A/L, 200 m mol B/L) is to be converted to products in a plug flow reactor (P F R). The kinetics of the reaction is represented by

$$A + B \rightarrow R, \quad -r_A = 200\, C_A\, C_B \text{ mol/ (L Min)}$$

Find the volume of reactor needed for 99.9 % conversion of A to product.

3 + 9 = 12

5. (a) Derive rate equation for autocatalytic reaction ?

(b) We plan to replace our present mixed flow reactor (M F R) with one having double the volume. For the same aqueous feed (10 mol A/L) and the same feed rate find the new conversion. The rate equation is given below.

$A \rightarrow R$, $-r_A = k\, C_A^{1.5}$ and present conversion is 70 %.

4 + 8 = 12

Group - D

6. (a) What do you understand by immobilization of cells?

(b) Glucose is converted to ethanol by immobilized yeast cells entrapped in gel beads. The specific rate of ethanol production is q_P= 0.2 g ethanol/g cells.h. The effectiveness factor for an average bead is 0.8. Each bead contains 50 g cells/L. The void volume in the column is 40%. Assume growth is negligible (all glucose is converted into ethanol). The feed flow rate is 500L/h, and glucose concentration in the feed is 150 g glucose/L. The diameter of the column is 1m and the yield coefficient is about 0.49 g ethanol/g glucose. The column height is 4m.
(i) What is the glucose conversion at the exit of the column?
(ii) What is the ethanol concentration in the exit stream?

2+ 10= 12

7. Write notes on :
(i)Perfusion system
(ii)Membrane bioreactor

(2 × 6) = 12