Seat No./Enrollment No.: _____

GUJARAT TECHNOLOGICAL UNIVERSITY
BACHELOR OF ENGINEERING – SEMESTER 4 – EXAMINATION – SUMMER 2026

Subject Code: 3140510 **Date: 25/05/2026**

Subject Name: Numerical Methods in Chemical Engineering

Time: 10:30 AM TO 01:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Q.1 **(a)** Differentiate between accuracy and precision with appropriate examples. **03**

(b) Explain diagonal dominant condition and its importance in convergence of Gauss-sidel method. **04**

(c) A chemical reaction A→B takes place in a CSTR. The following model describes the system: **07**

$$\frac{C_{in} - C_A}{\tau} - \frac{k\sqrt{C_A}}{K + C_A} = 0$$

where, k=1, K=0.25, C_{in}=1 and τ=0.25. Report C_A obtained after fourth iteration of Secant method. Consider C_A=0 and C_A=1 as two initial guesses for Secant method

Q.2 **(a)** Explain about the system of ill-conditioned equations using appropriate example **03**

(b) Define Following Terms **04**

1. Accuracy Numbers
2. Inherent Errors
3. Absolute, Relative and Percentage Errors
4. Truncation Errors

(c) Amount of dissolved oxygen in a lake gives an estimate of its health. The saturation concentration of dissolved oxygen in freshwater can be calculated using: **07**

$$\ln(O_S) = -139.34411 + \frac{1.575701 \text{ X } 10^5}{T} - \frac{6.642308 \text{ X } 10^7}{T^2} + \frac{1.243800 \text{ X } 10^{10}}{T^3} - \frac{8.621949 \text{ X } 10^{11}}{T^4}$$

In the above equation, T is the temperature in Kelvins and o_s is the saturation oxygen concentration. The typical saturation concentrations ranges from 14.621 mg/L at 273 K to 6.413 mg/L at 313 K. Using bisection method, find temperature of fresh water that gives o_s= 8 mg/L

OR

Q.2 **(c)** Solve the following system of equations using Gauss elimination method. **07**

$x + 4y - z = -5$, $x + y - 6z = -12$

$3x - y - z = 4$

Q.3 **(a)** Write significance of least square method **03**

(b) Write an algorithm for false position method. **04**

(c) Consider the following example of linear equations in four variables **07**

$5x_1 + 4x_3 + x_4 = -6$

$4x_1 + 5x_2 + 2x_3 = 8$

$4x_1 + 4x_2 + 4x_3 + x_4 = 1$

$x_1 + 2x_2 + 2x_3 + 3x_4 = 2$

Please write the equations in the form Ax=b, and calculate the values of four variables using Gauss-Jordan method.

OR

Q.3 **(a)** Find a real root of the equation $e^x - 3x = 0$ up to one decimal places using Newton-Raphson method. Take $x_0 = 0$. **03**

(b) Find the root of the equation $xlog_{10}^x = 1.2$ using the regula-falsi (false position) method up to two iterations. **04**

(c) **07**

The relationship between stress 'τ' and the strain 'γ' for a pseudoplastic fluid can be expressed by the following equation: $\tau = \mu\gamma^n$ The following data come from a 0.5% hydroxethylcellulose in water solution. Using linear least square method, Estimate the parameters 'μ' and 'n'.

γ	50	70	90	110	130
τ	6.01	7.48	8.59	9.19	10.21

Q.4 **(a)** Describe application of Newton's divided difference formula. **03**

(b) Apply Lagrange's interpolation formula to find the value of y when x=10, if the following values of x and y are given. **04**

x 5 6 9 11

y 12 13 14 16

(c) Find by Taylor's series method, the values of y at x = 0.1 and x = 0.2 to five places of decimals from $\frac{dy}{dx} = x^2y - 1$, y (0) = 1. **07**

OR

Q.4 **(a)** Round off the number 75462 to four significant digits and then calculate the absolute error and percentage error. **03**

(b) Using the modified Euler's method, find $y(0.2)$ given **04**

$$\frac{dy}{dx} = y + e^x, \qquad y(0) = 0$$

(c) Consider the following data obtained from experiments: **07**

x	1.0	1.1	1.2	1.3	1.4	1.5
y	2.0	2.3	2.6	2.95	3.34	3.76

The linear model is of the form: $y = a_0 + a_1x$

Obtain parameters a_0 and a_1 using method of group averages.

Q.5 **(a)** List out the methods used to solve ODEs using numerical method and also write its limitation. **03**

(b) **04**

Given that evaluate $\int_4^{5.2} \log x \, dx$ Using any one method.

x	4.0	4.2	4.4	4.6	4.8	5.0	5.2
log x	1.3863	1.4351	1.4816	1.5261	1.5686	1.6094	1.6487

(c) The following table gives the value of density (d) of a saturated water for various temperature (T) of saturated stream. **07**

Temp(T),˚C	100	150	200	250	300
Density(d),kg/m^3	958	917	586	799	712

Use Newton's forward interpolation formula to find the density when the temperature is 270˚C.

OR

Q.5 **(a)** Write the significance of Newton Rapson/Secant method. **03**

(b) Using Newton's divided difference formula find f(8) from given table: **04**

x	4	5	7	10	11	13
F(x)	48	100	294	900	1210	2028

(c) Using Runge-Kutta method of order 4, solve $\frac{dy}{dx} = xy + y^2$ with initial condition y (0) = 1 , For x = 0.1, 0.2. **07**

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