(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

FOURTH YEAR FIRST SEMESTER
SUPPLEMENTARY/SPECIAL EXAMINATIONS

FOR THE DEGREE

OF

BACHELOR OF SCIENCE (INDUSTRIAL CHEMISTRY)

COURSE CODE: SCI 461

COURSE TITLE: REACTOR DESIGN

DATE: 29/07/2022 **TIME:** 8.00-10.00 am

INSTRUCTIONS TO CANDIDATES

Answer all the Questions

TIME: 2 Hours

QUESTION 1 (20 MARKS)

a) What is the general mole balance equation **(1 Mark)**

b) From the general mole balance equation, derive the algebraic equation for CSTR i.e. $V = (Fjo - F_j)/-r_j$. Mention exactly how each assumption applies in the logical progression from the starting equation to this final equation. **(4 Marks)**

c) Which assumptions must you make so as to derive the plug-flow design equation i.e.

$$V = \int_{F_{A1}}^{F_{A0}} \frac{dF_A}{-r_A}$$

, from the general mole balance equation? **(2 Marks)**

d) Differentiate between initial reaction rate and instantaneous reaction rate (**4 Marks**).

e) Briefly describe a continuous stirred tank reactor **(5 marks)**

f) Discuss the advantages and disadvantages of the batch reactor **(4 Marks)**

Question 2 (15 Marks)

a) The reaction A + B ⟶ C takes place in a plug flow reactor. Derive the individual molar balances for A, B, and C in the PFR.
(5 Marks)

b) An isomerization occurs as per the following equation: A ⟶ B. It occurs in a CSTR at a temperature of 200K and pressure of 8 atm. The initial flow rate is 0.4 molData obtained from the reaction are in the table below. Calculate the volume necessary to achieve a conversion of 60%. **(4 Marks)**

X	$-r_A(mol/m^3s)$
0	0.45
0.1	0.37
0.2	0.30
0.4	0.195
0.6	0.113
0.7	0.079
0.8	0.05

c) Suppose the reactor in use in the previous question was a PFR. Determine the volume of the PFR necessary to achieve a conversion of 80%. **(6 Marks)**

Question Three (20 Marks)

a) Show that for a CSTR, $F_A = F_{A0}(1 - X)$ where nA is the molar flow rate of A Show also that $V = F_{A0}X/(-rA)$exit **(6 marks)**

b) State three factors that are considered during the design of reactors **(3 marks)**

c) A liquid phase first order reaction A B is carried out in an isothermal continuous flow reactor with an entering volumetric flow rate of $10dm^3/h$. Calculate both the CSTR and PFR reactor volume necessary to consume 99% of A| when the entering molar flow rate is 5 mol/h, assuming that the reaction rate is $-r_A = kC_A$ with $k = 0.0001s^{-1}$ **(11 marks)**

Question Four (15 Marks)

a) What is meant by the term conversion? Give its formula **(3 Marks)**

b) List four factors that affect reaction rate **(4 marks)**

c) Derive the design equation for a packed bed reactor **(6 Marks)**

d) When designing a CSTR, what assumptions are usually made? **(2 Marks)**