



# TECHNICAL UNIVERSITY OF MOMBASA

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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.**

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## Paper Two

### QUESTION ONE

- If a reaction's rate constant at 298K is  $33\text{M}^{-1}\text{s}^{-1}$  and  $45\text{M}^{-1}\text{s}^{-1}$  at 675K, calculate the activation energy. Outline significant of Arrhenius equation **5 marks**
- What is the Gibbs free energy change at the transition state when  $\Delta H$  at the transition state is 34 kJ/mol and  $\Delta S$  at transition state is 66 J/mol at 334K **5 marks**
- derive performance equation for a mixed flow Stirred tank reactor **8 marks**
- 1L/minutes of liquid contain A and B ( $C_{AO} = 0.1\text{mol/L}$ ,  $C_{BO} = 0.01\text{mol/L}$ ) flow into mixed reactor of volume  $V = 1\text{L}$ . Outlet stream from reactor contains A, B, and C ( $C_{AF} =$

0.02mol/L),  $C_{BF} = 0.03\text{mol/L}$  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  $1.5 \times 10^{-4}$  moles  $\text{sec}^{-1} \text{L}^{-1}$ . Calculate rate of formation of ammonia Reaction  $0.5\text{N}_2(\text{g}) + 1.5\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$  **4 mark**

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

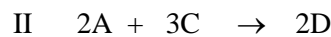
C. with the aid of a diagrams explain the operation of semi batch reactor **5 marks**

D. Show that the half-life ( $t_{1/2}$ ) of a reaction with respect to reactant A is given by the expression: where  $n$  = order of reaction,  $K$  = specific rate constant  $C_{AO}$  = initial concentration of A **6 marks**

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

### 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.



**5 Marks**

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

A. Pure gaseous A ( $C_{AO} = 100\text{millimol/Litre}$ ) is fed at steady rate into a mixed reactor ( $V = 0.1$  litre) where it dimerises by reaction  $2\text{A} \rightarrow \text{R}$ .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  $C_{AF} = 0.3\text{mol/Litre}$  **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
$t_A$ Mol/L.min	0.1	0.3	0.5	0.6	0.5	0.75	0.1	0.6	0.05	0.045

