Enrolment No./Seat No_____

# 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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