Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.TECH(BT)/SEM-2/MBT-202/2012

2012

BIOPROCESS ENGINEERING

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 the following : $5 \times 2 = 10$

   i) The plot of rate versus substrate concentration of an enzymatic reaction gives a section of rectangular hyperbola. The system represents a

      a) shifting order reaction

      b) first order reaction

      c) zero order reaction

      d) none of these.

ii) The maximum velocity (V_m) in Michaelis-Menten equation

a) is an intrinsic kinetic parameter

b) is not an intrinsic kinetic parameter

c) depends strongly on temperature

d) none of these.

iii) The Eadie-Hofstee plot gives slope equal to

a) V_m b) $\frac{V_m}{K_m}$

c) $-K_m$ d) $\frac{K_m}{V_m}$.

iv) Fed batch bioreactor is

a) an unsteady state reactor

b) a steady state reactor

c) an isothermal reactor

d) none of these.

v) The net effect of competition inhibition

a) is an increase in the maximum velocity

b) is a decrease in the maximum velocity

c) is an increase in the apparent Michaelis-Menten constant

d) is a decrease in the apparent Michaelis-Menten constant.

GROUP – B

(Short Answer Type Questions)

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

2. Derive the rate equation of a substrate uninhibited enzymatic reaction using steady state assumption of Briggs-Halden theory.

3. A fermentation industry wishes to produce a valuable biochemical by maintaining maximum rate of cell growth condition as far as possible. Starting with 15·5 mg/dm^3 of cells and 150 mg/dm^3 of substrate, the fermentation was carried out. The yield of cell was found to be 0·65 mg cell/mg substrate. The cell growth rate was reported to be $R_c = \frac{1 \cdot 2 C_A C_C}{C_A + 2}$ mg cells formed / hr. dm^3, where C_A and C_C are substrate and cell concentrations respectively. Find the maximum rate of cell growth that can be achieved at this condition.

4. Discuss the importance of enzyme inhibition study in pharmacology. How Eadie-Hofstee plot can be used to identify the nature of enzyme inhibition ?

5. Derive the performance equation of a Chemostat in terms of cell concentration and residence time used for carrying out a microbial fermentation reaction following substrate uninhibited Monod equation.

6. Discuss in detail the cell growth curve.

GROUP – C

(Long Answer Type Questions)

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

7. a) Discuss in detail the different methods used for evaluating the kinetic parameters of Michaelis-Menten equation. Why is direct data fit method superior to other methods ? 5 + 2

b) The following data have been obtained for two different initial enzyme concentrations for an enzyme-catalyzed reaction :

Substrate concentration (gm/litre)	20·0	10·0	6·7	5·0	4·0	3·3	2·9	2·5
Rate (g/l-min) with C_{E0} = 0·015 gm/litre	1·14	0·87	0·70	0·59	0·50	0·44	0·39	0·35
Rate (g/l-min) with C_{E0} = 0·00875 gm/litre	0·67	0·51	0·41	0·34	0·29	×	×	×

Find the intrinsic kinetic parameters of Michaelis - Menten equation by Hanes-Woolfs method. 8

8. a) Derive the performance equation of a batch fermenter used for carrying out an enzymatic reaction following Michaelis-Menten equation. 7

b) Reactant *A* decomposes in the presence of enzyme *E*. It is desired to design a batch fermenter for producing 2000 kg *R*/day from a feed containing C_{A0} = 1000 mol/m^3. The conversion of *A* is 90%. The plant should operate day and night and times for filling, cleaning and draining may be taken as 0·5 hrs. The molecular weight of *A* is 179 and the initial enzyme concentration is 10 gm/m^3. Find the volume of the reactor. The reaction is *A* = *R*. 8

9. Carbohydrate *A* decomposes in the presence of Enzyme *E*. We also suspect that the carbohydrate *B* in some way influences this decomposition. To study this phenomenon various concentrations of *A, B* and *E* flow into and out of a chemostat (V = 240 cm^3). From the data below find a rate equation for the decomposition and suggest a mechanism for this reaction.

Data :

C_{A0}, mol/m^3	C_A, mol/m^3	C_{B0}, mol/m^3	C_{E0}, mol/m^3	V_0, cm^3/min
200	50	0	12·5	80
900	300	0	5	24
1200	800	0	5	48
700	33·3	33·3	33·3	24
200	80	33·3	10	80
900	500	33·3	20	120

10. Sucrose is hydrolyzed in a batch reactor in presence of the enzyme sucrase as follows :

$$\text{Sucrose} \xrightarrow{\text{sucrase}} \text{product}$$

With C_{A0} = 1 mmol/litre and C_{E0} = 0·01 mmol/litre, the following data are obtained :

C_A, mmol/litre	0·84	0·68	0·53	0·38	0·27	0·16	0·09	0·04	0·018
Time, hr	1	2	3	4	5	6	7	8	9

Fit the Michaelis-Menten equation.

11. Write short notes on any *three* of the following : 3 × 5

a) Continuous sterilization of liquid media

b) Segregated model *vs* non-segregated model

c) Cell disruption

d) Substrate inhibition

e) Effect of external mass transfer on immobilized enzyme reaction.

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