Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS / B.TECH (BT-NEW) / SEM-5 / BT-502 / 2010-11

2010-11

BIOREACTOR DESIGN & ANALYSIS

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

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

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :

$10 \times 1 = 10$

i) The unit of 1st order reaction when partial pressure will be used in place of concentration is

a) atm^{-2} b) $atm^{-2}time^{-1}$

c) $time^{-1}atm^{-1}$ d) $time^{-1}$.

ii) For completely mixed system, the dimensionless variance, $6\theta^2$, for E-curve due to pulse input is

a) 0 b) equal to 1

c) less than 1 d) infinity.

iii) The volumetric mass transfer coefficient, RLa, is related to

a) oxygen transfer

b) mass transfer unit

c) packed bed absorption

d) diffusion rate.

iv) Air lift fermenter may be designed on the basis of

a) plug flow

b) plug flow with dispersion

c) completely mixed system

d) segregated model.

v) The growth curve of animal cell culture has no stationary phase due to

a) exhaustion of substrate

b) presence of inhibitors

c) production of toxic metabolites

d) foam formation.

vi) Penicillin-G is best produced in a reacto of the type

a) CSTR with baffles

b) CSTR without baffles

c) fluidized bed

d) air lift fermenter.

vii) The best choice of a reactor for the production of Monoclonal antibodies is

a) Microcarrier

b) Microencapsulation

c) Hollow fiber reactor

d) Tubular membrane reactor.

viii) The most important scale-up criterion for an aerobic CSTR is

a) constant K_{la}

b) geometric similarity

c) hydrodynamic similarity

d) constant impeller based Reynolds member.

ix) The design interior of a chemostat is

a) residence time b) dilution rate

c) specific growth rate d) space time.

x) Damköhler number is a measure of

a) molecular diffusion

b) biochemical reaction

c) pore diffusion

d) combination of (a) and (b).

xi) Thiele modulus is a measure of

a) molecular diffusion

b) pore diffusion

c) chemical reaction

d) combination of (a) and (b).

xii) Power number varies with impeller based Reynolds number, Re_I for turbulent flow

a) varies inversely

b) varies directly

c) independent of Re_I

d) varies asymptotically.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Milk is pasteurized if it is heated to 63°C for 30 minutes, but if it is heated to 74°C it only needs 15 s for the same result. Find the activation energy of this sterilization process.

3. Describe the operation of perfusion reactor.

4. Liquid *A* decomposes by second order kinetics and in a batch reactor. 50% of *A* is converted in a 5 minute run. How much longer would it take to reach 75% conversion ?

5. Describe the operation of a bubble column bioreactor and develop a model if the oxygen transfer rate (k_{la}) is the controlling one.

6. Distinguish between a chemostat and turbidostat. Derive a model for a chemostat for sterile feed in terms of *D*, *X*, *S* & μ.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. A simple, batch fermentation of an aerobic bacterium growing on methanol gave the results shown in the table. Calculate :

a) Maximum growth rate (μ_{max})

b) Yield on substrate ($Y_{X/S}$)

c) Mass doubling time (t_d)

d) Saturation constant (K_S)

e) Specific growth rate (μ_{net}) at t = 10h

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

8. The elementary liquid-phase reaction

$$A + 2B \underset{k_2}{\overset{k_1}{\rightleftharpoons}} R$$

$-r_A = -1/2r_B = (12.5\ \text{liter}^2/\text{mol}^2.\text{Min})\, C_A C_B{}^2 - (1.5\,\text{min}^{-1})C_R$, [mol/liter.min]

is to take place in a 6-liter steady-state mixed flow reactor. Two feed streams, one containing 2.8 mol A/liter and the other containing 1.6 mol B/liter, are to be introduced at equal volumetric flow rates into the reactor, and 75% conversion of limiting component is desired. What should be the flow rate of each stream ? Assume a constant density throughout.

9. Write a short notes on

   a) Dispersion model

   b) Tank in series model 7½ + 7½

10. Substrate A and enzyme E flow through a mixed flow reactor (V=6 liter). From the entering and leaving concentrations and flow rate find a rate equation to represent the action of enzyme on substrate.

$$A..... \rightarrow 3R$$

$C_{E)}$ mol/liter	C_{A0} mol/liter	C_A mol/liter	v, lit/hr.
0.02	0.2	0.04	3.0
0.01	0.3	0.15	4.0
0.001	0.69	0.60	1.2

11. Write short notes on any *three* of the following :

a) Trickling filter for waste water treatment

b) Production of vaccine in a Roller bottle

c) Perfusion system for animal cell culture

d) Fluidized bed reactor for animal cell culture

e) Determination of K_{la} by the steady state method.

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