Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

V SEMESTER B.TECH (BIOTECHNOLOGY)

END SEMESTER EXAMINATIONS, NOV/DEC 2017 (REGULAR)

SUBJECT: BIOREACTION ENGINEERING (BIO 3104)

REVISED CREDIT SYSTEM

Time: 3 Hours (24/11/2017) MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A.	The irreversible reaction A + B =AB has been studied kinetically, and the rate of formation of product has been found to be well correlated by the following rate equation $r_{AB}=KC_B^2$ independent of C_A. What reaction mechanism is suggested by this rate expression if the chemistry of the reaction suggests that the intermediate consists of an association of reactant molecules and that a chain reaction does not occur?	**4**
1B.	What do you mean by shifting order reactions? How do find the kinetics in the following shifting order reactions i. Shift from low to high order as the concentration drops ii. Shift from high to low order as the concentration drops	**4**
1C.	Explain: Molecularity and order of the reaction	**2**
2A.	A zero order gas reaction 2A $\rightarrow$ 3S proceeds in a batch fermenter with 20% inerts and 10% S at a constant pressure. Prove that fractional change in volume is equal to $[1-EXP(KRT.t/\pi_0]$, where R=Gas constant, K=rate constant, $\pi_{0=}$ Total pressure at t=0, T=temperature, t=time	**4**
2B.	Substrate A decomposes in a batch fermenter as follows: A $\rightarrow$ P. The composition of A in the fermenter is measured at various times with the results shown in the following table. Find the rate equation to represent the kinetic data using differential method of analysis	**6**
3A.	Hydrolysis of sucrose is carried out in an immobilized invertase enzyme packed bed bioreactor system in series that behaves like a PFR. The multiple reactor system consists of a number of Perspex columns with each 5cm diameter and Length=75 cm in series. The substrate sucrose (S_0=4M) is pumped at 0.1 L/min at entrance of the reactor system. The enzyme catalyzed reaction follows the substrate inhibition kinetics. Find the volume of the reactor to achieve 60% conversion at steady state. Also find the number	**5**

Time, min	0	20	40	60	120	180	300
CA, M	10	8	6	5	3	2	1

<table>
<tr><td></td><td>of tubes required to achieve this conversion with above specifications.

Substrate inhibition kinetics: $-rs = \dfrac{Vm.S}{(Km + S + \dfrac{S^2}{KI})}$ moles/liter.min
Kinetics data: V_m=0.028 M/min, K_m=0.23 M, K_I=0.2 M</td><td></td></tr>
<tr><td>3B.</td><td>Prove that N equal size mixed reactor in series behaves like a PFR system when N→∞ for first order kinetics.</td><td>5</td></tr>
<tr><td>4A.</td><td>At present we have 90% conversion of a liquid feed (n = 1, C_{A0} = 10 mol/liter to plug flow reactor with recycle of product (R = 2). If we shut off the recycle stream, by how much will this lower the processing rate of the feed to the same 90% conversion ?</td><td>4</td></tr>
<tr><td>4B.</td><td>We wish to explore various reactor setups for the transformation of A into R. The feed contains 99% A, 1% R; the desired product is to consist of 10% A, 90% R. The transformation takes place by means of the elementary reaction A + R → R + R With rate constant k = 1 liter/mol.min. The concentration of active materials is $C_{A0} + C_{R0} = C_A + C_R = C_0$ = 1 mol/liter throughout. What reactor holding time will yield a product in which C_R = 0.9 mol/liter (a) in a plug flow reactor, (b) in a mixed flow reactor, and (c) in a minimum-size setup without recycle?</td><td>6</td></tr>
<tr><td>5A.</td><td>Write on: (i) Washout dilution rate (ii) Optimum dilution rate</td><td>2</td></tr>
<tr><td>5B.</td><td>The concentration readings in the following table represents a continuous response to a pulse input into a closed vessel which is to be used as a bioreactor. The liquid decomposes with the rate $-r_A=KC_A$, K=0.307 min^{-1}. Find the fraction of the material unconverted in the real reactor. Also Draw the E(θ) curve

RTD data:

<table>
<tr><td>Time, min</td><td>0</td><td>5</td><td>10</td><td>15</td><td>20</td><td>25</td><td>30</td><td>35</td></tr>
<tr><td>Tracer concentration, g/l</td><td>0</td><td>3</td><td>5</td><td>5</td><td>4</td><td>2</td><td>1</td><td>0</td></tr>
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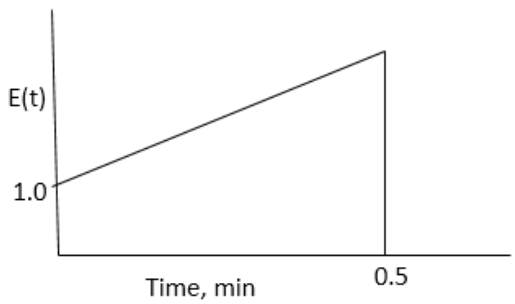
</td><td>5</td></tr>
<tr><td>5C</td><td>A macro fluid reacts according to A → R as it flows through a non-ideal bioreactor. Find the conversion of macro fluid A for the following flow pattern and kinetics.
Kinetics: C_{A0}=2 mol/liter, $-r_A=KC_A^2$, K=2 liter.mol^{-1} min^{-1}

 
</td><td>3</td></tr>
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