Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

VI SEMESTER B.TECH (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, MAY 2016

SUBJECT: CHEMICAL REACTION ENGINEERING 2 [CHE 306]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 100

Instructions to Candidates:

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

1A. A pulse study was performed on a real reactor. A first order reaction A → R is carried out in this reactor of dia. 10 cm and length 2 m. The specific reaction rate is 0.1 min^{-1}. Calculate conversion using a) Tank in series model; b) PFR; c) Single CSTR. **15**

t (s):	0	1	5	10	15	20	25	30	35	40	50	60	80
C_A (mg/L)	0	0.25	0.38	0.55	0.58	0.51	0.39	0.22	0.11	0.05	0.02	0.01	0.0

1B. **a).** If an impulse and later a step input is given to an ideal PFR, CSTR and a non-ideal reactor. How different will the input and output for each of them be? (Explain using conc. vs. time plots).

b). Say we have a tubular reactor, which upon analysis revealed non-ideality due to dispersion (not dead zones). But the conversion obtained from the application of the present Dispersion model did not fully explain the non-ideality. Explain with logical reasons. **5**

2. Derive an expression for concentration and effectiveness factor for a 1st order irreversible reaction A → products. Where diffusion is taking place in a cylindrical pore. **20**

3A. Say a reaction A + 2B → 2C + D is conducted in an adiabatic CSTR, what is the reactor volume and space time necessary to achieve 35% conversion of A? The reaction rate is first order in *A* and second order in B. **15**

Data:

ΔH_R = - 370.1 kJ/mol	T_O = 303 K
Cp_A = 84.5 J/(mol K)	F_{AO} = 10 mol/min
Cp_B = 137 J/(mol K)	F_{BO} = 30 mol/min
Cp_C = 170 J(mol K)	v_0 = 1000 L/min
Cp_D = 75 J/(mol K)	C_{AO} = 0.01 mol/L

$k = 0.090 \exp [(40\ kJ/mol)/R\ (1/303 - 1/T)]\ (L/mol)^2\ (min)^{-1}$

3B. Derive an expression for heat load for a non-isothermal continuous flow reactor. **5**

<table>
<tr><td>4A.</td><td>With a neat sketch relate time and conversion for a spherical particle of constant size, when the controlling resistance is diffusion through the ash layer.</td><td>10</td></tr>
<tr><td>4B.</td><td>Find an interim rate expression for the following catalytic reaction when surface reaction is controlling. A → B. Include the inhibition step.</td><td>10</td></tr>
<tr><td>5A.</td><td>Calculate the BET surface area per gram of solid for a sample, using the full BET equation and the one-point BET equation (where the constant is assumed to be a very large value). Are the values same? What is the BET constant?
<table>
<tr><td>P/P_O</td><td>0.02</td><td>0.03</td><td>0.04</td><td>0.05</td><td>0.1</td><td>0.15</td><td>0.2</td><td>0.25</td><td>0.3</td></tr>
<tr><td>Vol. adsorbed (cm^3/g)</td><td>23.0</td><td>25.0</td><td>26.5</td><td>27.7</td><td>31.7</td><td>34.2</td><td>36.1</td><td>37.6</td><td>39.1</td></tr>
</table></td><td>15</td></tr>
<tr><td>5B.</td><td>Explain with a neat diagram, the SCM and PCM models.</td><td>5</td></tr>
<tr><td>6A.</td><td>In a number of separate runs different concentrations of substrate and enzyme are introduced into a batch reactor and allowed to react. After a certain time the reaction is quenched and the vessel contents analyzed. From the results found below find a rate equation to represent the action of enzyme on substrate.
<table>
<tr><td>Run</td><td>$C_{E0,}$ mol/m^3</td><td>C_{A0}, mol/m^3</td><td>C_A, mol/m^3</td><td>t, hr</td></tr>
<tr><td>1</td><td>3</td><td>400</td><td>10</td><td>1</td></tr>
<tr><td>2</td><td>2</td><td>200</td><td>5</td><td>1</td></tr>
<tr><td>3</td><td>1</td><td>20</td><td>1</td><td>1</td></tr>
</table></td><td>12</td></tr>
<tr><td>6B.</td><td>Write a note on Multiple Steady States.</td><td>8</td></tr>
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