BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION)

CLASS: BE **SEMESTER: V**
BRANCH: CHEMICAL & POLYMER/CHEMICAL **SESSION : MO/2018**

SUBJECT : CL5005 REACTION ENGINEERING

TIME: 1.5 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The total marks of the questions are 30.
2. Candidates may attempt for all 30 marks.
3. In those cases where the marks obtained exceed 25 marks, the excess will be ignored.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. The missing data, if any, may be assumed suitably.

Q1 (a) What is conversion and extend of reaction. Explain their properties. [2]

(b) Pure gas A at 830 kPa enters a reactor with a volumetric flow rate of 2 liter/second at 500K. Calculate molar flow rate of A at the reactor outlet for 90% conversion. Assume the reactant and product gases behave ideally. [3]

Q2 (a) Why plug flow reactor is called an ideal reactor? [2]

(b) A homogeneous gas phase reaction is taking place in a plug flow reactor (PFR). What size of PFR operating at 649°C and 460 kPa can produce 80% conversion of feed consisting of 40 mol/hr of pure M. The reaction stoichiometry and kinetics is as follows. [3]

$$\mathbf{4M\ (g) \rightarrow R(g) + 6S(g)} \qquad \mathbf{(-r_M) = (10\ hr^{-1})C_M}$$

Q3 (a) The first-order reversible liquid phase reaction takes place in a batch reactor as given below. [2]

$$\boldsymbol{A \leftrightarrow R}, \qquad \boldsymbol{C_{A0} = 0.5 \frac{mol}{liter};\ C_{R0} = 0}$$

After 8 minutes, conversion of A is 33.3% while equilibrium conversion is 66.7%. Derive the design equation for this system.

(b) Find complete rate expression for this system. [3]

Q4 (a) What types of reactor or reactor combination are suitable for auto catalytic reaction. Explain graphically. [2]

(b) Consider the following autocatalytic reaction (C_{A0} = 2 mol/liter) taking place in a recycle reactor. [3]

$$A \rightarrow R\ ; \qquad (-r_A) = C_A C_R \frac{mol}{liter.min}$$

For 96% conversion of A, find the optimum recycle ratio for which the reactor will have minimum size.

Q5 (a) Consider the following series reaction taking place in a PFR. [2]

$$\boldsymbol{A \overset{k_1}{\rightarrow} R\ (desired) \overset{k_2}{\rightarrow} S}$$

Derive the expression for the concentration profile of R in term of C_{A0}, k_1, k_2 and τ.

(b) What will be the maximum concentration of R. [3]

Q6 (a) Define yield and selectivity for complex reaction systems. [2]

(b) Consider the following reaction taking place in a PFR. [3]

$$A + B \rightarrow R\ (desired) + S\ (undesired);$$

$$\frac{dC_R}{dt} = C_A^{1.5} C_B^{0.3} \frac{mol}{liter.min}$$

$$\frac{dC_S}{dt} = C_A^{0.5} C_B^{1.8} \frac{mol}{liter.min}$$

For 90% conversion of A find the concentration of R in the product stream. Equal volumetric flow rates of A and B streams are fed to the reactor. Each stream has a concentration of 20 mol/liter.

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