*Second Examination: March 9, 2005; 12:55 PM – 1:45 PM*
**Total – 100 points**

1. A liquid-phase reaction $A + 2B \rightarrow C$ is taking place in a semi-batch reactor. The reaction is begun with 84 moles of A in the reactor. The initial reactor volume is 50 liters. B is added at a volumetric rate of 2 lit/min and a concentration of 10 mol/lit. The reaction is assumed to be zero order with respect to both A and B. The rate constant $k$ is $0.125 \frac{\text{mol}}{\text{lit-min}}$. How much time does it take to reach a conversion of 50% A? What is the concentration of B at this time?

   20 points

2. A series reaction $A \xrightarrow{\text{1st order}} B \xrightarrow{\text{Zero order}} C$ is taking place in a CSTR. Derive the concentrations of A and B as functions of residence time $\tau$, the rate constants ($k_1$ and $k_2$) and the initial concentration of A ($C_{A0}$). Assume that the concentrations of B and C in the reactor entrance stream are zero.

20 points

3. Determine the composite rates of reaction for all of the species in the following reaction sequence.

$$A \underset{k_2 - \text{ First order}}{\overset{k_1 - \text{First order}}{\rightleftharpoons}} B \xrightarrow{k_3 - \text{ First order}} C$$

$$2A \xrightarrow{k_4 - \text{ Second order}} D$$

16 points

4. Measured concentrations in a constant-volume batch reactor are tabulated. Determine the order of the reaction and the rate constant.

| t (mins) | 0 | 5 | 13 | 20 | 30 |
|---|---|---|---|---|---|
| Ca (mol/lit) | 5 | 0.93 | 0.41 | 0.27 | 0.18 |

22 points

5. The following first-order reaction is taking place in a PBR.

$$A \rightarrow B$$

The reaction rate and the rate constant are given by:

$$-r_A' = kp_A \quad \frac{\text{mol}}{\text{kg cat-h}}$$

$$k = 0.75 \frac{\text{mol}}{\text{atm-kg cat-h}}$$

A is fed to the reactor with 50% inerts at $327^0$C and 1 atmosphere. Feed rate of A is 37.5 moles/h. The pressure drop parameter $\alpha = 0.0045\,\text{kg}^{-1}$. Obtain an expression that relates the conversion in the reactor to the weight of the catalyst used. What conversion can you obtain with 100 kg of the catalyst?

22 points