Name:	
Enrolment No:	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Sem Examination, May 2023

Programme Name: B. Tech in Chemical Engineering (Refining and Petrochemicals) **Semester : VI**
Course Name : Chemical Reaction Engineering II **Time : 3 hr**
Course Code : CHCE 3004 **Max. Marks : 100**
Nos. of page(s) : 3

Instructions: The exam will be an OPEN BOOKS and OPEN NOTES exam. The students are allowed to access all textbooks, photocopied, handwritten notes, and laptop.

Please make necessary assumptions and mention them whenever and wherever necessary. Please read every question very carefully before attempting.

SECTION A [40]

S. No.		Marks	CO
Q1.	You, as an engineer for a firm, have been asked to design a reactor. The reaction A → Product is elementary and has the rate constant k. You have designed the reactor and fabricated it and have performed the step RTD with data as given below.		

Time (min)	F(t)
0*t	0*f
0.1*t	0.001*f
0.22*t	0.02*f
0.32*t	0.12*f
0.42*t	0.28*f
0.53*t	0.48*f
0.62*t	0.64*f
0.7*t	0.76*f
0.81*t	0.84*f
1.1*t	0.9*f
1.31*t	0.94*f
1.52*t	0.97*f
2.12*t	0.99*f

Here,

t = Last TWO digits of your ROLL NUMBER

f = Last TWO digits of your ROLL NUMBER / Last THREE digits of your SAP ID

The MS-Excel sheet must be sent to the email ID nbanerjee@ddn.upes.ac.in, with the following file name Roll number_End sem.

	a) Calculate the three moments for the curves	**[10]**	**CO1**
	b) Calculate the "Vessel dispersion number" and the "Number of tanks" needed in series	**[5]**	**CO2**
	c) Based on the calculations in part a) and b) note down your observations and analyze your inferences with detailed reasoning and assumptions.	**[5]**	**CO3**
	d) What conversion will you expect if you are using the tank-in-series model to calculate the conversion? Will it be different if you change the model? Give reasons for your answer. Here **k = 0.017*Last THREE digits of the SAP ID.**	**[5]**	**CO4**
	e) What volume of CSTR and PFR will you be requiring if you are to achieve the above conversion? The molar flowrate for the system will be 10 kmol/min and the initial concentration of A is 150 kmol/m^3.	**[15]**	**CO5**
SECTION B [35]			
Q2.	Now that you have successfully designed the reactor for the above reaction, your boss wants you to perform a catalytic reaction in the above reactor. In the catalytic reaction is as follows $$A (g) + B(g) + C(g) \rightarrow R(g) + P (g)$$ The reaction proceeds as follows. a) Gases A and B get adsorbed on the surface of the catalyst. b) The adsorbed A and B reacts with C (g) (Still in the gas phase) to give product R and P. c) R and P desorbs in the gas phase.		
	a) Develop the reaction mechanism for the above steps using the Langmuir principles. Please mention all the assumptions.	**[5]**	**CO1**
	b) Develop the rate equation if the system is reaction rate controlled.	**[10]**	**CO2**
	c) What will be the rate equation if the system is controlled by the desorption of R.	**[10]**	**CO2**
	d) Derive the rate equation if the Adsorption of A controls the overall rate.	**[10]**	**CO2**
SECTION C [25]			
Q3.	On successful completion of the above two projects, you have now been asked to work on determining the time required to convert the solid ZnS particles to 80% of their original concentration on reacting with 0.08 mol/cm^3 of oxygen. On experimentation you observed that the particle size remains unchanged. The data are as follows: Density of the solid = 5.02 g/cm^3 Reaction rate constant = 1.28 cm/sec The ash layer diffusion coefficient = 0.06 cm^2/sec Initial particle size = 2 mm		

	a) Calculate the time required for 80% conversion of the solid when the reaction rate and film mass transfer diffusion is instantaneous.	**[10]**	**CO4**
	b) What will be the time required for complete conversion if the initial particle size is halved of its original size.	**[5]**	**CO4**
	c) You suddenly realize that the ash is flaking out from the surface of the solid particle. The system is now reaction controlled. Calculate the conversion of the reaction if you run the reaction for the time calculated in part a).	**[10]**	**CO4**