Enrollment No./Seat No.:

# GUJARAT TECHNOLOGICAL UNIVERSITY

**Bachelor of Engineering - SEMESTER - IV EXAMINATION - WINTER 2025**

**Subject Code: 3140510** **Date: 18-11-2025**

**Subject Name: Numerical Methods in Chemical Engineering**

**Time: 02:30 PM TO 05:00 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.**

| | | | Marks |
|---|---|---|---|
| **Q.1** | **(a)** | Differentiate between accuracy and precision with appropriate example. | **03** |
| | **(b)** | Describe different types of errors. | **04** |
| | **(c)** | Find the absolute error and relative error in $\sqrt{6}+\sqrt{7}+\sqrt{8}$ correct to 4 significant digits. | **07** |
| **Q.2** | **(a)** | Describe intermediate value properties. | **03** |
| | **(b)** | The area of cross-section of a rod is desired up to 0.2% error. How accurately should the diameter be measured? | **04** |
| | **(c)** | Use the method of false position, to find the fourth root of 32 correct to three decimal places. | **07** |
| | | **OR** | |
| | **(c)** | Find the root of the equation $xe^x = \cos x$ using the secant method correct to four decimal places. | **07** |
| **Q.3** | **(a)** | Explain Gauss elimination method with its pitfalls. | **03** |
| | **(b)** | Using Descartes rule of sign find maximum number of positive and negative roots of the following equation. $f(x) = 2x^7 - x^5 + 4x^3 - 5$ | **04** |
| | **(c)** | Apply Gauss elimination method to solve the equations $x + 4y - z = -5$; $x + y - 6z = -12$; $3x - y - z = 4$. | **07** |
| | | **OR** | |
| | **(a)** | Define Eigen values and Eigen vectors. | **03** |
| | **(b)** | Find the eigenvalues and eigenvectors of the matrix $\begin{bmatrix} 5 & 4 \\ 1 & 2 \end{bmatrix}$ | **04** |
| | **(c)** | Solve, by Jacobi's iteration method, the equations $20x + y - 2z = 17$; $3x + 20y - z = -18$; $2x - 3y + 20z = 25$ | **07** |

**Q.4** **(a)** Explain working procedure of method of least square. **03**

**(b)** Write normal equations to fit a straight line ($y=a_0+a_1x$) with the least square method. **04**

**(c)** Find the least squares fit of the form $y = a_0 + a_1x^2$ to the following data **07**

| x | -1 | 0 | 1 | 2 |
|---|---|---|---|---|
| y | 2 | 5 | 3 | 0 |

**OR**

**(a)** Establish Newton's backward interpolation formula. **03**

**(b)** Fit a straight line to the following data: **04**

| x | 6 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| y | 5 | 5 | 4 | 5 | 4 | 3 | 4 | 3 | 3 |

**(c)** Find the missing term in the following table using interpolation: **07**

| x | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| y | 1 | 3 | 9 | ... | 81 |

**Q.5** **(a)** State the formulas for Trapezoidal Rule, Simpsons $1/3^{rd}$ rule, Simpsons $3/8^{th}$ rule. **03**

**(b)** Find the cubic polynomial which takes the following values: **04**

| x | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| f(x) | 1 | 2 | 1 | 10 |

**(c)** Compute the value of $\int_{0.2}^{1.4}(sinx - logx + e^x)dx$ using Simpson's 3/8 rule. **07**

**OR**

**(a)** Find by Taylor's series method, the values of y at x = 0.1 and x = 0.2 to five places of decimals from $dy/dx = x^2y - 1$, $y(0) = 1$. **03**

**(b)** Using the modified Euler's method, find y(0.2) given $y' = y + e^x$, $y(0)=0$ **04**

**(c)** Apply the Runge-Kutta fourth order method to find an approximate value of y when x = 0.2 given that $dy/dx = x + y$ and $y = 1$ when $x = 0$. **07**

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# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE- SEMESTER–IV (NEW) EXAMINATION – WINTER 2024**

**Subject Code:3140510 Date:22-11-2024**

**Subject Name:Numerical Methods in Chemical Engineering**

**Time:02:30 PM TO 05:00 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.**

| | | | **Marks** |
|---|---|---|---|
| **Q.1** | **(a)** | Define significant figure, precision and error propagation. | **03** |
| | **(b)** | Discuss about the pitfalls of Gauss elimination method and techniques for improvement. | **04** |
| | **(c)** | Fit a second-degree polynomial $y = a + bx + cx^2$ using least squares method to the following data: | **07** |

| x | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| y | 1.7 | 1.8 | 2.3 | 3.2 |

| | | | |
|---|---|---|---|
| **Q.2** | **(a)** | Describe intermediate value properties. | **03** |
| | **(b)** | Suggest a method to plot the variables y and x given in the following equation, so that on curve fitting the data will fall on equation of a straight line. $$y = \frac{\alpha x}{1 + x(\alpha - 1)}$$ | **04** |
| | **(c)** | Find root of the equation $x^3 - 2x - 5 = 0$ using secant method correct up to three decimal places. | **07** |
| | | **OR** | |
| | **(c)** | Find a real root of the equation $x^3 - 9x + 1 = 0$ correct up to three decimal places in the interval [2, 3] by the regula falsi method. | **07** |
| **Q.3** | **(a)** | Derive formula for Trapezoidal rule for numerical integration. | **03** |
| | **(b)** | Evaluate the sum S = $\sqrt{3} + \sqrt{5} + \sqrt{7}$ to 4 significant digits and calculate its absolute and relative error. | **04** |
| | **(c)** | Derive the equation for Newton's forward difference polynomial. | **07** |
| | | **OR** | |
| **Q.3** | **(a)** | Explain about the system of ill-conditioned equations using appropriate example. | **03** |
| | **(b)** | Derive formula for Simpson's 1/3 rule of numerical integration. | **04** |
| | **(c)** | Fit an exponential curve $y = ae^{bx}$ to the following data using the principle of least squares: | **07** |

| x | 0 | 2 | 4 | 6 | 8 |
|---|---|---|---|---|---|
| y | 150 | 63 | 28 | 12 | 5.6 |

| | | | |
|---|---|---|---|
| **Q.4** | **(a)** | Discuss about convergence criteria for the Gauss-Siedel method. | **03** |
| | **(b)** | Explain the algorithm for Gauss-Jordan method. | **04** |
| | **(c)** | Derive the formula of Newton - Raphson method & also prove that Newton - Raphson method is quadratically convergent. | **07** |

**OR**

| | | | |
|---|---|---|---|
| **Q.4** | **(a)** | Discuss bracketing methods and open methods. | **03** |
| | **(b)** | Using Newton's backward difference formula, construct an interpolating polynomial of degree 3 for the data: $f(-0.75) = -0.0718125$, $f(-0.5) = -0.02475$, $f(-0.25) = 0.3349375$, $f(0) = 1.10100$. | **04** |
| | **(c)** | Evaluate $\int_0^{0.6} e^{-x^2}\, dx$ using the trapezoidal rule and Simpson's 1/3 rule, taking h = 0.1. | **07** |

| | | | |
|---|---|---|---|
| **Q.5** | **(a)** | Establish Newton's backward interpolation formula. | **03** |
| | **(b)** | Explain Milne's predictor-corrector method. | **04** |
| | **(c)** | Use the Taylor series method to calculate y (0.2), given that $dy/dx = 2y + 3e^x$, $y(0) = 1$. Taking h = 0.2. | **07** |

**OR**

| | | | |
|---|---|---|---|
| **Q.5** | **(a)** | Explain the principle of least squares. | **03** |
| | **(b)** | Explain in brief about ordinary differential equation - boundary value problems. | **04** |
| | **(c)** | Applying Euler's method to solve the initial value problem, $\frac{dy}{dx} = x - \frac{y}{2}$ where $y(0) = 1$ over [0, 3] using step size 0.5. | **07** |

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# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–IV (NEW) EXAMINATION – WINTER 2023**

**Subject Code:3140510 Date:19-01-2024**

**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.**

| | | | **MARKS** |
|---|---|---|---|
| **Q.1** | **(a)** | Enlist various methods for solving linear algebraic equations. | **03** |
| | **(b)** | Explain intermediate value property theorem. | **04** |
| | **(c)** | Round off the numbers 658740 and 67.36584 to four significant figures and compute Ea, Er, Ep in each case. | **07** |
| **Q.2** | **(a)** | Explain error propagation in addition and subtraction operation. | **03** |
| | **(b)** | Define Inherent, Rounding off and Truncation error. | **04** |
| | **(c)** | Find a root of the equation $x^3 - 2x - 5 = 0$, using the method of false position correct to three decimal places. | **07** |
| | | **OR** | |
| | **(c)** | Find the root of the equation $xe^x = \cos x$ using the secant method correct to four decimal places. | **07** |
| **Q.3** | **(a)** | Explain Descarte's rule of sign with example. | **03** |
| | **(b)** | Explain iterative method to improve accuracy of an ill conditioned equation. | **04** |
| | **(c)** | Find the eigen-values and eigenvectors of the matrix $\begin{bmatrix} 5 & 4 \\ 1 & 2 \end{bmatrix}$. | **07** |
| | | **OR** | |
| **Q.3** | **(a)** | Write short note on iterative methods. | **03** |
| | **(b)** | Define Eigen values and Eigen vectors. | **04** |
| | **(c)** | Using the Gauss elimination method, solve the equations: $x + 2y + 3z - u = 10; 2x + 3y - 3z - u = 1;$ $2x - y + 2z + 3u = 7; 3x + 2y - 4z + 3u = 2$ | **07** |
| **Q.4** | **(a)** | Write an algorithm for Newton-Raphson method. | **03** |
| | **(b)** | Define curve fitting. What is meant by the curve of best fit? | **04** |
| | **(c)** | Solve, by Jacobi's iteration method, the equations $20x + y - 2z = 17; 3x + 20y - z = -18; 2x - 3y + 20z = 25$ | **07** |
| | | **OR** | |
| **Q.4** | **(a)** | Write an algorithm for Newton's forward interpolation formula. | **03** |
| | **(b)** | Find the missing term is the table: | **04** |

| x: | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| y: | 45.0 | 49.2 | 54.1 | ? | 67.4 |

| | | | | |
|---|---|---|---|---|
| **(c)** | Find the polynomial f (x) by using Lagrange's formula and hence find f(3) for | | | **07** |

| x | 0 | 1 | 2 | 5 |
|---|---|---|---|---|
| f(x) | 2 | 3 | 12 | 147 |

**Q.5** **(a)** Write an algorithm for trapezoidal rule. **03**

**(b)** Use Simpson's 1/3rd rule to find $\int_0^{0.6} e^{-x^2}\,dx$ by taking seven ordinates. **04**

**(c)** Find the least squares fit of the form $y = a_0 + a_1 x^2$ to the following data **07**

| x: | -1 | 0 | 1 | 2 |
|---|---|---|---|---|
| y: | 2 | 5 | 3 | 0 |

**OR**

**Q.5** **(a)** Write an algorithm of Simpson's 3/8 rule. **03**

**(b)** Discuss in brief about boundary problems. **04**

**(c)** Using Euler's method, find an approximate value of y corresponding to $x = 1$, given that $dy/dx = x + y$ and $y = 1$ when $x = 0$. **07**

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# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–IV(NEW) EXAMINATION – WINTER 2022**

**Subject Code:3140510 Date:15-12-2022**

**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.**

| | | | MARKS |
|---|---|---|---|
| **Q.1** | **(a)** | Describe different types of errors. | **03** |
| | **(b)** | Fit the straight line that best fits to the following data: | **04** |

| x | 1 | 2 | 3 | 4 | 6 | 8 |
|---|---|---|---|---|---|---|
| y | 2.4 | 3 | 3.6 | 4 | 5 | 6 |

| | | | | Fit a second-degree parabola to the following data: | **07** |
|---|---|---|---|---|---|

| x | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| y | 1 | 1.8 | 1.3 | 2.5 | 6.3 |

| | | | | Prepare Forward difference table for the following data: | **03** |
|---|---|---|---|---|---|

| x | 0 | 5 | 10 | 15 | 20 | 25 |
|---|---|---|---|---|---|---|
| $y$ | 7 | 11 | 14 | 18 | 24 | 32 |

| | | | | Using Newton Raphson method, find the root of $x^4 - x - 10 = 0$ correct up to three decimal places. | **04** |
|---|---|---|---|---|---|

| | | | | Using Secant method, find the root of $x^3 + x^2 - 3x - 3 = 0$ correct up to five decimal places starting from $x_0 = 1$ and $x_1 = 2$ | **07** |
|---|---|---|---|---|---|

**OR**

| | | | | Find the square root of 10 correct to three decimal places, by using Newton-Raphson iteration formula. | **07** |
|---|---|---|---|---|---|

| | | | | Find the percentage error in computing the parallel resistance R of two resistances $R_1$ and $R_2$ if $R_1$ , $R_2$ are each in error by 2%. | **03** |
|---|---|---|---|---|---|

| | | | | Find $A^{-1}$ if A$= \begin{bmatrix} 1 & 2 & 3 \\ 2 & 5 & 3 \\ 1 & 0 & 8 \end{bmatrix}$ | **04** |
|---|---|---|---|---|---|

| | | | | Using Bisection method find the root of the equation $x^3 - 5x + 3 = 0$ , correct up to two decimal places. | **07** |
|---|---|---|---|---|---|

**OR**

| | | | | Explain the Gauss Jordan method to solve the system of linear equations. | **03** |
|---|---|---|---|---|---|
| | **(b)** | | | Solve the following system of equations by Gauss Elimination method: $x + 3y + 2z = 5$ , $2x + 4y - 6z = -4$ , $x + 5y + 3z = 10$ | **04** |

**(c)** Solve the following system of equations by Gauss-Jacobi method: **07**
$6x + 2y - z = 4$ , $x + 5y + z = 3$ , $2x + y + 4z = 27$

**Q.4** **(a)** Using Euler's method find y (1.2), given that $\frac{dy}{dx} = x\sqrt{y},\ y(1) = 1$ , **03**
Taking $h = 0.1$

**(b)** Apply 4th order Runge Kutta Method to compute y for $x = 0.5$ , given **04**
that $\frac{dy}{dx} = \sqrt{x + y},\ y(0.4) = 0.41,\quad h = 0.1$

**(c)** Use the Taylor series method to find $y(0.1)$, given that $\frac{dy}{dx} = x^2 + y^2$, **07**
$y(0) = 1$. Taking $h = 0.1$

**OR**

**Q.4** **(a)** Derive formula for Simpson's 1/3 rule of numerical integration. **03**

**(b)** Find the isothermal work done on the gas if it is compressed from $v_1 = 22L$ to $v_2 = 2L$. Use Trapezoidal rule to find $W = -\int_{v_1}^{v_2} p\ dv$ **04**

| V(L) | 2 | 7 | 12 | 17 | 22 |
|---|---|---|---|---|---|
| P(atm) | 12.20 | 3.49 | 2.049 | 1.44 | 1.11 |

**(c)** Evaluate $\int_0^3 \frac{dx}{1+x}$ by using Simpson's 3/8 Rule and hence calculate $log\ 2$ **07**

**Q.5** **(a)** Prove that (1) $\Delta\nabla = (\Delta - \nabla)$ (2) $\Delta = E\nabla = \Delta E$ **03**

**(b)** Using Newton's divided difference formula, evaluate $f(9)$ from the following data: **04**

| x | 5 | 7 | 11 | 13 | 17 |
|---|---|---|---|---|---|
| f(x) | 150 | 392 | 1452 | 2366 | 5202 |

**(c)** Use Lagrange's interpolation formula to find the value of y when $x = 4$, if the values of x and y are given below: **07**

| x | 2 | 3 | 5 | 7 |
|---|---|---|---|---|
| y | 0.1506 | 0.3001 | 0.4517 | 0.6259 |

**OR**

**Q.5** **(a)** Discuss in brief about boundary value problems. **03**

**(b)** Find $Y(2.36)$ from the following table using Newton's backward interpolation method. **04**

| x | 1.6 | 1.8 | 2 | 2.2 | 2.4 | 2.6 |
|---|---|---|---|---|---|---|
| y | 4.95 | 6.05 | 7.39 | 9.03 | 11.02 | 13.46 |

**(c)** Use Milne's predictor-corrector method to find $y(4.4)$. Given that **07**
$5xy' + y^2 - 2 = 0$ , $y(4) = 1,\ y(4.1) = 1.0049$ , $y(4.2) = 1.0097$ ,
$y(4.3) = 1.0143$ , with $h = 0.1$

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