Code No: RR312303 **Set No. 1**

III B.Tech I Semester Regular Examinations, November 2006
BIO-CHEMICAL ENGINEERING
(Bio-Technology)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Define the following terms: order of a reaction, molecularity, elementary and non-elementary reactions.
   (b) Explain the term steady-state approximation ? [8+8]

2. Consider a 1000-litre CSTR in which Biomass is being produced with glucose as the substrate. The Microbial system follows a Monod relationship with μ_{Max}=0.4 hr^{-1}, K_s= 1.5 g/litre and the yield factor $Y_{x/s}$=0.5 g $\frac{g\,biomass}{g\,substrate}$ consumed. If Normal operation is with a sterile feed containing 10g/lit glucose at the rate of 100 lit/hr.
   (a) What is the specific Biomass production rate at steady state?
   (b) If Recycle is used with a recycle stream of 10 $\frac{lit}{hr}$ and a recycle biomass concentration five times as large as that in the reactor exit, what would be the new specific biomass production rate? [8+8]

3. Define Ideal Bioreactors? What are the conditions that contribute for their ideality, Explain different classes of Ideal bioreactors? [16]

4. A Reversible, first order reaction $A \underset{K_2}{\overset{K_1}{\longleftrightarrow}} R$ is carried out in a mixed flow reactor. When the temperature of operation was 300^0K, for a 60% conversion of A, the volume of the reactor was found to be 100 litres. Show that it is not possible to obtain a conversion of 60%. If the temperature of operation is 400^0K. Find the temperature of operation which would minimize the size of the mixed reactor for the same conversion and feed rate.
   Given $K_1 = 10^3$ e= $\frac{-4800}{RT}$; $\Delta C_P = C_P$R ? C_PA = 0.
   ΔH_r = -8 Kcal/mol at 300^0K.
   K = 10 at 300^0K. Feed is pure A and total pressure is constant. [16]

5. Qualitatively find the optimum temperature progression to maximize C_s for the Reaction scheme
   A→R→S→T
   Data E_1=10, E_2=25, E_3=15, E_4=10, E_5=20, E_6=25 [16]

6. The following data is obtained from a tracer test conducted in Non ideal reactor

Time(Sec)	10	20	30	40	50	60	70	80
C $\frac{Mol.s}{lit}$	0	3	5	5	4	2	1	0

(a) What fraction of the material is spent in the reactor between 20 and 50 sec?

(b) What fraction of the material is spent, less than the mean residence time of the reactor. [8+8]

7. Response measurements to a step-function input time are made for a reaction vessel.

Time Sec	0	15	25	35	45	55	65	75	95
Tracer g/cm^3 concn.	0	0.5	1.0	2.0	4.0	5.5	6.5	7.0	7.7

(a) Plot the R_{TD} Vs time

(b) What is the mean residence time for this flow rate? [8+8]

8. Explain in detail the stiochiometry involved in the cell growth? [16]

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Code No: RR312303

Set No. 2

III B.Tech I Semester Regular Examinations, November 2006
BIO-CHEMICAL ENGINEERING
(Bio-Technology)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
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1. Data on the effect of temperature on the reaction between ethanol and acetic acid are reported below. Find out the values of the constants in the Arrhenious equation. [16]

T^0C :	30	40	50	60	70
K lit/gmol-hr :	0.5	1.1	2.2	4.0	6.0

2. (a) Explain the significance of dissolved oxygen stat?
   (b) Explain the significance of PH stat? [8+8]

3. 100 liters/hr of Radio active fluid having a half life of 20 hr is to be treated by passing it through two ideal stirred tanks in series, V=40,000 liters each. In passing through the system how much has the activity decayed? [16]

4. Given the Reactions
   A + 2B → R $\quad r_R = K_1 C_A C_B^2 \quad$ with $K_2 = 2$K
   A + B → S $\quad r_S = K_2 C_A C_B$

   (a) What are the fractional yield expressions $\phi\left(\frac{R}{A}\right)$ and $\phi\left(\frac{R}{B}\right)$ for this reaction system.
   (b) How to operate a mixed reactor so as to maximize the production of R from a single feed consisting of $C_{AO} = C_{BO} = 1$. [8+8]

5. The Reversible first order Gas reaction $A \underset{2}{\overset{1}{\longleftrightarrow}} R$ is to be carried out in a mixed flow Reactor. For operations at 300 K, the volume of Reactor required is 100 liters for 60% conversion of A. What should be the volume of the reactor for the same feed rate and conversion but with operations at 400 K? [16]

   Date $\quad K_1 = 10^3\, e^{-\frac{2415}{T}}$

   $\Delta C_p = CP_R - CP_A = 0$

   $\Delta H_r = -8000\, Cal/mol\, at\, 300K$

   $K = 10\, at\, 300\, K$

   $Feed\, consists\, of\, Pure\, `A'\, total\, pressure\, stays\, cons\tan t$

6. Develop an expression for external age distribution of N number of equal sized back mixed reactor in series assuming tank in series model holds good. [16]

7. Discuss the Techniques employed in Diagnosing the ills of operating equipment with regard to Non ideal flow ? [16]

8. Explain in detail the stiochiometry involved in the cell growth? [16]

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Code No: RR312303 **Set No. 3**

III B.Tech I Semester Regular Examinations, November 2006
BIO-CHEMICAL ENGINEERING
(Bio-Technology)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Define the following terms: order of a reaction, molecularity, elementary and non-elementary reactions.
   (b) Explain the term steady-state approximation ? [8+8]
2. How cells grow in continuous culture and explain about specific devices for continuous culture? [16]
3. Explain CSTR designs for Enzyme catalyzed reactions with neat sketches? [16]
4. Reactant A in a liquid either isomerizes (or) dimerizes as follows
   A → R desired $r_R = K_1 C_A$
   A+A → S undesired $r_S = K_2 C_A^2$
   (a) Write ϕ (R/A) and $\phi\left(\frac{R}{R+S}\right)$ with a feed stream of concentration C_{AO} find C_{RMax} which can be formed
   (b) in a plug flow reactor
   (c) in a Mixed reactor. [4+6+6]
5. A tubular-flow reactor is to be designed for the production of butadiene from butene by the gas phase reaction
   $C_4H_8 \rightarrow C_4H_6 + H_2$
   The composition of the feed is 10 moles of steam per mole of butene and no butadiene. The hydrogen operates at 2 atmospheres pressure with an inlet (feed) temperature of 1200^0F. The reaction rate follows a first order, irreversible reaction for which the rate constant 'K' as a function of temperature is

T,K	922(1200^{0}F)	900	877	855	832
K	11.0	4.90	2.04	0.85	0.32

   $\left(K = \frac{\text{Im}\, ol\; Butene\, reacted}{(Hour\;/\;Liter)\, atm}\right)$

   The heat of reaction may be taken as constant and equal to ΔH_R=26360 cal/gmol. The specific heat of the feed stream may be regarded as constant and equal to 0.5 But/lb ^0R.
   What would be the volume required for a conversion of 20% if the reactor were operated isothermally at 1200^0F with a butene plus steam feed rate of 22 lb mol/hr. [16]

6. Develop an expression for external age distribution of N number of equal sized back mixed reactor in series assuming tank in series model holds good. [16]

7. A 12 m ? length of pipe is packed with 1 m of 2 mm material, 9m of 1 cm material and 2 m of 4 mm material. Estimate the variance in output c curve for this packed section if the fluid takes 2 min to flow through the section. Assume a constant bed voidage and a constant intensity of dispersion given by $\frac{D}{4dp}$=2. [16]

8. Explain in detail the stiochiometry involved in the cell growth? [16]

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Code No: RR312303

Set No. 4

III B.Tech I Semester Regular Examinations, November 2006
BIO-CHEMICAL ENGINEERING
(Bio-Technology)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Define the following terms: order of a reaction, molecularity, elementary and non-elementary reactions.
   (b) Explain the term steady-state approximation ? [8+8]

2. Pencillin is produced by P. Chrysogenum in a fed batch culture with the intermittent addition of glucose solution to the culture medium. The initial culture volume at quasi ? steady state is V_0=500 lit and Glucose containing nutrient solution is added with a flow rate of F=50 lit/hr. Glucose concentration in the feed solution and initial cell concentration are S_0=300 g/lit and X_0= 20 g/lit respectively. The kinetic and yield coefficients of the organism are μ_{max}=0.2 hr^{-1} K_s=0.5 g/lit and $Y_{x/s}$=0.3 g $\frac{dw}{g\,glu\cos e}$.
   (a) Determine the Culture volume at t=10hr.
   (b) Determine the concentration of glucose at t=10hr at quasi-steady state.
   (c) Determine the concentration and total amount of cells at quasi-steady state when t=10hr. [4+6+6]

3. (a) One liter/min of liquid containing A and B (C_{AO}=0.10 mol/liter, C_{B0}=0.01 mol/liter flow into a mixed Reactor of volume V=1 liter. The materials react in a complex manner for which the stiochiometry is unknown. The outlet stream from the reactor contains A, B, and C (C_{Af}=0.02 Mol/liter). Find the rate of reaction of A, B and C for the conditions with in the reactor?
   (b) Pure Gaseous Reactant A (C_{A0}=100 Milli Mol/liter) is fed at steady Rate into a mixed Reactor (V=0.1 liter) where it dimerizes (2A- - - R). For different gas feed rates the following data are obtained.

Run Number	1	2	3	4
V_0 lit./hr	30.0	9.0	3.5	1.5
C_A, out $\frac{Mil\lim ol}{Lit}$	85.7	66.7	50	33.3

   Find a Rate equation for this reaction. [4+12]

4. Equimolar quantities of A, B and D are continuously fed to a mixed flow reactor. The elementary reactions that proceed in the reactor are as follows:
   $A + D \xrightarrow{K_1} P$; $B + D \xrightarrow{K_2} Q$

   Given $K_1/K_2 = 0.2$, calculate the fraction of 'P' forced when

(a) 50% of A is consumed and

(b) 50% of D is consumed [8+8]

5. The reaction between sodium thiosulfate and Hydrogen peroxide in dilute acqueous solution is irreversible and second order in thiosulfate. The rate constant is the following function of temperature
K = 6.85 × 10^{-4} e $\frac{-18300}{RT}$ Cm^3 / moles sec
Reaction stiochiometry indicates that 2 moles of H_2O_2 react with one mole of N$a_2S_2O_3$. The heat of reaction at 25^0C is ΔH_R = -131000 cal/gmol
Reactor volume = 2790 cm^3
Feed temperature = 25^0C
Feed Rate = 14.2 cm^3/s
Consider Adiabatic operation and feed concentration of 2.04×10^{-3} gmol/cm^3 and 4.08×10^{-4} gmol/cm^3 of thiosulfate and H_2O_2 respectively. What would be the conversion and temperature in the reactor effluent? [16]

6. Develop an expression for external age distribution of N number of equal sized back mixed reactor in series assuming tank in series model holds good. [16]

7. (a) The concentration readings in table given below represent a continuous response to a delta function input into a closed vessel which is to be used as a chemical reactor. Plot the exit age distribution E.

Time(Min)	0	5	10	15	20	25	30	35
Tracer output conce.I/lit.	0	3	5	5	4	2	1	0

(b) The vessel of above problem is to be used as a reactor for a liquid decomposing with rate ?r_A=K_{CA}. K=0.307 min^{-1}. Find the fraction of reactant unconverted in the real reactor and compare with the fraction unconverted in a plug flow reactor of the same size. [8+8]

8. Explain in detail the stiochiometry involved in the cell growth? [16]

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