ADVANCES IN BIOREACTOR DESIGN, DEVELOPMENT AND SCALE UP
(BIOT 5202)

Time Allotted : 2½ hrs   **Full Marks : 60**

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
<u>any 4 (four)</u> from Group B to E, taking <u>one</u> from each group.*

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) If the rate is given as $-r_A = K\ C_A{}^{0.6}\ C_B{}^{0.4}$ then the molecularity and order of the reaction is
(a) 1 and 1   (b) 1 and 2
(c) 2 and 1   (d) 2 and 2

(ii) Amount of CO_2 produced per amount of O_2 consumed is known as
(a) Yield coefficient   (b) Respiratory quotient
(c) Degree of reduction   (d) maintenance coefficient

(iii) Cell suspension is a non-Newtonian fluid of the type
(a) Bingham plastic   (b) pseudo plastic
(c) dialant   (d) none of the above

(iv) Airlift fermenter is used for the production of
(a) alcohol   (b) penicillin G
(c) enzyme   (d) antibody

(v) Monoclonal antibodies are best produced in a reactor of the type
(a) CSTR without baffles   (b) air-lift reactor
(c) bubble column reactor   (d) hollow fiber reactor

(vi) When the cells grow on lysis products of the lysed cell, it is known as
(a) trans-substrate genesis   (b) cryptic growth
(c) diauxic growth   (d) dialism

(vii) The units of 1st. order rate constant is
(a) mole/lit. sec   (b) mole/sec
(c) 1/sec   (d) 1/mole

(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 impeller tip velocity   (d) equal impeller based Reynolds number (R_{eI})

(ix)   If the reaction rate doubles as the concentration of the reactant A increases by a factor of two, 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

(x)   Which of the following equation must be perfunctorily satisfied while dealing with fluid flow problems?
(a) Newton's third law   (b) Law of conservation of momentum
(c) Continuity equation   (d) Newton's second law.

Fill in the blanks with the correct word

(xi)   Kinetics of mixed growth linked product is studied using_____

(xii)   For zero order reaction if $C_A = 0$, t (time) will be _____.

(xiii) Doubling time is expressed as _____.

(xiv)   Monod model behaves as a reaction of _____ order for small substrate

(xv) $-r_A = (K_1 C_A)/(1 + K_2 C_A)$ From this rate equation At low C_A the reaction is of _____ order.

Group - B

2.   In the cultivation of Baker's yeast in a stirred and aerated tank, lethal agents are added to the fermentation medium to kill the organisms immediately. Increase in dissolved oxygen (DO) concentration upon addition of lethal agents is followed with the aid of a DO analyser and a recorder. Using the following data, determine the oxygen transfer coefficient ($k_l a$) for the reactor. Saturation DO concentration is $C^*=9mg/L$.

Time (min)	DO (mg/L)
1	1
2	3
2.5	4
3	5
4	6.5
5	7.2

[(CO1)(Calculate, Analyse/HOCQ)]
12

3.   The following date were obtained in a chemostat for the growth of *E. aerogenes* on a glycerol limited growth medium

D,h⁻¹, Dilution rate	0.05	0.1	0.2	0.4	0.6	0.7	0.8	0.84
S,mg/ml, glycerol concentration	0.012	0.028	0.05	0.1	0.15	0.176	0.8	9
X, mg/ml, cell concentration	3.2	3.7	4	4.4	4.75	4.9	4.5	0.5

$S_0 = 10mg/ml$
For this system estimate the values of K_s, μ_m, $Y^M_{x/s}$, maintenance coefficient(m_s).

[(CO1)(Calculate/HOCQ)]
12

Group - C

4. (a) Find the conversion after 60 minutes in a batch reactor for A $\rightarrow$ R , $-r_A = 3\, C_A^{1.5}$ (mole) / (litre. hr.) , $C_{A0} = 1$ mole/lit. *[(CO4)(Calculate/IOCQ)]*

   (b) Derive 1st order rate equation and show the result graphically in terms of C_A and X_A. *[(CO1)(Apply/IOCQ)]*

   6 + 6 = 12

5. (a) Liquid A decomposes by first-order kinetics, and in a batch reactor 45% of A is converted in a 5-minutes run. How much longer would it take to reach 85 % conversion? *[(CO2)(Analyse/IOCQ)]*

   (b) In a homogeneous isothermal liquid polymerization, 20 % of the monomer disappears in 34 minutes for initial monomer concentration of 0.04 and also for 0.8 mol/lit. What rate equation represents the disappearance of the monomer? *[(CO4)(Remember/IOCQ)]*

   6 + 6 = 12

Group - D

6. (a) Discuss the application of hollow fibre reactor. *[(CO5)(Remember)/LOCQ)]*

   (b) With the help of a clean diagram explain the operating principles of bubble column bioreactor (BCR). *[(CO5)(Remember)/LOCQ)]*

   6 + 6 = 12

7. (a) With the help of a schematic diagram explain the operating principles of Air-lift fermenter (ALF). *[(CO3)(Remember/IOCQ)]*

   (b) What do you understand by perfusion system? *[(CO5)(Remember/IOCQ)]*

   (c) Why perfusion system is suitable for animal cell culture? *[(CO5)(Remember/IOCQ)]*

   5 + 3 + 4 = 12

Group - E

8. (a) Why digital controller is essential for computer controlled fermenter? *[(CO6)(Analyse/HOCQ)]*

   (b) With the help of a clean diagram explain the functioning of galvanic oxygen electrode. *[(CO6)(Remember/LOCQ)]*

   4 + 8 = 12

9. (a) Explain the basic operating principles of pH meter. *[(CO6)(Understand/IOCQ)]*

   (b) How do you control the temperature and R P M in a bioreactor? *[(CO6)Understand/IOCQ)]*

   6 + (3 + 3) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	20.84	50	29.16