Registration No : | | | | | | | | | | |

Total number of pages : 02 **B.Tech**

PCE5I103

5th Semester Regular/Back Examination 2018–19

CHEMICAL REACTION ENGINEERING

BRANCH : CHEM

Time : 3 Hours

Max Marks : 100

Q.CODE : E484

Answer Question No.1 (Part-I) which is compulsory, any EIGHT from Part-II, and any TWO from Part-III.

The figures in the right-hand margin indicate marks.

Assume suitable notations and any missing data wherever necessary.

Answer all parts of a question at a place.

Part – I

Short Answer Type Questions (Answer All TEN)

Q1 **Answer the following questions :** **(2 x 10)**

a) Name different ways of defining the rate of reaction.

b) For non-elementary reactions, there is a difference between order and stoichiometric coefficients. Justify the statement.

c) Draw a plot showing the temperature dependency of rate.

d) Whenever we have to use CSTRs in series, the overall economic consideration would always recommend the use of equal size CSTRs in series. Why so?

e) What is the significance of Damkohlernumber?

f) A high concentration of reactant favours the reaction of higher order. Comment on the statement.

g) Differentiate between CSTR and batch reactors.

h) Write the design equation for steady-state mixed flow reactor.

i) Phosphine decomposes when heated according to the reaction: 4 PH_3 (g) $\rightarrow$ P_4 (g) + 6 H_2 (g).
At a given instant, the rate at which phosphine decomposes is $2.4x10^{-3}$mol/l.s.Express the rate in three different ways, using differential notation and show the relationship between them.

j) What is Oswald's isolation method?

Part – II

Focused-Short Answer Type Questions(Answer Any EIGHT out of TWELVE)

Q2 **Answer the following questions :** **(6 x 8)**

a) Compare transition state theory with collision theory.

b) A gas A, decomposes irreversibly to form a gas C as per the reaction: A $\rightarrow$ 2C.The decomposition of A is first order reaction which is carried out in an isothermal constant pressure batch reactor. Derive an expression for the volume of the system as function of time. Assume that the reacting gases behave ideally.

c) With suitable examples explain in details the variable and constant volume reactors.

d) Explain the basics of non-ideal flow.

e) Explain the relationship between the F and E curves.

f) The concentrations of a compound undergoing chemical change were 5.72, 3.23, and 1.96 at the times 0, 20, and 50 min from the commencement of reaction. Suggest about its order of reaction.

g) In an isothermal batch reactor 70 % of a reactant A is converted in 13 minutes. Find the space time and space velocity needed to effect this conversion in a plug flow reactor and in a mixed flow reactor.

h) Give a qualitative description of product distributions in chemical reactions.

i) Explain in details mean residence time.

j) Differentiate between order and molecularity with suitable examples.

k) At 500 K the rate of a bimolecular reaction is 10 times the rate at 400 K. Find the activation energy for this reaction from Arrhenius law and collision theory.

l) Consider a gas phase reaction: 2A = R + 2S with unknown kinetics. If for 90 % conversion of A in a plug flow reactor, the space velocity of 1/min is needed, find the corresponding space time and mean residence time or holding time of a fluid in the reactor.

Part – III

Long Answer Type Questions (Answer Any TWO out of FOUR)

Q3 A homogeneous liquid phase reaction: $A \rightarrow S$, $-r_A = k(C_A)^2$ takes place with 50 % conversion in a mixed reactor. **(16)**

a) What will be the conversion if this reactor is replaced by another mixed flow reactor having volume 6 times that of the original reactor? All else remainsunchanged.

b) What will be the conversion if the original reactor is replaced by a plug flow reactor of same size? All else remain unchanged.

Q4 Discuss the product distribution in case of irreversible first order reaction followed by zero order reaction. **(16)**

Q5 At present the elementary liquid phase reaction: **(16)**

$$A + B \rightarrow R + S$$

takes place in a plug flow reactor using equimolar quantities of A and B. Conversion is 96 %. $C_{AO} = C_{BO} = 1$ mol/l.If a mixed reactor ten times as large as plug flow reactor were hooked up series with the existing unit, which unit should come first and by what fraction could the production be increased for that set-up?

Q6 Derive the integrated rate equation for irreversible bimolecular type second order reaction with $C_{Ao} \neq C_{B0}$ in terms of conversion. **(16)**