B.TECH/CHE/6TH SEM/CHEN 3233/2018
BIOPROCESS ENGINEERING
(CHEN 3233)

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) The maximum velocity (V_m) in Michaelis- Menten equation is not an intrinsic constant since it contains

(a) initial concentration of substrate
(b) initial concentration of enzyme
(c) initial concentration of both substrate and enzyme
(d) none of the above.

(ii) The Hanse – woolf plot gives slope equal to

(a)V_m (b)V_m / K_m (c)$1/V_m$ (d)K_m / V_m.

(iii) From a plot of rate versus substrate concentration, K_m can be calculated using the formula

(a) $K_m = V_m/2$ (b) $K_m = 2V_m$
(c) $K_m = (V_m)^{0.5}$ (d) none of the above.

(iv) No diffusion limitation is observed in case of immobilized enzyme reaction system

(a) if K_m values for free and immobilized enzymes are same
(b) if V_m values for free and immobilized enzymes are same
(c) if both K_m and V_m values for free and immobilized enzymes are same
(d) none of the above.

(v) Yield coefficient of cells ($Y_{C/A}$) is constant

(a) during lag phase (b) during exponential phase
(c) during stationary phase (d) none of the above.

(vi) In order to avoid wash out of cells from a chemostat, kτ_m should be

(a) equal to unity (b) greater than unity
(c) less than unity (d)none of the above.

Where k = maximum specific cell growth rate and $\tau_m = residence$ time

(vii) The plot of rate versus substrate concentration of an enzymatic reaction following Michaelis Menten equation gives

(a) a section of rectangular hyperbola (b) a linear plot
(c) an irregular plot (d) none of the above.

(viii) The slope of of Lineweaver and Burk plot is equal to

(a) $1/V_m$ (b) $-1 / K_m$ (c) $- K_m$ (d) K_m / V_m.

(ix) Batch bioreactor is

(a) an unsteady state reactor (b) a steady state reactor
(c) an isothermal reactor (d) none of the above.

(x) 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

2. (a) Derive the rate equation of a substrate uninhibited enzymatic reaction using Michaelis – Mentane theory.

(b) 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

$RC = 1.2\ C_A C_C / (C_A + 2)$ mg cells formed / hr. dm^3

Find the maximum rate of cell growth that can be achieved at this condition.

6 + 6 = 12

3.(a) Deduce the initial slope of Michaelis-Menten equation and state how this can be used to determine the Michaelis-Menten constant (K_m) from rate versus substrate concentration plot

(b) Using Lineweaver and Burk plot find the rate equation of the following enzyme reaction:

Concentration of substrate (C_A), kmol/m^3	0.2	0.02	0.01	0.005	0.002
Rate of conversion of A, ($-r_A$), kmol/m^3-s	1.08	0.55	0.38	0.20	0.09

6 + 6 = 12

Group – C

4. (a) Distinguish between competitive inhibition and non competitive inhibition. Explain the graphical procedure by which they can be distinguished.

(b) Consider the aerobic production of a single extra cellular product

$CH_mO_n + aO_2 + bNH_3 \longrightarrow c\,CH_\alpha O_\beta N_\delta + d\,CH_xO_yN_z + eH_2O + f\,CO_2$

Find the degree of reduction of the substrate, biomass and product.

6 + 6 = 12

5. A strain of mold was grown in a batch culture on glucose and the following data were obtained

Time (h)	0	9	16	23	30	34	36	40
Cell concentration (g/l)	1.25	2.45	5.1	10.5	22	33	37.5	41
Glucose concentration (g/l)	100	97	90.4	76.9	48.1	20.6	9.38	0.63

Find the cell growth rate equation in gm cell formed/h-l

12

Group – D

6. (a) Derive the performance equation of a mixed flow reactor in terms of cell concentration and space time used for carrying out a microbial fermentation reaction following Monod equation and find the condition of wash out.

(b) A fermentation reaction having the following rate equation

$R_c = \frac{1.2C_AC_C}{C_A+2}$, C_A = gm substrate/m^3 and $Y_{C/A}$ = 0.1 gm cell/gm substrate

is carried out in mixed flow reactor of volume $5m^3$. Find the outlet concentration of cells produced for optimum operation when 1 m^3/h of substrate solution (C_{A0} = 6 gm/m^3) is fed to the reactor

6 + 6 = 12

7. (a) Find the concentration of substrate at the maximum rate of cell growth when the system follows Monod's equation.

(b) Show that the optimum residence time (τ_m) in chemostat with $C_{C_0} = 0$ is given by

$k\tau_m = \frac{N}{N-1}$ where $N^2 = \frac{K_S + C_{A_0}}{K_S}$. The system follows the Monods equation.

6 + 6= 12

Group – E

8. (a) Describe with the help of a neat diagram the working principle of tubular bowl centrifuge.

(b) The centrifugal separation of a biomass of 80μm sized cells of density 1.04 gm / cm^3 was carried out in a tubular centrifuge having a diameter of 15 cm and rotating at 1200 rpm. Calculate the residence time if the distance between the liquid surface and the axis of rotation was 0.8 cm, the liquid density and viscosity were 1.0 gm / $cm^3$and 0.013 gm/cm.s respectively.

7 + 5 = 12

9. (a) Classify different types of chromatographic techniques. Describe in details any one of them.

S (mg/cm^{-3})	0.139	0.089	0.066	0.047	0.037
C_a (mg/g)	0.03	0.026	0.0225	0.021	0.018

(b) Show that it follows Langmuir type adsorption isotherm

7 + 5 = 12