Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2018

Course: Chemical Reaction Engineering I **Semester: V**
Programme: B.Tech. CERP **Course Code: CHEG333**
Time: 03 hrs. **Max. Marks: 100**

i) **Instructions: Exchange of calculators not allowed.**
ii) **Make necessary assumptions**

SECTION A (20 Marks)

S. No.		Marks	CO
Q 1	In case of a first reaction, show that the times required for 75% conversion is double the time required for 50% conversion in a batch reactor.	5	CO1
Q2	A first order reaction is to be treated in a series of two mix reactors. Show that the total volume of the two reactors is minimum when reactors are of equal size.	5	CO4
Q3	Derive the process design equation for Mixed Flow reactor.	5	CO3
Q4	Compare the Integral and Differential method of analysis for analyzing reaction kinetics data.	5	CO2

SECTION B (60 Marks)

Q 5	A reversible reaction A↔B is taking place in a PFR. The equilibrium constant (in terms of concentrations) is 4. 50% of the equilibrium conversion is obtained. A CSTR of equal size is placed downstream of the PFR (PFR-CSTR) to increase conversion. What is the total conversion in the reactor sequence with this arrangement?	12	CO4
Q6	The reversible (elementary) reaction 2A ⇔ C+ D is conducted in a CSTR at a feed rate of 100 liters/min with an inlet concentration C_{Ao}=1.5 mols/lit. The specific rate in the forward direction is 10 lit/mol-min and the equilibrium constant is 16. 80% of the equilibrium conversion is required. Find the size of a CSTR to achieve this conversion.	12	CO2
Q7.	Derive the relationship between total pressure of system and partial pressure of reactants for the isothermal gas phase reaction carried out in a constant volume system.	12	CO3
Q8	A series reaction $A \xrightarrow[\text{1st order}]{} B \xrightarrow[\text{Zero order}]{} C$ is taking place in a CSTR. Derive the Concentrations of A, B and C as functions of residence time τ , the rate constants k_1 and k_2) and the initial concentration of A (C_{Ao}). Assume that the concentrations of B and C in the reactor entrance stream are zero.	12	CO2
Q9	The conversion of an irreversible first-order, liquid-phase reaction, taking place in a PFR of 500 liter capacity is 50%. In order to increase conversion, a 300 liter CSTR	12	CO3

is installed upstream of (before) the PFR. What is the exit conversion in the new system?

SECTION-C (20 Marks)

Q 10

The liquid-phase irreversible reaction A $\rightarrow$ B is carried out in a CSTR. To learn the rate law, the residence time, τ is varied and the effluent concentrations of species A are measured. Pure A enters the reactor at a concentration of 7.5 mol/liter in all the runs given below.

Run	1	2	3	4
T (min)	1	15	30	100
$C_{A,}$ (mol/liter)	3.2	0.72	0.46	0.21

a. Write the mole balance for the CSTR where an nth order equation is taking place (in terms of concentrations and residence time).
b. Show how you will plot the above data to obtain a straight line, and thus determine the reaction order (n) and reaction rate constant k.
c. Plot the data on the paper provided and find n and k by the method you describe in step b.

20

CO5