UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, April/May 2018

Course: Chemical Reaction Engineering II **Semester: VI**
Program: B.Tech. CE+RP
Time: 03 hrs. **Max. Marks: 100**

Instructions: (i) This question paper has three sections- A, B and C. All questions of each section are compulsory. (iii) Attempt all the sub-parts of a question together.

SECTION A (20 Marks)

S. No.		Marks	CO
Q 1	Explain the steps involved in heterogeneous reaction with any example.	**5**	**CO5**
Q 2	How does catalyzed reaction change with energy of reacting particles?	**5**	**CO4**
Q 3	Discuss heat effects during solid catalyzed reactions.	**5**	**CO5**
Q 4	Derive the Langmuir adsorption isotherm expression for dissociative adsorption.	**5**	**CO3**

SECTION B (60 Marks)

Q 5	What is effectiveness factor? Derive a relationship between effectiveness factor and Thiele Modulus for first order reaction.	**12**	**CO4**
Q 6	The catalytic reaction $A \longrightarrow 4R$ Is run at 3.2 atm and 117°C in a plug flow reactor which contains 0.01 kg of catalyst and uses a feed consisting of the partially converted product of 20 liters/hr of pure unreacted A. the results are as follows: (see table below)	**12**	**CO 5**
Q 7	Gaseous reactant A diffuses through a gas film and reacts on the surface of a solid according to a reversible first -order rate, $-r_A = k(C_{As} - C_{Ae})$ Where C_{Ae} is the concentration of A in equilibrium with the solid surface. Develop an expression for the rate of reaction of A accounting for both the mass transfer and reaction steps.	**12**	**CO 2**
Q 8	The following data on an irreversible reaction are obtained with decaying catalyst in a	**12**	**CO 5**

Table for Q 6:

Run	1	2	3	4
C_{Ain}, mol/liter	0.100	0.08	0.060	0.040
C_{Aout}, mol/liter	0.084	0.070	0.055	0.038

batch reactor (batch-solids, batch-fluid). Determine the kinetics of reaction and deactivation from the following data:

CA	1.000	0.802	0.675	0.532	0.422	0.363
T, hr	0	0.25	0.5	1	2	(∞)

Q 9 The concentration reading in given table represents a continuous response to a pulse input in a closed vessel and is well represented by the dispersion model. Calculate the vessel dispersion number D/uL. The C versus t tracer response of this vessel is: [12]

t, min	0	5	10	15	20	25	30	35
C_{pulse}, gm/lit	0	3	5	5	4	2	1	0

Marks: **12** | **CO1**

SECTION-C (20 Marks)

Q 10 (a). The oxidation of methanol to formaldehyde in presence of solid oxide catalyst was studied with a recycle. The rate of circulation of the mixture (with a pump) was much higher than feeding rate and removal of product. The following reaction takes place:

$$CH_3OH + 0.5\,O_2 \longrightarrow CH_2O + H_2O$$
$$CH_2O + 0.5O_2 \longrightarrow CO + H_2O$$

$$CH_2O + 0.5O_2 \longrightarrow CO + 2H_2O$$

The gas flow rate was 10 liters/hr, catalyst volume = 5 cm^3, C_{Ao} = 6.5 by volume, overall conservation 98% and yield of formaldehyde as 0.9%. Calculate the rate constants for both the reactions in presence of catalyst.

(b) In the case of catalyst decaying, it is practiced to feed with the new catalyst to keep the level of activity constant. The relation between conversion, activity of catalyst and catalyst weight is given by

$$W = \frac{FAo * XA}{-rA} = \frac{FA0 * XA}{\acute{a}\, ko\, CA^n}$$

Where, $\acute{a}$, represents mean activity in the reactor. Determine the mean activity for first order decay in C.S. T. R.

Marks: **20** | **CO4**