Name:

Enrolment No:

UPES
End Semester Examination, May 2023
Course: Process Modelling and Simulation **Semester : II**
Program: M. Tech Chemical Engineering **Time : 03 hrs.**
Course Code: CHPD7009 **Max. Marks: 100**

Instructions: 1) Answer the questions section wise in the answer booklet. 2) Assume suitable data wherever necessary. 3) The notations used here have the usual meanings.

<table>
<tr><td colspan="4">SECTION A
(5Qx4M=20Marks)</td></tr>
<tr><td>S. No.</td><td></td><td>Marks</td><td>CO</td></tr>
<tr><td>Q 1</td><td>Discuss about dynamic modelling of a chemical engineering system.</td><td>04</td><td>CO1</td></tr>
<tr><td>Q 2</td><td>Explain about the mathematical consistency of a process model.</td><td>04</td><td>CO1</td></tr>
<tr><td>Q 3</td><td>Discuss the sequential modular approach of process simulation</td><td>04</td><td>CO1</td></tr>
<tr><td>Q 4</td><td>State the assumptions of continuously stirred tank reactor.</td><td>04</td><td>CO1</td></tr>
<tr><td>Q 5</td><td>Define the variables and the parameters used in a mathematical model.</td><td>04</td><td>CO1</td></tr>
<tr><td colspan="4">SECTION B
(4Qx10M= 40 Marks)</td></tr>
<tr><td>Q 6</td><td>Illustrate the application of Neumann and Dirichlet boundary conditions in mathematical modelling with suitable examples.</td><td>10</td><td>CO2</td></tr>
<tr><td>Q 7</td><td>For laminar flow, the friction coefficient ‘f’ is related to Reynolds number as $f = aRe^b$. Determine a & b using a method of least squares to fit the following data.
<table>
<tr><td>f</td><td>500</td><td>1000</td><td>1500</td><td>2000</td></tr>
<tr><td>Re</td><td>0.0320</td><td>0.0160</td><td>0.0107</td><td>0.0080</td></tr>
</table></td><td>10</td><td>CO2</td></tr>
<tr><td>Q 8</td><td>Write down the mass balance and energy balance equations for multicomponent distillation column for single stage operation.</td><td>10</td><td>CO3</td></tr>
<tr><td>Q 9</td><td>Describe the solution of partial differential equations by Orthogonal collocation technique.
<i><u>OR</u></i>
Classify the partial differential equations.</td><td>10</td><td>CO5</td></tr>
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SECTION-C
(2Qx20M=40 Marks)

Q 10	Explain the application of a Newton-Raphson’s method to solve the mathematical model equations of a triple-effect evaporator system for a forward feed arrangement.	**20**	**CO3**
Q 11	Develop a two-dimensional pseudo heterogeneous model of fixed bed reactor with suitable boundary conditions. State the assumptions clearly. ***OR*** The Van de Vusse reaction operated in a continuous stirred tank reactor is given as follows: $A \overset{k_1}{\rightarrow} B \overset{k_2}{\rightarrow} C$ $2A \overset{k_3}{\rightarrow} D$ The component material balance equations are described as: $\frac{dC_A}{dt} = -k_1 C_A - k_3 C_A^2 + \frac{F}{V}\left(C_{Af} - C_A\right)$ $\frac{dC_B}{dt} = k_1 C_A - k_2 C_B + \frac{F}{V} C_B$ (i) Compute the steady state values of C_A and C_B using the given data. (ii) Perform three iterations employing the fourth-order Runge–Kutta method for dynamic study using a step size of 1 for $0 \leq t \leq 2$ h for a given data and plot the values of C_A and C_B as a function of time. Data: Reactor volume (V) = 2 lit Feed flow rate (F) = 50 lit/h Feed concentration of reactant A(C_{Af}) = 10 mol/lit Kinetic constant (k_1) = 50 h^{-1} Kinetic constant (k_2) = 100 h^{-1} Kinetic constant (k_3) = 10 lit/mol.h	**20**	**CO4**