Name:

Enrolment No:

UPES

End Semester Examination, December 2023

Course: Chemical Reaction Engineering I — **Semester: V**
Program: B. Tech Chemical Engineering — **Time: 03 hrs.**
Course Code: CHCE3004 — **Max. Marks: 100**

Instructions: This is an <u>OPEN BOOK, OPEN NOTES, AND OPEN RESOURCE</u> examination. The students are allowed to carry any <u>TEXTBOOKS, HANDWRITTEN AND PHOTOCOPIED NOTES, AND LAPTOP</u>.

Please read all the questions carefully. Take and mention all necessary assumptions.

SECTION A (100 marks)

S. No.		Marks	CO
	You and your supervisor are working in an ethylene plant. Both of you feel that there is something wrong with the current process. Your supervisor gives you the kinetic data set given below and asks you to check for the kinetic equations that can be used for reactor design.		

The reaction follows the following stoichiometry

$$2C_2H_4 + O_2 \rightarrow 2C_2H_4O$$

$$2A + B \rightarrow 2C$$

t (min)	C_A (kmol/m^3)	C_B (kmol/m^3)
0*T	1*Cao	1*Cbo
0.01*T	0.99*Cao	0.870*Cbo
0.02*T	0.91*Cao	0.740*Cbo
0.03*T	0.83*Cao	0.610*Cbo
0.04*T	0.76*Cao	0.480*Cbo
0.05*T	0.68*Cao	0.350*Cbo
0.06*T	0.60*Cao	0.220*Cbo
0.07*T	0.52*Cao	0.090*Cbo
0.08*T	0.44*Cao	0.083*Cbo
0.09*T	0.37*Cao	0.076*Cbo
0.10*T	0.29*Cao	0.068*Cbo
0.11*T	0.21*Cao	0.061*Cbo
0.12*T	0.13*Cao	0.054*Cbo

	Here, **T = Last THREE digits of your SAP ID (min)** **Cao and Cbo = Last TWO digits of your ROLL NUMBER ($kmol/m^3$)**		
Q1.	What will be the rate law for the above kinetic data? Choose your methodology with justification. Mention all the necessary assumptions taken.	**15**	**CO2**
Q2.	Note your observations from Q1 and analyze your conclusions with detailed reasoning and assumptions.	**15**	**CO1**
Q3.	Based on the above kinetic equations, your supervisor wishes you to choose for the best reactor arrangements from below to meet the required conversion if the molar flowrates for A and B are 10 kmol/min and 12 kmol/min respectively. i) One CSTR (97% conversion) ii) PFR (40% conversion) + PFR (30% conversion) + CSTR (27% conversion) [in series] iii) PFR (40% conversion) + CSTR (30% conversion) + PFR (27% conversion) [in series] iv) CSTR (40% conversion) + PFR (30% conversion) + PFR (27% conversion) [in series] Give proper justification for your choice.	**20**	**CO4**
Q4.	Your supervisor is happy with your findings and reactor design. However, you realized that the design is based on ideal conditions and the reactor that you have in the plant will have non-ideal conditions. To identify the same you did tracer RTD analysis with pulse input and received the following data		

t (min)	C (g/min)
0*T	0*Ci
0.1*T	0.18*Ci
0.2*T	0.98*Ci
0.3*T	1.10*Ci
0.4*T	1.90*Ci
0.5*T	3.90*Ci
0.6*T	4.00*Ci
0.7*T	2.60*Ci
0.8*T	1.80*Ci
0.9*T	1.28*Ci
1.0*T	0.44*Ci
1.1*T	0.10*Ci
1.2*T	0.08*Ci

Here,

	T = Last THREE digits of your SAP ID (min) **Ci = Last TWO digits of your ROLL NUMBER (g/min) of tracer**		
	a. Generate the ***Exit age distribution curve*** from the data you received from the experiments.	**5**	**CO2**
	b. Calculate the "***moments for the curve***" and the "***Vessel dispersion number***" for the data.	**10**	**CO2**
	c. Based on the calculations in part a) and b) note down your observations and analyze your inferences with detailed reasoning and assumptions.	**15**	**CO1**
	d. As you need to run these reactions and get the final product your supervisor is interested in knowing what conversion we achieve in the reactor. Choose your model and calculate the expected conversion for your reactor. Provide reasoning for your choice of the model. Comment on the conclusions that you derive from the above results.	**20**	**CO4**