TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES

DEPARTMENT OF PURE AND APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN APPLIED CHEMISTRY (INDUSTRIAL OPTION)

BTAC 12S SEPT 2012

ACH 4409 REACTOR DESIGN

END OF SEMESTER EXAMINATION

SERIES:

TIME:2 HOURS

DATE:

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of FIVE questions. Attempt Question one compulsory and any other two question

Do not write on the question paper.

Paper Two

QUESTION ONE

A. If a reaction's rate constant at 298K is $33M^{-1}s^{-1}$ and $45M^{-1}s^{-1}$ at 675K, calculate the activation energy Outline significant of Arrhenius equation **5 marks**

B. What is the Gibbs free energy change at the transition state when ΔH at the transition state is 34 kJ/mol and ΔS at transition state is 66 J/mol at 334K **5 marks**

C. derive performance equation for a mixed flowStirred tank reactor **8 marks**

D. 1L/minutes of liquid contain A and B (C_{AO} = 0.1mol/L, C_{BO} = 0.01mol/L) flow into mixed reactor of volume V = 1L. Outlet stream from reactor contains A, B, and C (C_{AF} =

0.02mol/L), C_{BF} = 0.03mol/L and C_{CF} = 0.04) find the rate of reaction of A, B, C for conditions within reactor. **6 marks**

E. Explain operational difference between Trickling bed reactors and fixed bed reactor **6 marks**

QUESTION TWO

A. Outline Some important aspects of the Plug flow Reactor **6 marks**

B. Describe factors to be consider while designing chemical reactor **6 Marks**

C. distinguish between space-time and space velocity **4 marks**

D. Derive differential rate equation for plug flow reactor **4 marks**

QUESTION THREE

A. The rate of disappearance of Nitrogen is 1.5 X 10^{-4} moles sec^{-1} L^{-1}.Calculate rate of formation of ammonia Reaction $0.5N_2(g) + 1.5H_2(g) \rightleftharpoons 2NH_3(g)$ **4 mark**

B. explain operational difference between Batch reactor and continuous reactor **5 marks**

C. with the aid of a diagrams explain the operation of semi batch reactor **5 marks**

D. Show that the half-life (t ½) of a reaction with respect to reactant A is given by the expression: where n = order of reaction, K = specific rate constant CAO = initial concentrationof A **6 marks**

$$In\, t_{1/2} = (1-n)InC_{Ao} + In\left[\frac{2^{n-1}-1}{K(n-1)}\right]$$

QUESTION FOUR

A. Use Algorithm methode to write the net rate law of specis A and C in the following multiple reaction taking place in plug flow Reactor.

I $A + B \rightarrow C$

II $2A + 3C \rightarrow 2D$ **5 Marks**

A. The rate constants of a reaction at 500K. and 700K are $0.02s^{-1}$ and $0.07s^{-1}$ respeetively calculate the activation energy. **4 marks**

A. Pure gaseous A (C_{AO} = 100millimol/Litre) is fed at steady rate into a mixed reactor (V = 0.1 litre) where it dimerises by reaction 2A - R.for different feed rates the following data were obtain .determine fractional conversion and rate of reaction for each run and hence rate equation for this reaction **11 marks**

Run no	1	2	3	4
V_o L/hr	30	9.0	3.6	1.5
$C_{A,\,out}$ Millimol/L	85.7	66.7	50	33.3

QUESTION FIVE

A. Define the following term as used in chemical reaction kinetics

i. Rate law

ii. Residence Time Distribution **4 Marks**

B. Define product selectivity and explain how to increase yield **3 marks**

C. Data for Reaction A -R operated in a batch reactor is given below . How long must we react each batch for concentration to drop from C_{AO} = 1.3 to C_{AF} = 0.3mol/Litre **13 Marks**

C_A Mol/L	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.3
r_A Mol/L.min	0.1	0.3	0.5	0.6	0.5	0.75	0.1	0.6	0.05	0.045