Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

V SEMESTER B.TECH (BIOTECHNOLOGY)

END SEMESTER EXAMINATIONS, NOV/DEC 2015 (REGULAR)

SUBJECT: BIOPROCESS AND BIOREACTION ENGINEERING (BIO 311)

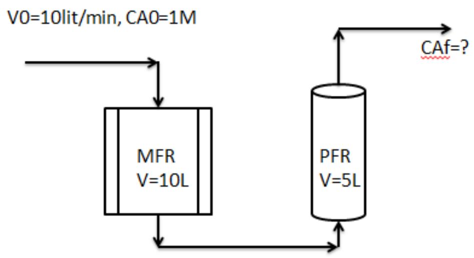
REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** the questions.
- Missing data may be suitable assumed.

1A.	Give any two differences between Integral and differential method of analysis that are used for interpretation of batch reactor data.	**2**
1B.	How do you define the reaction rate for the following two situations i. Homogeneous reaction system of hydrolysis of sucrose in a shake flask ii. Heterogeneous reaction system of hydrolysis of sucrose in an immobilized packed bed bioreactor	**3**
1C.	Derive the final integrated expression which can be used for fitting the experimental data of the following irreversible second order reaction taking place in a constant volume batch reactor. Reaction: 2A + B $\rightarrow$ Product If C_{B0}= 2.5 M, C_{A0}=1 M are taken for kinetics study of the above reaction and it has been found that 75 % of the reactant is converted in 9 min. Find the reaction rate constant ? If the same reaction is performed by taking C_{B0}= 1 M, C_{A0}=2 M then find the time required for 90% conversion in the constant volume batch reactor.	**5**
2A.	A zero order gas reaction 2A $\rightarrow$ 3R proceeds in a batch reactor with 20% inerts and 10% R at a constant pressure. Prove that fractional change in volume as $\left[1 - e^{\left(KRT.\frac{t}{2\pi o}\right)}\right]$	**4**
2B.	A biochemical product is produced using Pseudomonas species in a batch fermenter. It was found that the reaction follows the first order elementary series reaction type: A $\rightarrow$R$\rightarrow$S, K_1=1 day^{-1}, K_2=2 day^{-1}. In the above series reaction it was found that R is the desired product and S is the undesired product. Two researchers John and Reed have conducted the fermentation reaction for 1.5 days and 0.9 days respectively with initial substrate concentration of 10 M. Find the amount of desired product formed in both the	**6**

	cases. Comment on the amount of downstream processing they need to involve in both the cases to purify the product. If they want to minimize the undesired product (S) and maximize the desired product (R) , suggest how they need to carry out the above series reaction?	
3A.	At 600 K the reversible gas reaction $C_2H_4 + Br_2 \leftrightarrow C_2H_4Br_2$ has rate constants K_1=500 liter/mol.hr, K_2=0.032hr^{-1}. If a MFR is to be fed 600 m^3/h of gas containing 60% Br_2 and 30% C_2H_4 and 10% inerts by volume at 600 K and 1.5 atm compute i. The maximum possible fractional conversion of C_2H_4 into $C_2H_4Br_2$ ii. The volume of reaction vessel required to obtain 60% of this maximum conversion.	**6**
3B.	Write on the various accessories needed for the operation of laboratory Chemostat with cell culture? How do plan your laboratory Chemostat to operate at steady state?	**4**
4A.	An aqueous feed of A and B (400 liter/min, 100 mmol A/liter, 200 mmol B/liter) is to be converted to product in a plug flow reactor. The kinetics of the reaction is represented by A + B → R, *k*=200 liter/mol.min $$-r_A = kC_AC_B \frac{mol}{liter.\text{min}}$$ Find the volume of reactor needed for 99.9% conversion of A to product	**5**
4B.	A particular biochemical liquid product is produced in a cascade reactor system of MFR + PFR as shown in the fig 1. The substrate concentration at 1 M, v0=10 lit/min is pumped into the MFR of volume 10 liters. Then the reaction mixture is sent through the PFR of 5 liters capacity. Reaction system follows the 2nd order kinetics with K=1 liter/gmole.min. Find the conversion of the substrate at the exit of cascade reactor system 	
5A.	Write on the advantages of recycle reactor in bioprocess industries. Write the design equations of Recycle reactor for constant volume and General case. Represent these design equations graphically.	**4**
5B.	In the presence of a specific enzyme E, Which acts as a homogeneous catalyst, a harmful organic A present in industrial waste water degrades into harmless chemicals. At a given enzyme concentration C_E tests in a laboratory mixed flow reactor give the following results We wish to treat 0.1 m^3/min of this waste water having C_{A0} = 10 mmol/m^3 to 90% conversion with this enzyme at concentration C_E i. One possibility is to use a long tubular reactor (assume plug flow) with possible recycle of exit fluid. What design do you recommend? Give the size of the reactor, tell if it should be used with recycle and if so determine the recycle flow rate. Sketch your recommended design. ii. What arrangement of plug flow and mixed flow reactor would you use to minimize the total volume of the reactors needed? Sketch your recommended design and show the size of the units.	**6**

C_{A0}, mmol/m^3	2	5	6	6	11	14	16	24
C_{Af}, mmol/m^3	0.5	3	1	2	6	10	8	4
τ, min	30	1	50	8	4	20	20	4

6A.	Write on: i. Macro and Micro fluids ii. Calculation of conversion for Macro fluid with zero order kinetics	**5**
6B.	A step input to a non-ideal bioreactor gives the results shown the following fig. If the data is consistent determine: (i)Bioreactor volume (V) (ii) Mean residence time (iii) F-curve (iv) E-curve	**5**