# GUJARAT TECHNOLOGICAL UNIVERSITY

## BE – SEMESTER 3 – OLD PAPER – W25 TO S26 – QUESTION BANK

**Subject Name & Code:** Numerical Methods in Chemical Engineering – BE03005041

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## Chapter 1: Approximations and Errors

### Repeated Questions:

*None identified.*

### Other Important Questions:

**1. Errors (Theory):**

- **Q.** Explain following terms: 1) Significant figures, 2) Truncation Error. **(WINTER 2025, 3 Marks)**
- **Q.** Explain sources of arising errors in numerical computation. **(WINTER 2025, 4 Marks)**

**2. Numerical Problems:**

- **Q.** Round off the numbers 865250 and 37.46235 to four significant figures and compute $E_a$, $E_r$, $E_p$ in each case. **(WINTER 2025, 7 Marks)**
- **Q.** Find the relative error if the number X = 0.004997 is
  i. truncated to three decimal digits
  ii. rounded off to three decimal digits. **(SUMMER 2026)**
- **Q.** The area of cross-section of a rod is desired up to 0.2% error. How accurately should the diameter be measured? **(SUMMER 2026)**

## Chapter 2: Solution of Algebraic and Transcendental Equations

### Repeated Questions:

**1. Intermediate Value Theorem (Theory):**

- **Q.** Describe intermediate value properties theorem. / Describe intermediate value properties. **(WINTER 2025, 3 Marks; SUMMER 2026)**

### Other Important Questions:

**1. Root-Finding Methods (Theory):**

- **Q.** Explain algorithm for finding the root of an equation using Newton-Raphson method. **(SUMMER 2026)**

**2. Numerical Problems:**

- **Q.** Find a root of the equation $x^3 - x - 1 = 0$, using the bisection method correct to three decimal places. **(WINTER 2025, 4 Marks)**
- **Q.** Find by Newton's method, the real root of the equation $3x = \cos x + 1$, correct to four decimal places. **(WINTER 2025, 7 Marks)**
- **Q.** Find the root of the equation $xe^x = \cos x$ using the secant method correct to four decimal places. **(WINTER 2025, 7 Marks OR)**
- **Q.** Use the method of false position, to find the fourth root of 32 correct to three decimal places. **(SUMMER 2026)**
- **Q.** Using the bisection method find a positive real root of $x \log_{10} x = 1.2$. **(SUMMER 2026 OR)**
- **Q.** Solve $x^4 - 5x^3 + 20x^2 - 40x + 60 = 0$, by Newton's method given that all the roots of the given equation are complex. **(SUMMER 2026, 7 Marks)**

## Chapter 3: Solution of Linear Equations

### Repeated Questions:

**1. Eigenvalues and Eigenvectors (Numerical):**

- **Q.** Find the eigenvalues and eigenvectors of the matrix [matrix given]. [Diagram required – refer to the original question paper] (The matrix differs between the W25 and S26 papers.) **(WINTER 2025, 4 Marks OR; SUMMER 2026)**

### Other Important Questions:

**1. Theory:**

- **Q.** Explain the Gauss Jordan method to solve the system of linear equations. **(WINTER 2025, 3 Marks)**
- **Q.** Explain Eigen values and Eigen vectors. **(WINTER 2025, 3 Marks OR)**

**2. Direct Methods (Numerical):**

- **Q.** Apply Gauss elimination method to solve the equations:
  $x + 4y - z = -5$; $x + y - 6z = -12$; $3x - y - z = 4$ **(WINTER 2025, 4 Marks)**
- **Q.** Solve the equations using Gauss-Jordan method:
  $10x - 7y + 3z + 5u = 6$
  $-6x + 8y - z - 4u = 5$
  $3x + y + 4z + 11u = 2$
  $5x - 9y - 2z + 4u = 7$ **(SUMMER 2026)**

**3. Iterative Methods (Numerical):**

- **Q.** Apply the Gauss-Seidel iteration method to solve the equations:
  $20x + y - 2z = 17$; $3x + 20y - z = -18$; $2x - 3y + 20z = 25$ **(WINTER 2025, 7 Marks)**
- **Q.** Solve by Jacobi's iteration method, the equations correct to two decimal places:
  $10x + y - z = 11.19$; $x + 10y + z = 28.08$; $-x + y + 10z = 35.61$ **(WINTER 2025, 7 Marks OR)**

## Chapter 4: Curve Fitting

### Repeated Questions:

*None identified.*

### Other Important Questions:

**1. Least Squares Fitting (Theory):**

- **Q.** Write down normal equations to fit the straight line y = a + bx. **(WINTER 2025)**

**2. Numerical Problems:**

- **Q.** Fit a straight line to the following data:
  x: 6, 7, 7, 8, 8, 8, 9, 9, 10
  y: 5, 5, 4, 5, 4, 3, 4, 3, 3 [Diagram required – refer to the original question paper] **(WINTER 2025)**
- **Q.** An experiment gave the following values. It is known that v and t are connected by the relation $v = ab^t$. Find the best possible values of a and b. [Diagram required – refer to the original question paper] [Data truncated in source – refer to the original question paper] **(SUMMER 2026)**
- **Q.** Find the least squares fit of the form $y = a_0 + a_1x^2$ to the following data:
  x: −1, 0, 1, 2
  y: 2, 5, 3, 0 [Diagram required – refer to the original question paper] **(SUMMER 2026)**

## Chapter 5: Finite Differences & Interpolation

### Repeated Questions:

*None identified.*

### Other Important Questions:

**1. Operators and Interpolation Methods (Theory):**

- **Q.** Establish the following identities:
  (1) $\Delta = E - 1$
  (2) $\Delta = 1 - E^{-1}$ **(WINTER 2025 OR)**
- **Q.** List out the interpolation methods, which can be used when data points are available at unequal intervals. **(SUMMER 2026 OR)**

**2. Numerical Problems:**

- **Q.** Find the missing term in the table:
  x: 2, 3, 4, 5, 6
  y: 45.0, 49.2, 54.1, ..., 67.4 [Diagram required – refer to the original question paper] **(WINTER 2025)**
- **Q.** From the following table, estimate the number of students who obtained marks between 40 and 45:
  Marks: 30-40, 40-50, 50-60, 60-70, 70-80
  No. of Students: 3, 14, 25, 135, 31 [Diagram required – refer to the original question paper] **(WINTER 2025 OR)**
- **Q.** Determine f(x) as a polynomial in x for the following data:
  x: −4, −1, 0, 2, 5
  y = f(x): 124, 5, 33, 5, 1335 [Diagram required – refer to the original question paper] **(SUMMER 2026)**
- **Q.** Using Lagrange's formula, express the given function as a sum of partial fractions:
  $(3x^2 + x + 1) / ((x - 1)(x - 2)(x - 3))$ **(SUMMER 2026)**

## Chapter 6: Numerical Differentiation & Integration

### Repeated Questions:

*None identified.*

### Other Important Questions:

**1. Integration Formulas and Algorithms (Theory):**

- **Q.** Write the formula of Simpson's one-third rule. **(WINTER 2025)**
- **Q.** Write an algorithm for trapezoidal rule. **(SUMMER 2026)**

**2. Numerical Differentiation (Numerical):**

- **Q.** Find the distance moved by a particle and its acceleration at the end of 4 seconds, if the time versus velocity data is as follows:
  t: 0, 1, 3, 4
  v: 2, 11, 5, 12, 10 [Diagram required – refer to the original question paper] **(WINTER 2025 OR)**
- **Q.** Find the maximum and minimum value of y from the following data:
  x: −2, −1, 0, 1, 2, 3, 4
  y: 2, −0.25, 0, −0.25, 2, 15.75, 56 [Diagram required – refer to the original question paper] **(SUMMER 2026)**
- **Q.** A slider in a machine moves along a fixed straight rod. Its distance x cm along the rod is given below for various values of the time t seconds. Find the velocity of the slider and its acceleration when t = 0.3 second.
  t: 0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6
  x: 30.13, 31.62, 32.87, 33.64, 33.95, 33.81, 33.24 [Diagram required – refer to the original question paper] **(SUMMER 2026)**

**3. Numerical Integration (Numerical):**

- **Q.** Use the Trapezoidal rule to estimate the integral $\int_0^2 e^{x^2}\,dx$ taking 10 intervals. **(WINTER 2025)**
- **Q.** The velocity v (km/min) of a moped which starts from rest, is given at fixed intervals of time t (min) as follows. Estimate approximately the distance covered in twenty minutes.
  t: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20
  v: 10, 18, 25, 29, 32, 20, 11, 5, 2, 0 [Diagram required – refer to the original question paper] **(SUMMER 2026)**
- **Q.** A solid of revolution is formed by rotating about the x-axis, the area between the x-axis, the lines x = 0 and x = 1 and a curve through the points with the following coordinates. Estimate the volume of the solid formed using Simpson's rule.
  x: 0.00, 0.25, 0.50, 0.75, 1.00
  y: 1.0000, 0.9896, 0.9589, 0.9089, 0.8415 [Diagram required – refer to the original question paper] **(SUMMER 2026, 4 Marks)**

## Chapter 7: Ordinary Differential Equations

### Repeated Questions:

**1. Predictor-Corrector Methods (Theory):**

- **Q.** Describe Milne's predictor-corrector method. **(WINTER 2025 OR; SUMMER 2026)**

**2. Euler's Method (Numerical):**

- **Q.** 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. **(WINTER 2025; SUMMER 2026)**

### Other Important Questions:

**1. Boundary Value Problems (Theory):**

- **Q.** Explain in brief about ordinary differential equations - boundary value problems. **(SUMMER 2026)**

**2. Taylor's Series Method (Numerical):**

- **Q.** Solve $y' = x + y$, $y(0) = 1$ by Taylor's series method. Hence find the values of y at x = 0.1 and x = 0.2. **(WINTER 2025 OR)**
- **Q.** Solve by Taylor's series method, here y(1.1) and y(1.2), given y(1) = 2.
  $dy/dx = \log(xy)$ **(SUMMER 2026, 7 Marks)**

**3. Runge-Kutta Method (Numerical):**

- **Q.** 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. **(WINTER 2025 OR)**
- **Q.** Using the Runge-Kutta method of fourth order, solve for y at x = 1.2 and x = 1.4, given $x_0 = 1$, $y_0 = 0$.
  $dy/dx = (2xy + e^x) / (x^2 + xe^x)$ **(SUMMER 2026)**

**4. Milne's Method (Numerical):**

- **Q.** Using Milne's method find y(4.5) given $5xy' + y^2 - 2 = 0$ given y(4) = 1, y(4.1) = 1.0049, y(4.2) = 1.0097, y(4.3) = 1.0143, y(4.4) = 1.0187. **(SUMMER 2026)**

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