Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

V SEMESTER B.TECH (BIOTECHNOLOGY)

END SEMESTER EXAMINATIONS, NOV/DEC 2016 (REGULAR)

SUBJECT: BIOREACTION ENGINEERING (BIO 3104)

REVISED CREDIT SYSTEM

Time: 3 Hours (3/12/2016) MAX. MARKS: 50

Instructions to Candidates:

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

<table>
<tr><td>1A.</td><td>With the suitable examples explain the parameters affecting the rate reaction in homogeneous and heterogeneous reaction system</td><td>4</td></tr>
<tr><td>1B.</td><td>The secondary metabolites (P and Q) are produced using <i>Bacillus</i> species in submerged fermentation process. The following mechanism has been proposed.
$A \Leftrightarrow P + Q^*$
$Q^* \rightarrow R^* + S$
$R^* + Q^* \rightarrow 2P$
A is a substrate, P and S are metabolic products and R*& Q* are intermediates. Prove that above proposed mechanism is consistent with and can explain the observed first order decomposition of substrate A.</td><td>4</td></tr>
<tr><td>1C.</td><td>Write the type of the intermediates generally proposed in kinetic modelling</td><td>2</td></tr>
<tr><td>2A.</td><td>A zero order homogeneous gas reaction $A \rightarrow \gamma R$ proceeds in a constant-volume batch reactor, $\pi=1$ when t=0 and $\pi=1.5$ when t=1 hour. If the same reaction, same feed composition and initial pressure proceeds in a constant pressure setup, find V at t=1 if V=1 at t=0</td><td>5</td></tr>
<tr><td>2B.</td><td>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</td><td>5</td></tr>
<tr><td>3A.</td><td>The following data are obtained at 0ºC in a constant-volume batch reactor using pure gaseous A. The stoichiometry of the decomposition is A → R. Find a rate equation which satisfactorily represents this decomposition
<table>
<tr><td>Time, min</td><td>0</td><td>2</td><td>4</td><td>6</td><td>8</td><td>10</td><td>12</td><td>14</td><td>∞</td></tr>
<tr><td>Partial Pressure of A, mm</td><td>760</td><td>600</td><td>475</td><td>390</td><td>320</td><td>275</td><td>240</td><td>215</td><td>150</td></tr>
</table></td><td>6</td></tr>
</table>

3B. A plug flow reactor ($2m^3$) processes an aqueous feed (100 liter/min) containing reactant A (C_{A0}=100 mmol/liter). This reaction is reversible and represented by $A \Leftrightarrow R$ $-r_A = (0.04\ min^{-1})\ C_A - (0.01\ min^{-1})\ C_R$. First find the equilibrium conversion and then find the actual conversion of A in the reactor.

4

4A. The Kinetics of the aqueous-phase decomposition of A is investigated in two mixed flow reactors in series, the second having twice the volume of the first reactor. At steady state with a feed concentration of 1 mol A/liter and mean residence time of 96 sec in the first reactor, the concentration in the first reactor is 0.5 mol A/liter and in the second is 0.25 mol A/liter. Find the kinetic equation for the decomposition

4

4B. We wish to treat 10liters/min of liquid feed containing 1 mol A/liter to 99% conversion. The stoichiometry and kinetics of the reaction are given by

$$A \rightarrow R, \qquad -r_A = \frac{1C_A}{0.2 + C_A} \frac{mol}{liter\,.\min}$$

Suggest a good arrangement for doing this using two mixed flow reactors, and find the size of the two units needed. Sketch the final design chosen

6

5A. Chemostat of 1000 liters capacity is used for the production biomass using glucose as the substrate. The microbial system follows a Monod growth kinetics with μ_m = 0.4 h^{-1}, K_S = 1.5 g/l and the yield factor $Y_{X/S}$ = 0.5 g biomass/g substrate consumed. The sterile feed containing 10g/l substrate is pumped at 100 L/h to the chemostat.

i. Determine the substrate and biomass concentrations at steady state
ii. Estimate the washout dilution rate

3

5B. The following data were obtained from a non-ideal bioreactor during the RTD experiment using NaCl as the tracer material. Calculate

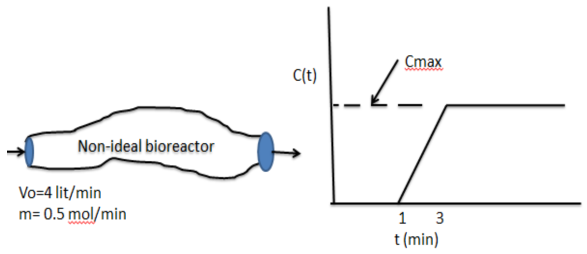
i. The mean residence time of fluid in the bioreactor
ii. Draw the E (θ) vs θ curve

RTD data:

Time (min)	0	5	10	15	20	25	30	35
Tracer conc. (g/l)	0	3	5	5	4	2	1	0

4

5C A step input to a non-ideal bioreactor gives the results shown the following fig. If the data is consistent determine: (i) F-curve (ii) E-curve



3