FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI
SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY (SEET)
DEPARTMENT OF CHEMICAL ENGINEERING
Session: 2017/2018 Rain Semester Examination.
Course Code: CHE302; Course Title: Chemical Engineering Reaction and Kinetics; Time: 3 hours

Instructions: ***Answer any FIVE questions*** (Universal gas constant: 8.314 J/mol. K)

1. (a) Explain the integral method of analysis for the interpretation of batch reaction data.
(b) Use the integral method of analysis to derive an equation in terms of conversion to show that an irreversible chemical reacjkyition of the form: $2A \rightarrow Products$, follow a second order kinetics.

2. (a) Discuss the importance of chemical kinetics in the design of a chemical reactor.
(b) Use the data below to predict the order of reaction of hydrolysis of a simple sugar in aqueous solution at 298K. Determine the reaction rate constant.

Time (min)	0	60	130	180	240	300
Concentration (mol/dm^3)	1.00	0.81	0.63	0.53	0.43	0.35

3. Pure gaseous reactant A (C_{AO} = 100 millimol/liter) is fed at a steady rate into a mixed flow reactor (V = 0.1 liter) according to the reaction equation: $3A \rightarrow R$. For different gas feed rates, the following data are obtained:

Run number	1	2	3	4
v_o, liter/hr	10.0	3.0	1.2	0.5
C_{Af}, millimol/liter	85.7	66.7	50	33.4

Find a rate equation for this reaction.

4. (a) At present, 95% of reactant A is converted into product by a second order reaction in a single mixed flow reactor. We plan to place a second reactor similar to the one being used in series with it.
(i) For the same treatment rate as that used at present, how will this addition affect the conversion of reactant?
(ii) For the same 95% conversion, by how much can the treatment rate be increased?

(b)The reactor set-up below consists of three plug flow reactors in two parallel branches. Branch A has a reactor of volume 50 liters. Branch B has a reactor of volume 30 liters followed by a reactor of volume 60 liters. What fraction of the feed should go to branch A?

5. (a) The kinetics of the irreversible reaction S + R → T has been studied and it has been found to follow the rate equation: $r_T = kC_R^2$. In an attempt to find the reaction mechanism, the following model has been proposed:

$$2S \underset{k_2}{\overset{k_1}{\rightleftharpoons}} S_2^*$$

$$S_2^* + R \underset{k_4}{\overset{k_3}{\rightleftharpoons}} S + T$$

Check if the proposed mechanism matches the rate equation
(b) The reaction A → R is carried out in a batch reactor at two different temperatures. At 300K $-r_A = 1.4p_A^2$, at 350K $-r_A = 1.5p_A^2$. Assuming A is an ideal gas; find the activation energy of the reaction ($R = 82.06 cm^3 atm K^{-1} mol^{-1}$)

6. (a) Analyse the relationship between thermodynamics and chemical kinetics
(b) Briefly discuss the catalytic behavior of nitric oxide toward ozone
(c) Explain heterogeneous catalysis using hydrogenation of ethylene as example