GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER 4 – OLD PAPER – S22 TO S26 – QUESTION BANK

Subject Name & Code: Numerical Methods in Chemical Engineering - 3140510

Chapter 1 – Approximations and Errors

Repeated Questions:

1. Theory:

- **Q.** Differentiate between accuracy and precision with appropriate example. **(SUMMER 2024, 3 Marks; WINTER 2025, 3 Marks; SUMMER 2026, 3 Marks)**
- **Q.** Describe different types of errors. **(WINTER 2022; WINTER 2025, 4 Marks)**

2. Numerical:

- **Q.** Evaluate sum S = √4 + √6 + √8 to four significant digits and find absolute & relative errors. / Evaluate the sum S = √3 + √5 + √7 to 4 significant digits and calculate its absolute and relative error. / Find the absolute error and relative error in √6 + √7 + √8 correct to 4 significant digits. **(SUMMER 2022; WINTER 2024, 4 Marks; WINTER 2025, 7 Marks)**

Other Important Questions:

1. Definitions and Concepts (Theory):

- **Q.** Explain three sources of arising errors in numerical computation. **(SUMMER 2023, 3 Marks)**
- **Q.** Explain following terms: 1) Significant figures, 2) Truncation Error. **(SUMMER 2022, 3 Marks)**
- **Q.** Define: 1) Absolute error, 2) Relative error, 3) Percentage error, 4) Inherent Error. **(SUMMER 2022)**
- **Q.** Explain error propagation in addition and subtraction operation. **(WINTER 2023, 3 Marks)**
- **Q.** Define Inherent, Rounding off and Truncation error. **(WINTER 2023, 4 Marks)**
- **Q.** Define significant figure, precision and error propagation. **(WINTER 2024, 3 Marks)**
- **Q.** Define following terms: 1. Accuracy Numbers 2. Inherent Errors 3. Absolute, Relative and Percentage Errors 4. Truncation Errors. **(SUMMER 2026)**
- **Q.** Explain various types of errors in computations. **(SUMMER 2025, 4 Marks)**

2. Percentage Error and Error Propagation (Numerical):

- **Q.** In calculating the area of a rectangle, an error of 3% is made in measuring each of its sides. Find the percentage error in calculating area of the rectangle. **(SUMMER 2023)**
- **Q.** Find the percentage error in the area of an ellipse where an error of 1% is made in measuring its major and minor axis. **(SUMMER 2024, 4 Marks)**
- **Q.** 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%. **(WINTER 2022)**
- **Q.** The area of cross-section of a rod is desired up to 0.2% error. How accurately should the diameter be measured? **(WINTER 2025, 4 Marks)**

3. Rounding Off and Truncation (Numerical):

- **Q.** Round off the numbers 658740 and 67.36584 to four significant figures and compute E_a, E_r, E_p in each case. **(WINTER 2023)**
- **Q.** Round off the number 75462 to four significant digits and then calculate the absolute error and percentage error. **(SUMMER 2026, 3 Marks OR)**
- **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 2025, 7 Marks)**

Chapter 2 – Solution of Algebraic and Transcendental Equations

Repeated Questions:

1. Theory:

- **Q.** Explain intermediate value property theorem. / Describe intermediate value properties. **(SUMMER 2022, 3 Marks; WINTER 2023, 4 Marks; WINTER 2024, 3 Marks; SUMMER 2025, 4 Marks; WINTER 2025, 3 Marks)**
- **Q.** Explain Descartes' rule of sign with example. / Use Descartes' rule of signs to find the number of positive, negative and imaginary roots of the function: $x^6 - x^5 - 10x + 7 = 0$ **(WINTER 2023, 3 Marks; SUMMER 2024, 3 Marks; SUMMER 2025, 3 Marks)**

2. Bisection Method (Numerical):

- **Q.** Find a root of the function $f(x) = \cos x - x e^x$ using Bisection Method. **(SUMMER 2023)**
- **Q.** Find root of the equation $x^3 - 2x - 5 = 0$ using bisection method correct up to three decimal places. **(SUMMER 2024, 4 Marks)**

3. Secant and False Position Methods (Numerical):

- **Q.** Find the root of the equation $x^3 - 2x - 5 = 0$ using Secant method correct up to three decimal places. **(SUMMER 2023; WINTER 2024, 7 Marks)**
- **Q.** Find root of the equation $x^3 - 2x - 5 = 0$, using the method of false position correct to three decimal places. **(WINTER 2023)**
- **Q.** Find the root of the equation $x e^x = \cos x$ using the secant method correct to four decimal places. **(WINTER 2023, OR; SUMMER 2025, OR; WINTER 2025, 7 Marks OR)**

4. Newton-Raphson Method (Theory and Numerical):

- **Q.** Enlist limitations of Newton-Raphson Method also find root of the function $x^4 - x = 10$ up to three decimal places using Newton-Raphson method. / Enlist limitations of Newton-Raphson's Method. / Using Newton-Raphson method, find the root of $x^4 - x - 10 = 0$ correct up to three decimal places. **(SUMMER 2022; WINTER 2022; SUMMER 2025, 3 Marks OR)**

Other Important Questions:

1. Theory, Derivations and Algorithms:

- **Q.** Write an algorithm for Newton-Raphson method. **(WINTER 2023, 3 Marks)**
- **Q.** Write an algorithm for false position method. **(SUMMER 2026, 4 Marks)**
- **Q.** Derive the formula of Newton-Raphson method & also prove that Newton-Raphson method is quadratically convergent. **(WINTER 2024, 7 Marks)**
- **Q.** Discuss bracketing methods and open methods. **(WINTER 2024, 3 Marks OR)**
- **Q.** Explain False position method. **(SUMMER 2025, 3 Marks)**
- **Q.** Find the iterative formula for finding $\sqrt{N}$ where N is a real number, using Newton-Raphson formula. **(SUMMER 2025, 3 Marks)**
- **Q.** Using Descartes' rule of sign find maximum number of positive and negative roots of the following equation. $f(x) = 2x^7 - x^5 + 4x^3 - 5$ **(WINTER 2025, 4 Marks)**

2. Bisection Method (Numerical):

- **Q.** Using Bisection method find the root of the equation $x^3 - 5x + 3 = 0$, correct up to two decimal places. **(WINTER 2022)**
- **Q.** Find a root of the equation $x^2 - 4x - 9 = 0$, using the bisection method correct to three decimal places. **(SUMMER 2025)**

3. False Position Method (Numerical):

- **Q.** Find a positive root of $x^3 - 4x + 1 = 0$ by the method of false position correct up to three decimal places. **(SUMMER 2023, OR)**

- **Q.** Find the root of the equation $x \log_{10} x = 1.2$ using the regula-falsi (false position) method up to two iterations. **(SUMMER 2026, 4 Marks OR)**
- **Q.** Use the method of false position, to find the fourth root of 32 correct to three decimal places. **(WINTER 2025, 7 Marks)**

4. Newton-Raphson Method (Numerical):

- **Q.** Using Newton-Raphson iterative method, find the real root of $x \log_{10} x = 1.2$ correct to five decimal places. **(SUMMER 2023)**
- **Q.** Find the square root of 10 correct to three decimal places, by using Newton-Raphson iteration formula. **(WINTER 2022, OR)**
- **Q.** Solve following equation using Newton Raphson technique starting with $x_0 = 0.5$ and $y_0 = 1.5$, carry out two iterations. $\sin x - y = -0.9793$, $\cos y - x = -0.6703$ **(SUMMER 2022, OR)**
- **Q.** Find x_2 of $x^4 - x = 10$, correct to three decimal places, using the Newton-Raphson method, where $x_0 = 2$. **(SUMMER 2025, 4 Marks)**
- **Q.** Find a real root of the equation $e^x - 3x = 0$ up to one decimal place using Newton-Raphson method. Take $x_0 = 0$. **(SUMMER 2026, 3 Marks OR)**

5. Secant Method (Numerical):

- **Q.** 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 $x_1 = 2$. **(WINTER 2022)**

6. Applications (Chemical Engineering):

- **Q.** Air at 25 °C and 1 atm flows through a 4 mm diameter tube... Calculate the friction factor using the Colebrook equation... Determine the pressure drop... [Data truncated in source – refer to the original question paper] [Diagram required – refer to the original question paper] **(SUMMER 2024, 7 Marks)**
- **Q.** Solid particles having a diameter of 0.12 mm... Estimate the minimum fluidization velocity using Newton Raphson method. [Data truncated in source – refer to the original question paper] [Diagram required – refer to the original question paper] **(SUMMER 2024, 7 Marks OR)**
- **Q.** A chemical reaction $A \longrightarrow B$ takes place in a CSTR... Report C_A obtained after fourth iteration of Secant method. [Data truncated in source – refer to the original question paper] **(SUMMER 2026, 7 Marks)**
- **Q.** Amount of dissolved oxygen in a lake gives an estimate of its health... Using bisection method, find temperature of fresh water that gives $O_S = 8$ mg/L. [Data truncated in source – refer to the original question paper] **(SUMMER 2026)**

Chapter 3 – Solution of Linear Equations

Repeated Questions:

1. Theory:

- **Q.** Explain the Gauss Jordan method to solve the system of linear equations. **(WINTER 2022, OR; SUMMER 2023)**
- **Q.** Explain Gauss elimination method with its pitfalls. / Discuss about the pitfalls of Gauss-Elimination method and techniques for improving solutions. **(SUMMER 2022, 3 Marks; WINTER 2024, 4 Marks; WINTER 2025, 3 Marks)**
- **Q.** Explain about the system of ill-conditioned equations using appropriate example. **(WINTER 2024, 3 Marks OR; SUMMER 2026, 3 Marks)**
- **Q.** Define Eigen values and Eigen vectors. **(WINTER 2023, 4 Marks OR; SUMMER 2024, 3 Marks; WINTER 2025, 3 Marks OR)**
- **Q.** Enlist various methods for solving linear algebraic equations. **(WINTER 2023, 3 Marks; SUMMER 2025, 3 Marks)**

2. Eigen Values and Eigen Vectors (Numerical):

- **Q.** Find the eigen-values and eigenvectors of the matrix [[5, 4], [1, 2]] (rows: 5 4 and 1 2). [Diagram required – refer to the original question paper] **(WINTER 2023; WINTER 2025, 4 Marks OR)**

3. Iterative Methods – Gauss-Seidel and Jacobi (Numerical):

- **Q.** Solve the following system of simultaneous equations by Gauss Seidel method: $20x + y - 2z = 17$, $3x + 20y - z = -18$, $2x - 3y + 20z = 25$ **(SUMMER 2024, OR)**
- **Q.** Solve, by Jacobi's iteration method, the equations: $20x + y - 2z = 17$; $3x + 20y - z = -18$; $2x - 3y + 20z = 25$ **(WINTER 2023, 7 Marks; WINTER 2025, 7 Marks OR)**

4. Gauss Elimination (Numerical):

- **Q.** Solve the following equations by the Gauss elimination method: $x + y + z = 9$; $2x - 3y + 4z = 13$; $3x + 4y + 5z = 40$ **(SUMMER 2025, 4 Marks OR; SUMMER 2026, 7 Marks OR)**

Other Important Questions:

1. Theory and Algorithms:

- **Q.** Explain iterative method to improve accuracy of an ill conditioned equation. **(WINTER 2023, 4 Marks)**
- **Q.** Write short note on iterative methods. **(WINTER 2023, 3 Marks OR)**
- **Q.** Discuss about convergence criteria for the Gauss-Seidel method. **(WINTER 2024, 3 Marks)**
- **Q.** Explain the algorithm for Gauss-Jordan method. **(WINTER 2024, 4 Marks)**
- **Q.** Explain diagonal dominant condition and its importance in convergence of Gauss-Seidel method. **(SUMMER 2026, 4 Marks)**

2. Gauss Elimination (Numerical):

- **Q.** Examine the system of equations $3x + 3y + 2z = 1$, $x + 2y = 4$, $10y + 3z = -2$, $2x - 3y - z = 5$ for consistency and then solve it by Gauss Elimination method. **(SUMMER 2023, OR)**
- **Q.** Solve the following system of equations by Gauss Elimination method: $2x + y + z = 10$; $3x + 2y + 3z = 18$; $x + 4y + 9z = 16$ **(SUMMER 2024)**
- **Q.** Using the Gauss elimination method, solve the equations: $x + 2y + 3z - u = 10$; $2x + 3y - 3z - u = 1$; $2x - y + 2z + 3u = 7$; $3x + 2y - 4z + 3u = 2$ **(WINTER 2023, 7 Marks OR)**
- **Q.** Apply Gauss elimination method to solve the equations $x + 4y - z = -5$; $x + y - 6z = -12$; $3x - y - z = 4$. **(WINTER 2025, 7 Marks)**

3. Gauss-Jordan Method and Matrix Inverse (Numerical):

- **Q.** Apply Gauss Jordan to solve the equations 10x + y + z = 12; x + 10y + z = 12; x + y + 10z = 12 **(SUMMER 2024, OR)**
- **Q.** Consider the following example of linear equations in four variables... calculate the values of four variables using Gauss-Jordan method. [Data truncated in source – refer to the original question paper] **(SUMMER 2026, 7 Marks)**
- **Q.** Find A^{-1} if A = [[1, 2, 3], [2, 5, 3], [1, 0, 8]] (rows: 1 2 3, 2 5 3 and 1 0 8). **(WINTER 2022)**

4. Iterative Methods – Gauss-Seidel and Jacobi (Numerical):

- **Q.** Re-arrange the given equations in diagonally dominant form and solve the new linear system by using Gauss Seidel Method with X_0 = [0 0 0]. Perform only three iterations... [Data truncated in source – refer to the original question paper] **(SUMMER 2023)**
- **Q.** Solve the following system of equations by Gauss-Jacobi method: 6x + 2y − z = 4, x + 5y + z = 3, 2x + y + 4z = 27 **(WINTER 2022, 7 Marks OR)**
- **Q.** Solve following set of equation using Jacobi's iteration method correct up to three decimal places. $x_0 = y_0 = z_0 = 0$ [Diagram required – refer to the original question paper] **(SUMMER 2022)**
- **Q.** Solve the following equations using Gauss-Jacobi's method: 27x + 6y − z = 85; x + y + 54z = 110; 6x + 15y + 2z = 72 **(SUMMER 2025, 7 Marks)**

5. Eigen Values – Power Method (Numerical):

- **Q.** Determine the largest eigenvalue and the corresponding eigenvector of the matrix A = [[5, 4], [1, 2]] (rows: 5 4 and 1 2). **(SUMMER 2023, 3 Marks OR)**
- **Q.** Find numerically the largest Eigen value and corresponding Eigen Vector of the following matrix using power method. [Diagram required – refer to the original question paper] **(SUMMER 2024)**
- **Q.** Find the eigen-values and eigenvectors of the matrix (Matrix not provided in text). [Data truncated in source – refer to the original question paper] [Diagram required – refer to the original question paper] **(SUMMER 2022, 4 Marks OR)**

Chapter 4 – Curve Fitting

Repeated Questions:

1. Theory:

- **Q.** Write normal equations to fit a straight line ($y = a_0 + a_1x$) with the least square method. / Give the normal equation to fit the straight line $y = a + bx$ to n observations. **(SUMMER 2022, OR; SUMMER 2025, 3 Marks OR; WINTER 2025, 4 Marks)**
- **Q.** Explain working procedure of method of least square. / Explain the principle of least squares. **(WINTER 2024, 3 Marks OR; SUMMER 2025, 4 Marks; WINTER 2025, 3 Marks)**

2. Second Degree Polynomial / Parabola (Numerical):

- **Q.** Fit a second degree polynomial using least square method to the following data: x: 0, 1, 2, 3, 4; y: 1, 1.8, 1.3, 2.5, 6.3. / Fit a second degree parabola to the following data. [Diagram required – refer to the original question paper] **(WINTER 2022; SUMMER 2023; SUMMER 2024, 7 Marks)**
- **Q.** Find the least squares fit of the form $y = a_0 + a_1x^2$ to the following data. [Diagram required – refer to the original question paper] **(WINTER 2023, 7 Marks; WINTER 2025, 7 Marks)**

3. Exponential Curve (Numerical):

- **Q.** Fit a curve of the form $y = a\ e^{bx}$ to the following data. / Fit an exponential curve $y = a\ e^{bx}$ to the following data using the principle of least squares. [Diagram required – refer to the original question paper] **(SUMMER 2023, 4 Marks; WINTER 2024, 7 Marks OR; SUMMER 2025, 7 Marks OR)**

Other Important Questions:

1. Theory:

- **Q.** Define curve fitting. What is meant by the curve of best fit? **(WINTER 2023, 4 Marks)**
- **Q.** Write significance of least square method. **(SUMMER 2026, 3 Marks)**
- **Q.** 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. $y = \alpha x / (1 + x(\alpha - 1))$ **(WINTER 2024, 4 Marks)**

2. Straight Line Fit (Numerical):

- **Q.** Fit the straight line that best fits to the following data. [Diagram required – refer to the original question paper] **(WINTER 2022)**
- **Q.** Fit a straight line to the following data. [Diagram required – refer to the original question paper] **(WINTER 2025, 4 Marks OR)**
- **Q.** If P is pull required to lift a load W by means of a pulley block, find a linear law of form $P = mW + C$ connecting P & W, using following data. [Diagram required – refer to the original question paper] **(SUMMER 2022, 4 Marks)**
- **Q.** Consider the following data obtained from experiments... Obtain parameters a_0 and a_1 using method of group averages. [Data truncated in source – refer to the original question paper] [Diagram required – refer to the original question paper] **(SUMMER 2026, 7 Marks OR)**

3. Second Degree Polynomial (Numerical):

- **Q.** Fit a second-degree polynomial $y = a + bx + cx^2$ using least squares method to the following data. [Diagram required – refer to the original question paper] **(WINTER 2024, 7 Marks)**

4. Non-linear Curve Fitting (Numerical):

- **Q.** Fit a curve of the form $y = ax^b$ to the following data. [Diagram required – refer to the original question paper] **(SUMMER 2023, 4 Marks OR)**
- **Q.** The pressure and volume of a gas are related by the equation $pV^\gamma = k$ ... Fit this equation to the following set of observations. [Data truncated in source – refer to the original question paper] [Diagram required – refer to the original question paper] **(SUMMER 2022, OR)**

- **Q.** The relationship between stress 'τ' and the strain 'γ' for a pseudoplastic fluid can be expressed by the following equation: $\tau = \mu\gamma^n$ ... Using linear least square method, estimate the parameters 'μ' and 'n'. [Data truncated in source – refer to the original question paper] [Diagram required – refer to the original question paper] **(SUMMER 2026, 7 Marks OR)**

Chapter 5 – Finite Differences & Interpolation

Repeated Questions:

1. Theory:

- **Q.** Establish Newton's backward interpolation formula. **(SUMMER 2022, 3 Marks; WINTER 2024, 3 Marks OR; WINTER 2025, 3 Marks OR)**
- **Q.** Prove the following (i) $\Delta = E - 1$ (ii) $\nabla = 1 - E^{-1}$ / Prove that (1) $\Delta\nabla = (\Delta - \nabla)$ (2) $\Delta = E\nabla = \Delta E$ **(WINTER 2022, 3 Marks; SUMMER 2024)**
- **Q.** Write an algorithm for Newton's forward interpolation formula. **(WINTER 2023, 3 Marks OR; SUMMER 2025, 3 Marks)**

2. Lagrange's and Newton's Divided Difference Interpolation (Numerical):

- **Q.** Find the polynomial f(x) by using Lagrange's interpolation formula and hence find f(3) for the below data: x: 0, 1, 2, 5; f(x): 2, 3, 12, 147. [Diagram required – refer to the original question paper] **(SUMMER 2023, 7 Marks; WINTER 2023, OR)**
- **Q.** Using Newton's divided difference formula, evaluate f(9) from the following data: x: 5, 7, 11, 13, 17; f(x): 150, 392, 1452, 2366, 5202. / Given the values [table] Determine f(9). [Diagram required – refer to the original question paper] **(WINTER 2022; SUMMER 2024)**

3. Newton's Backward Interpolation and Polynomial Construction (Numerical):

- **Q.** 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. **(SUMMER 2022, 4 Marks OR; WINTER 2024, 4 Marks OR)**
- **Q.** Find the cubic polynomial which takes the following values: x: 0, 1, 2, 3; f(x): 1, 2, 1, 10. [Diagram required – refer to the original question paper] **(SUMMER 2025, 7 Marks OR; WINTER 2025, 4 Marks)**

Other Important Questions:

1. Theory and Derivations:

- **Q.** Describe application of Newton's divided difference formula. **(SUMMER 2026, 3 Marks)**
- **Q.** Derive the equation for Newton's forward difference polynomial. **(WINTER 2024, 7 Marks)**

2. Finite Differences (Numerical):

- **Q.** Construct the divided difference table with the arguments 2, 4, 9, 10 of the function $f(x) = x^3 - 2x$. **(SUMMER 2023, 3 Marks)**
- **Q.** Prepare Forward difference table for the following data. [Diagram required – refer to the original question paper] **(WINTER 2022)**
- **Q.** Evaluate (i) $\Delta \tan^{-1} x$, (ii) $\Delta(e^x \log 2x)$ **(SUMMER 2025, 4 Marks OR)**

3. Newton's Forward and Backward Interpolation (Numerical):

- **Q.** Using Newton's forward interpolation formula, find the value of f(1.6). [Diagram required – refer to the original question paper] **(SUMMER 2023, 4 Marks)**
- **Q.** The residents of a town are given below. Estimate the residents for the year 1830 using Newton's backward interpolation. [Diagram required – refer to the original question paper] **(SUMMER 2023, 4 Marks OR)**
- **Q.** Find Y(2.36) from the following table using Newton's backward interpolation method. [Diagram required – refer to the original question paper] **(WINTER 2022, OR)**
- **Q.** The following table gives the value of density (d) of a saturated water for various temperature (T) of saturated steam... Use Newton's forward interpolation formula to find the density when the temperature is 270 °C. [Data truncated in source – refer to the original question paper] [Diagram required – refer to the original question paper] **(SUMMER 2026, 7 Marks)**

4. Lagrange's Interpolation (Numerical):

- **Q.** The function y = sin x is tabulated below... Using Lagrange's interpolation formula find the value of sin(π/6). [Data truncated in source – refer to the original question paper] [Diagram required – refer to the original question paper] **(SUMMER 2024, OR)**
- **Q.** Use Lagrange's interpolation formula to find the value of y when x = 4, if the values of x and y are given below. [Diagram required – refer to the original question paper] **(WINTER 2022)**
- **Q.** Obtain the density of a 26% solution of H_3PO_4 in water at 20 °C using Lagrange's interpolation formula. Can we perform the same calculation using Newton's forward difference interpolation formula? Yes or No? [Diagram required – refer to the original question paper] **(SUMMER 2022)**
- **Q.** Apply Lagrange's interpolation formula to find the value of y when x = 10, if the following values of x and y are given. [Diagram required – refer to the original question paper] **(SUMMER 2026, 4 Marks)**

5. Newton's Divided Difference Interpolation (Numerical):

- **Q.** Using Newton's divided difference formula find f(8) from given table. [Diagram required – refer to the original question paper] **(SUMMER 2026, 4 Marks OR)**

6. Missing Terms (Numerical):

- **Q.** Find the missing term in the table. [Diagram required – refer to the original question paper] **(WINTER 2023, 4 Marks OR)**
- **Q.** Find the missing values in the following data. [Diagram required – refer to the original question paper] **(SUMMER 2025, 7 Marks)**
- **Q.** Find the missing term in the following table using interpolation. [Diagram required – refer to the original question paper] **(WINTER 2025, 7 Marks OR)**

Chapter 6 – Numerical Differentiation & Integration

Repeated Questions:

1. Theory, Derivations and Algorithms:

- **Q.** Derive formula for Trapezoidal Rule of numerical integration. **(SUMMER 2023, 3 Marks OR; SUMMER 2024, OR; WINTER 2024, 3 Marks)**
- **Q.** Derive formula for Simpson's 1/3 Rule of numerical integration. **(WINTER 2022, 3 Marks OR; SUMMER 2023, 3 Marks OR; WINTER 2024, 4 Marks OR)**
- **Q.** State the formulas for Trapezoidal Rule, Simpson's $1/3^{rd}$ rule, Simpson's $3/8^{th}$ rule. **(SUMMER 2024; WINTER 2025, 3 Marks)**
- **Q.** Write an algorithm for trapezoidal rule. **(SUMMER 2022, 3 Marks OR; WINTER 2023, 3 Marks; SUMMER 2025, 3 Marks OR)**

2. Numerical Integration (Numerical):

- **Q.** Evaluate $\int(0 \text{ to } 0.6)\ e^{-x^2}\ dx$ using the trapezoidal rule and Simpson's 1/3 rule, taking h = 0.1. / Use Simpson's $1/3^{rd}$ rule to find $\int(0 \text{ to } 0.6)\ e^{-x^2}\ dx$ by taking seven ordinates. **(SUMMER 2022, OR; WINTER 2023, 4 Marks; WINTER 2024, 7 Marks OR)**
- **Q.** Compute the value of $\int(0.2 \text{ to } 1.4)\ (\sin x - \log x + e^x)\ dx$ using Simpson's 3/8 rule. **(SUMMER 2022, 4 Marks; WINTER 2025, 7 Marks)**

Other Important Questions:

1. Theory and Algorithms:

- **Q.** Write an algorithm of Simpson's 3/8 rule. **(WINTER 2023, 3 Marks OR)**

2. Numerical Differentiation (Numerical):

- **Q.** Given that [table] Find dy/dx at x = 1.1 [Diagram required – refer to the original question paper] **(SUMMER 2024, 3 Marks OR)**

3. Numerical Integration – Simpson's Rules and Trapezoidal Rule (Numerical):

- **Q.** Evaluate $\int(0 \text{ to } 3)\ 1/(1 + x)\ dx$ with n = 6 by using Simpson's 3/8 rule. **(SUMMER 2023, 4 Marks)**
- **Q.** Evaluate $\int(0 \text{ to } 3)\ dx/(1 + x)$ by using Simpson's 3/8 Rule and hence calculate log 2. **(WINTER 2022, 7 Marks OR)**
- **Q.** Given that y = ln x and [table] Evaluate $\int(4 \text{ to } 5.2)\ \ln x\ dx$ using Simpson's 3/8 rule. [Diagram required – refer to the original question paper] **(SUMMER 2024)**
- **Q.** Given that [table] evaluate $\int(4 \text{ to } 5.2)\ \log x\ dx$ using any one method. [Diagram required – refer to the original question paper] **(SUMMER 2026)**
- **Q.** Evaluate $\int(0 \text{ to } 6)\ 1/(1 + x)\ dx$ taking h = 1 using Simpson 1/3 rule. **(SUMMER 2024, OR)**
- **Q.** Use the Trapezoidal rule to estimate the integral $\int(0 \text{ to } 2)\ e^{x^2}\ dx$ taking the number of intervals as 10. **(SUMMER 2025)**

4. Application (Chemical Engineering):

- **Q.** Find the isothermal work done on the gas if it is compressed from $v_1 = 22$ L to $v_2 = 2$ L. Use Trapezoidal rule to find $W = -\int(v_1 \text{ to } v_2)\ p\ dv$ [Diagram required – refer to the original question paper] **(WINTER 2022, OR)**

Chapter 7 – Ordinary Differential Equations

Repeated Questions:

1. Theory:

- **Q.** Discuss in brief about boundary value problems. / Discuss in brief about boundary problems. / Explain in brief about ordinary differential equation - boundary value problems. **(SUMMER 2022, 3 Marks; WINTER 2022, 3 Marks OR; WINTER 2023, 4 Marks; WINTER 2024, 4 Marks OR; SUMMER 2025, 4 Marks OR)**
- **Q.** Describe Milne's predictor-corrector method. **(SUMMER 2022, 3 Marks OR; WINTER 2024, 4 Marks OR)**
- **Q.** List out the methods used to solve ODEs using numerical method and also write its limitation. / Discuss in brief about initial and boundary value problems. **(SUMMER 2024; SUMMER 2026, 3 Marks)**

2. Euler's, Modified Euler's and Runge-Kutta Methods (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. **(SUMMER 2022; WINTER 2023; SUMMER 2025, OR)**
- **Q.** Using the modified Euler's method, find y(0.2) given $y' = y + e^x$, y(0) = 0. **(WINTER 2025, 4 Marks OR; SUMMER 2026, 4 Marks OR)**
- **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. **(SUMMER 2022, OR; WINTER 2025, 7 Marks OR)**

3. Taylor Series Method (Numerical):

- **Q.** Use the Taylor series method to find y(0.2), given that $dy/dx = 2y + 3e^x$, y(0) = 1. Taking h = 0.1. / Taking h = 0.2. **(SUMMER 2023, OR; WINTER 2024, 7 Marks OR)**
- **Q.** 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. **(WINTER 2025, 3 Marks OR; SUMMER 2026, 7 Marks)**

4. Milne's Predictor-Corrector Method (Numerical):

- **Q.** Use Milne's Predictor-Corrector Method, find y(4.4) given that $5x\,y' + y^2 - 2 = 0$ with y(4) = 1, y(4.1) = 1.0049, y(4.2) = 1.0097, y(4.3) = 1.0143. **(WINTER 2022, OR; SUMMER 2023, 7 Marks)**

Other Important Questions:

1. Euler's Method (Numerical):

- **Q.** Find the approximate solution of dy/dx = x + y, y(0) = 0 with h = 2 using Euler's Method in five steps. **(SUMMER 2023, 3 Marks)**
- **Q.** Using Euler's method, find an approximate value of y corresponding to x = 0.1 for the following equation. dy/dx = (y − x)/(y + x). Take y(0) = 1 and h = 0.02 **(SUMMER 2024)**
- **Q.** Using Euler's method find y(1.2), given that $dy/dx = x\sqrt{y}$, y(1) = 1, taking h = 0.1 **(WINTER 2022)**
- **Q.** Applying Euler's method to solve the initial value problem, dy/dx = x − y/2 where y(0) = 1 over [0, 3] using step size 0.5. **(WINTER 2024, 7 Marks OR)**

2. Modified Euler's and Second Order Runge-Kutta Methods (Numerical):

- **Q.** Using Modified Euler's method, find an approximate value of y when x = 0.6 with h = 0.1 given that dy/dx = x + 3y, subject to y(0) = 1. **(SUMMER 2023, 7 Marks OR)**
- **Q.** Use second order Runge-Kutta method to compute y(0.2) given that $dy/dx = x + \sqrt{y}$, y(0) = 4 by taking h = 0.1. **(SUMMER 2023, 4 Marks OR)**

3. Taylor Series Method (Numerical):

- **Q.** Use the Taylor series method to find y(0.1), given that $dy/dx = x^2 + y^2$, y(0) = 1. Taking h = 0.1 **(WINTER 2022)**

- **Q.** Solve by Taylor's series method the equation dy/dx = log(xy) for y(1.1) and y(1.2), given y(1) = 2. **(SUMMER 2022, OR)**
- **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 **(SUMMER 2025, 7 Marks)**

4. Fourth Order Runge-Kutta Method (Numerical):

- **Q.** Using Runge-Kutta method of fourth order, solve the following at x = 0.2 and 0.4. Take y(0) = 1: $dy/dx = (y^2 - x^2)/(y^2 + x^2)$ **(SUMMER 2024, OR)**
- **Q.** Apply 4^{th} order Runge-Kutta Method to compute y for x = 0.5, given that $dy/dx = \sqrt{(x + y)}$, y(0.4) = 0.41, h = 0.1 **(WINTER 2022)**
- **Q.** Using Runge-Kutta method of order 4, solve $dy/dx = xy + y^2$ with initial condition y(0) = 1, for x = 0.1, 0.2. **(SUMMER 2026, 7 Marks OR)**

5. Significance of Newton-Raphson / Secant Method:

- **Q.** Write the significance of Newton-Raphson/Secant method. **(SUMMER 2026, 3 Marks OR)**

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