Name: Enrolment No:	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2022

Course: Process Modelling and Simulation **Semester : VI**
Program: B. Tech CE+RP **Time : 03 hrs.**
Course Code: CHCE4013P **Max. Marks: 100**

Instructions: 1) Answer the questions section wise in the answer booklet. 2) Assume suitable data wherever necessary. The notations used here have the usual meanings.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Discuss about lumped parameter system.	**4**	**CO1**
Q 2	Distinguish between physical modelling and mathematical modelling.	**4**	**CO1**
Q 3	State about independent and dependent variables and parameters.	**4**	**CO1**
Q 4	Write down the model equation for a batch reactor.	**4**	**CO2**
Q 5	State the assumptions of mathematical model developed for a bioreactor.	**4**	**CO3**

SECTION B
(4Qx10M= 40 Marks)

S. No.		Marks	CO
Q 6	Develop a mathematical model for a single effect evaporator. Draw a neat sketch showing all the model parameters and state the assumptions clearly. ***OR*** Develop a mathematical model for the following sections of ideal binary distillation column. a) Rectifying section b) Feed section	**10**	**CO2**
Q 7	Use the method of least squares to fit the best equation of the type $Nu = a\,Pr^n$ to the data given in Table 1. Table 1: Experimental data on *Nu* and *Pr* (see below)	**10**	**CO3**

Table 1: Experimental data on *Nu* and *Pr*

Nu	24.8	60.3	84.5	150	165	193	245	315	380
Pr	0.46	4.2	10	25.3	37	58.5	95	185	340

Q 8	Discuss the working of a process simulation software.	**10**	**CO4**
Q 9	Explain the working of a simple artificial neural network with a neat diagram.	**10**	**CO5**
SECTION-C (2Qx20M=40 Marks)			
Q 10	Develop a mathematical model for three perfectly mixed reactors operated in series with constant hold up and variable holdups. Assume the temperatures of the three reactors to be constant and reactant A is consumed in each of the three reactors by first order reaction to produce product B. ***OR*** Develop a mathematical model for a CSTR system in which temperature can change with time. An irreversible, exothermic reaction, $A \overrightarrow{k} B$, is carried out in a single perfectly mixed CSTR. The reaction is nth-order in reactant A and has a heat of reaction A (kJ/mol of A reacted). Negligible heat losses and constant densities are assumed. To remove the heat of reaction, a cooling jacket surrounds the reactor.	**20**	**CO2**
Q 11	The irreversible chemical reaction in which solid potassium dichromate ($K_2Cr_2O_7$), water and sulfur combine to form gaseous sodium dioxide, solid potassium hydroxide and solid chromic oxide: $2\ K_2Cr_2O_7 + 2\ H_20 + 3S \rightarrow 4\ KOH + 2\ Cr_2O_3 + 3SO_2$ If n_1 molecules of potassium dichromate, n_2 molecules of H_20 and n_3 molecules of sulfur are combined, the number of molecules of KOH, x(t), as a function of time is given by: $\frac{dx}{dt}=k\left(n_1-\frac{1}{2}x\right)^2\left(n_2-\frac{1}{2}x\right)^2\left(n_3-\frac{3}{4}x\right)^3$ where k is a rate constant with a value of $6.22 \times 10^{-19}\ sec^{-1}$. If $n_1 = n_2 = 2000$ and $n_3 = 3000$. How many units of potassium hydroxide will have been formed after 0.3 seconds? Solve using Runge-Kutta fourth order method using h = 0.1.	**20**	**CO3**