

**INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR**

**Date:** September, 2016 FN/AN, **Time :** 2 Hrs **Full Marks :** 30, **Deptt.** Chemical Engineering

**No. of Students :** 87

**Mid Autumn Semester Examination**

**Subject No :** CH31009

**Subject Name :** Reaction Engineering

**3<sup>rd</sup> Yr. B. Tech.(H)/M.Tech(Dual)**

**Instructions :** Attempt all questions. Assume the missing parameters.

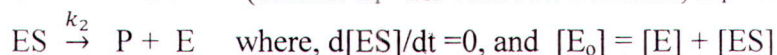
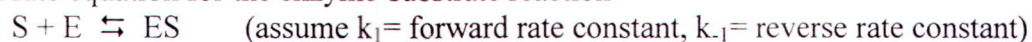
**PART-A**

Q1. Answer the following questions.

(a) For the stoichiometry  $A + B \rightarrow R$ , find the reaction order with respect to A and B if

$C_A$	2	2	3
$C_B$	125	64	64
$-r_A$	50	32	48

(b) Derive a rate equation for the enzyme-substrate reaction



$[E_0]$  represents the total enzyme and  $[E]$  represents the free unattached enzyme. [2+3]

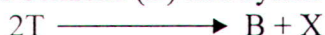
Q2. The gas phase reaction  $A + 2B \rightarrow 2D$  is to be carried out in an isothermal plug-flow reactor at 5.0 atm. The feed contains 20 mole% of A, 50 mole% of B and rest inerts.

(a) Set up a stoichiometric table for the above reaction and express the concentration of each species of the reaction as a function of conversion.

(b) How large must the plug-flow reactor be to achieve a conversion (based on A) of 0.70 if the feed temperature in the reactor is uniform (55°C), the volumetric feed rate is 50 dm<sup>3</sup>/min and the rate equation at 55°C is  $-r_A = 2.5C_A^{1/2}C_B \text{ kmol}/(m^3 \cdot \text{min})$  [4+6]

**PART-B**

Q3. (a) Toluene (T) disproportionation reaction on zeolite catalyst surface at vapour phase produces benzene (B) and xylene (X) by the following reaction:



The surface reaction is irreversible in nature. Assuming reaction as rate controlling step, deduce the rate law and show the nature of relation between initial rate and toluene concentration. The reaction is not influenced by mass transfer resistance.

(b) Which rate kinetics are you following in this deduction? [(3+1)+2=6]

Q4. (a) Derive the expression of mass flux of A for the following mass transfer limited reaction,



Considering the reaction is happening with resistance to the external mass transfer to a solid catalyst and surface reaction is rate controlling.

(b) Explain properly how the rate of the above type of reaction is dependent on the velocity of the reactant and particle size of the catalyst. [3+6=9]