As are the crests on the hoods of peacocks,
As are the gems on the heads of cobras,
So is Mathematics, at the top of all Sciences.

Class II B.Sc., CS (Third Semester)
Subject Mathematics
Paper Numerical Methods
With effect from 2009– 2010 (Under CBCS)

SYLLABUS
LESSON PLAN
QUESTION PATTERN
BLUE PRINT
MODEL QUESTION PAPER
QUESTION BANK
ASSIGNMENT / TEST SCHEDULE

Prepared
By
S. Mahaalingam
Semester III  NUMERICAL METHODS (Problem Oriented Paper)

SYLLABUS

Unit 1 Numerical Solution of Algebraic and Transcendental Equations

Unit 2 Solution of Simultaneous Linear Algebraic Equations
Direct Methods: Gauss-Elimination Method - Gauss-Jordon Method
Iterative Methods: Condition of Convergence of Iterative Methods - Gauss Jacobi Method - Gauss Seidel Method

Unit 3 Interpolation with Equal Intervals
Gregory-Newton Forward Interpolation Formula - Gregory-Newton Backward Interpolation Formula - Gauss Forward Interpolation Formula - Gauss Backward Interpolation Formula - Stirling’s Formula - Bessel’s Formula

Unit 4 Interpolation with Unequal Intervals: Divided Differences - Newton’s Interpolation Formula - Lagrange’s Interpolation Formula - Inverse Interpolation
Unit 5 Solutions of Ordinary Differential Equations of the First Order of the Form
\[ y' = f(x, y) \text{ with } y(x_0) = y_0 \]

Solution by Taylor Series (Type I) – Euler’s Method – Improved Euler Method – Modified Euler Method – Runge-Kutta Method of Fourth Order Only

Text Book Numerical Methods by P. Kandasamy, K. Thilagavathy, K. Gunavathy

Published by S. Chand & Company Limited, Ram Nagar, New Delhi – 110055.

Chapters

Unit 1Chapter 3 (3.1-3.5)
Unit 2Chapter 4 (4.1-4.2, 4.7-4.9)
Unit 3Chapter 6 (6.1-6.7), 7 (7.1-7.6)
Unit 4Chapter 8 (8.1-8.2, 8.5-8.8), 9 (9.7-9.11, 9.13-9.16)
Unit 5Chapter 11(11.5, 11.9-11.13)

References Numerical Methods in Engineering and Science by Dr. B.S. Grewal

Published by Khanna Publishers, 2-B – Nath Market, Nai Sarak, Delhi – 110006

SUBBALAKSHMI LAKSHMIPATHY COLLEGE OF SCIENCE
Department of Mathematics

LESSON PLAN

Class : II Year B.Sc., Computer Science
Semester : Third
Subject : Numerical Methods (Code – CBCS 2301)
Hours : 80

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**SUBBALAKSHMI LAKSHMIPATHY COLLEGE OF SCIENCE**

Department of Mathematics

**EXTERNAL QUESTION PATTERN**

Class : II B.Sc., Computer Science             Max. Marks : 75

Subject : Numerical Methods                     Duration : 3 hours

Subject Code : CBCS 2301

**Part A**  Answer all the questions (10 x 1)  10

**Part B**  Answer all the questions (Either or type) (5 x 7)  35

**Part C**  Answer any THREE questions (3 out of 5) (3 x 10)  30

6
INTERNAL QUESTION PATTERN

Class : II B.Sc., Computer Science
Max. Marks : 30

Subject : Numerical Methods
Duration : 2 hours
Subject Code : CBCS 2301

Part A  Answer all the questions (6 x 1) 06

Part B  Answer all the questions (Either or type) (2 x 7) 14

Part C  Answer any THREE questions (3 out of 5) (1 x 10) 10

Total Marks 30
Directions for the Examiners

The students having this paper didn’t study Mathematics in depth at higher secondary levels. Moreover, they are doing B.Sc., Computer Science and not B.Sc., Mathematics. So, just problematic approach is given for students.

Direction for the Students

Scientific / Engineering calculators and Clerk’s Table are allowed in both the internal and the external examinations.
Part A  **(Answer all the questions)**

10 x 1 = 10

1. If \(\sqrt{2} + \sqrt{3}\) is a root of an equation, then find the other roots.
2. What is a reciprocal equation?
3. What is the order of convergence of Newton’s method?
4. Write the condition of convergence of Iteration method.
5. What is the condition for existence of inverse, of a square matrix \(A\)?
6. Which method uses the process of back substitution in solving simultaneous linear algebraic equations?
7. What is the relation between the forward and the shift operator?
8. When we apply Stirling’s central difference interpolation formula?
9. Write trapezoidal rule for numerical integration.
10. Write Euler’s formula to solve a first order differential equation.

Part B  **(Answer all the questions)**

5 x 7 = 35

11. (a) Solve the reciprocal equation \(x^5 - 5x^4 + 9x^3 - 9x^2 + 5x - 1 = 0\).

(b) If \(\alpha, \beta, \gamma\) are the roots of \(x^3 + qx + r = 0\), find the value of \((\alpha + \beta)(\beta + \gamma)(\gamma + \alpha)\) and \((\alpha + \beta - 2\gamma)(\beta + \gamma - 2\alpha)(\gamma + \alpha - 2\beta)\)
12. (a) Find a real root of the equation $\cos x = 3x - 1$ correct to 4 places of decimals by iteration method.

**OR**

(b) Find the positive root of $x^3 - x = 1$ correct to four decimal places by bisection method.

13. (a) Solve the system of equations $x + 2y + z = 3$, $2x + 3y + 3z = 10$, $3x - y + 2z = 13$ by Gauss Elimination method.

**OR**

(b) Solve the following equations using relaxation method: $10x - 2y - 2z = 6$, $-x + 10y - 2z = 7$, $-x - y + 10z = 8$.

14. (a) Use Newton Gregory forward difference formula to calculate $\sqrt[5]{5}$ given $\sqrt[2]{2} = 2.236$, $\sqrt[3]{3} = 2.449$, $\sqrt[5]{5} = 2.646$ and $\sqrt[7]{7} = 2.828$.

**OR**

(b) Using Newton’s divided difference formula, find $f(2)$ given the following table:

<table>
<thead>
<tr>
<th>x</th>
<th>4</th>
<th>5</th>
<th>7</th>
<th>10</th>
<th>11</th>
<th>13</th>
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<tr>
<td>f(x)</td>
<td>48</td>
<td>100</td>
<td>294</td>
<td>900</td>
<td>1210</td>
<td>2028</td>
</tr>
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15. (a) Evaluate $\int_{\frac{x}{x^2 + x}} \frac{dx}{x^2 + x}$ using Simpson’s rule.

**OR**

(b) Using Taylor series method, find, correct to four decimal places, the value of $y(0.1)$, given $\frac{dy}{dx} = x^2 + y^2$ and $y(0) = 1$.

**Part C** *(Answer any TWO questions)*

$2 \times 15 = 30$

16. Find the condition that the roots of the equation $x^3 + px^2 + qx + r = 0$ may be in (a) Arithmetic Progression (b) Geometric Progression (c) Harmonic Progression
17. Find the positive root of $x^3 + 3x - 1 = 0$, correct to 2 decimal places, by Horner’s method.

18. Solve the system of equations $10x - 5y - 2z = 3$, $4x - 10y + 3z = -3$, $x + 6y + 10z = -3$ by Gauss Seidel method.

19. Use Gauss’s forward formula to get $y_{30}$ given that, $y_{21} = 18.4708$, $y_{25} = 17.8144$, $y_{29} = 17.1070$, $y_{33} = 16.3432$, $y_{37} = 15.5154$.

20. Apply the fourth order Runge-Kutta method to find $y(0.2)$ given $y' = x + y$, $y(0) = 1$ by taking $h = 0.1$.

QUESTION BANK

SUBJECT    NUMERICAL METHODS    CODE    CBCS 2301
CLASS      II B.Sc., Computer Science (Third Semester)

UNIT 1    The Solution of Numerical Algebraic and Transcendental Equations

PART A

1. Define an algebraic equation of $n^{th}$ degree.
2. Diminish by 3 the roots of $x^4 + 3x^3 - 2x^2 - 4x - 3 = 0$.
3. Increase by 2 the roots of $x^4 - x^3 - 10x^2 + 4x + 24 = 0$.
4. Diminish the roots of $3x^3 + 8x^2 + 8x + 12 = 0$ by 4.
5. Increase by 7 the roots of the equation $3x^4 - 7x^3 - 15x^2 + x - 2 = 0$.
6. State Descarte’s rule of sings.
7. Determine the nature of the roots of $x^6 + 3x^5 + 5x - 1 = 0$. 
8. Discuss the nature of roots of the equation \( x^5 + x^4 + x^2 + x + 1 = 0 \).

9. Discuss the nature of roots of the equation \( x^6 - 3x^4 + 2x^3 - 1 = 0 \).

10. Discuss the nature of roots of the equation \( x^5 + 5x - 9 = 0 \).

11. Discuss the nature of roots of the equation \( x^5 + x^2 - 1 = 0 \).

12. Discuss the nature of roots of the equation \( x^5 + 27 = 0 \).

13. Discuss the nature of roots of the equation \( x^5 - 6x^2 - 4x + 7 = 0 \).

14. Write the condition of convergence of Newton’s method.

15. Write the condition of convergence of Iteration method.

16. What is the order of convergence of Newton’s method?

17. What is the order of convergence of Iteration method?

18. Write the iterative formula of Newton’s method.

19. Write the iterative formula of Iteration method.

20. Write the formula to compute ‘c’ in Bisection method.

21. Write the formula to compute ‘c’ in Regula-falsi method.

22. What is the other name of Newton’s method?

23. Obtain the interval of the positive root of \( x^3 - x - 1 = 0 \).

24. Write the Iterative formula and condition of convergence of Newton’s method.

25. Write the Iterative formula and condition of convergence of Iteration method.

26. Write short notes on Horner’s method.

27. Find an iterative formula to find \( \sqrt{N} \).

28. Find an iterative formula to find the reciprocal of a given number N.

29. Find the order of convergence of Newton’s method.

30. Find the order of convergence of Iterative method.

31. Construct \( \phi(x) \) from \( \cos x = 3x - 1 \) that satisfies the condition of convergence.

32. Construct \( \phi(x) \) from \( 4x - e^x = 0 \) that satisfies the condition of convergence.
33. How will you find the negative real root of the equation \( f(x) = 0 \)?

**PART B**

34. Explain bisection method to find the real root of the equation \( f(x) = 0 \).

35. Find the positive root of \( x^3 - x = 1 \) correct to four decimal places by bisection method.

36. Assuming that a root of \( x^3 - 9x + 1 = 0 \) lies in the interval \((2, 4)\), find that root by bisection method.

37. Find the positive root of \( x - \cos x = 0 \) by bisection method.

38. Find the positive root of \( x^4 - x^3 - 2x^2 - 6x - 4 = 0 \) by bisection method correct to 2 places of decimals.

39. Find the positive root of \( x^3 = 2x + 5 \) by false position method.

40. Solve for a positive root of \( x^3 - 4x + 1 = 0 \) by regula falsi method.

41. Find an approximate root of \( x \log_{10} x - 1.2 = 0 \) by false position method.

42. Solve for a positive root of \( x - \cos x = 0 \) by regula falsi method.

43. Solve the equation \( x \tan x = -1 \) by regula falsi method, starting with \( a = 2.5 \) and \( b = 3 \) correct to 3 decimal places.

44. Find a positive root of \( x e^x = 2 \) by the method of false position.

45. Find the positive root of the equation \( x^3 - 4x - 9 = 0 \) by bisection method.

46. Find the positive root of the equation \( e^x = 3x \) by bisection method.

47. Find the positive root of the equation \( x^3 + 4x - 1 = 0 \) by bisection method.
48. Find the positive root of the equation $3x = \cos x + 1$ by bisection method.
49. Find the positive root of the equation $x^3 + x^2 - 1 = 0$ by bisection method.
50. Find the positive root of the equation $2x = 3 + \cos x$ by bisection method.
51. Solve $x e^x = 3$ for a positive root by false position method.
52. Solve $4x = e^x$ for a positive root by false position method.
53. Solve $x \log_{10} x = 1.2$ for a positive root by false position method.
54. Solve $e^x = \sin x$ for a positive root by false position method.
55. Solve $x^3 - 5x - 7 = 0$ positive root by false position method.
56. Solve $2x - \log_{10} x = 7$ for a positive root by false position method.
57. Solve $3x - \cos x = 1$ for a positive root by false position method.
58. Solve $2x - 3\log x = 5$ for a positive root by false position method.
59. Find the positive root of $f(x) = 2x^3 - 3x - 6 = 0$ by Newton-Raphson method correct to five decimal places.
60. Using Newton’s method, find the root between 0 and 1 of $x^3 = 6x - 4$ correct to five decimal places.
61. Find the real positive root of $3x - \cos x - 1 = 0$ by Newton’s method correct to 6 decimal places.
62. Find the positive root of $x = \cos x$ by Newton’s method.
63. Find the root of $4x - e^x = 0$ that lies between 2 and 3 using Newton’s method.
64. Find the positive root of $x^3 - x - 1 = 0$ using Newton-Raphson method.
65. Find the positive root of $f(x) = \cos x - x e^x$ using Newton-Raphson method.
66. Find a real root of $x^3 + 2x^2 + 50x + 7 = 0$ using Newton-Raphson method.
67. Find the value of \( \sqrt[3]{\frac{3}{18}} \) using Newton-Raphson method.

68. Find the positive root of \( x - 2 \sin x = 0 \) by Newton’s method.

69. Find a real root of \( x^3 + x + 1 = 0 \) using Newton-Raphson method.

70. Find the cube root of 24 correct to 3 decimal places using Newton’s method.

71. Find a real root of \( x^3 - x - 2 = 0 \) using Newton-Raphson method.

72. Solve for a positive root of \( x \, e^x = 1 \) using Newton-Raphson method.

73. Solve for a positive root of \( 2x - 3 \sin x = 5 \) using Newton-Raphson method.

74. Find a positive root of \( x \, e^x = \cos x \) using Newton-Raphson method.

75. Solve \( e^x - 3x = 0 \) by the method of iteration.

76. Find a real root of the equation \( \cos x = 3x - 1 \) correct to 4 places of decimals by iteration method.

77. Solve the equation \( x^3 + x^2 - 1 = 0 \) for the positive root by iteration method.

78. Solve \( x^3 = 2x + 5 \) for the positive root by iteration method.

79. Find a positive root of \( 3x - \sqrt{x^2 + \sin x} = 0 \) by iteration method.

80. Solve the equation \( 3x - \cos x - 2 = 0 \) using iteration method.

81. Solve the equation \( x^3 + x + 1 = 0 \) using iteration method.

82. Solve the equation \( 2x - \log_{10} x = 7 \) using iteration method.

83. Solve the equation \( \cos x = 3x - 1 \) using iteration method.

**PART C**

84. Using bisection method, find the negative root of \( x^3 - 4x + 9 = 0 \).

85. Find a positive root of \( 3x = \sqrt{x^2 + \sin x} \) by bisection method.
86. Solve \( x^3 + 2x^2 + 10x - 20 \) for a positive root by false position method.
87. Find a negative real root of \( \sin x = 1 + x^3 \) using Newton–Raphson method.
88. Find a negative real root of \( x^2 + 4 \sin x = 0 \) using Newton–Raphson method.
89. Solve for \( x \) from \( \cos x - x e^x = 0 \) by iteration method.
90. Find an iterative formula to find \( \sqrt[3]{N} \) (where \( N \) is a positive number) and hence find \( \sqrt[3]{8} \).
91. Find an iterative formula to find the reciprocal of a given number \( N \) and hence find the value of \( \frac{3}{\sqrt[7]{3}} \).
92. Find the positive root of \( x^3 + 3x - 1 = 0 \), correct to two decimal places, by Horner’s method.
93. Find the positive root between 1 and 2 which satisfies \( x^3 - 3x + 1 = 0 \) to 3 decimal places by using Horner’s method.
94. By Horner’s method, find the root of \( x^3 - 3x^2 + 2.5 = 0 \) that lies between 2 and 3.
95. By Horner’s method, find the root of \( x^3 + 6x + 2 = 0 \) that lies between 0 & -1.
96. By Horner’s method, find the root of \( x^3 - 2x^2 - 3x - 4 = 0 \) whose root lies between 3 and 4.
97. By Horner’s method, find the positive root of \( x^3 - 8x - 40 = 0 \).
98. By Horner’s method, find the positive root of \( h^3 + 3h^2 - 12h - 11 = 0 \).
99. By Horner’s method, find the positive root of \( x^3 - 6x - 18 = 0 \).
100. By Horner’s method, find the positive root of \( x^3 - x = 9 \).
101. By Horner’s method, find the root of \( 10x^3 - 15x + 3 = 0 \) that lies between 1 and 2.
UNIT 2 Solution of Simultaneous Linear Algebraic Equations

PART A

1. Name the two types of methods involved in solving simultaneous linear algebraic equations.
2. Name any two direct methods to solve simultaneous linear algebraic equations.
3. What is the condition for existence of inverse, of a square matrix A?
4. Name any two iterative methods to solve simultaneous linear algebraic equations.
5. Which method uses the process of back substitution in solving simultaneous linear algebraic equations?
6. Give the conditions of converge of Iterative methods to solve system of simultaneous linear equations.
7. What is the major difference between direct and iterative methods in solving system of simultaneous linear equations?
8. Check whether the system of equations $2x - 3y + 10z = 3$, $-x + 4y + 2z = 20$, $5x + 2y + z = -12$ satisfies the condition of convergence or not.
9. Check whether the system of equations $8x + y + z + w = 14$, $2x + 10y + 3z + w = -8$, $x - 2y - 20z + 3w = 111$, $3x + 2y + 2z + 19w = 53$ satisfies the condition of convergence or not.
10. When a matrix is said to be diagonally dominant?
11. Write Gauss Jacobi iterative formula to solve the system of equations \( a_1x + b_1y + c_1z = d_1, \ a_2x + b_2y + c_2z = d_2, \ a_3x + b_3y + c_3z = d_3. \)

12. Write Gauss Jacobi iterative formula to solve the system of equations \( a_1x + b_1y + c_1z = d_1, \ a_2x + b_2y + c_2z = d_2, \ a_3x + b_3y + c_3z = d_3. \)

13. Write the condition of convergence of Relaxation method.

14. Write the condition of convergence of Gauss Jacobi method.

15. Write the condition of convergence of Gauss Seidel method.

**PART B**

16. Solve the system of equations \( x + 2y + z = 3, \ 2x + 3y + 3z = 10, \ 3x - y + 2z = 13 \) by Gauss Elimination method.

17. Solve the system of equations \( 2x + 3y - z = 5, \ 4x + 4y - 3z = 3, \ 2x - 3y + 2z = 2 \) by Gauss Elimination method.

18. Using Gauss Elimination method, solve the system \( 3.15x - 1.96y + 3.85z = 12.95, \ 2.13x + 5.12y - 2.89z = -8.61, \ 5.923x + 3.05y + 2.15z = 6.88 \)

19. Solve by Gauss Elimination method: \( 3x + 4y + 5z = 18, \ 2x - y + 8z = 13, \ 5x - 2 + 7z = 20. \)

20. Solve the system of equations \( x - y + z = 1, \ -3x + 2y - 3z = -6, \ 2x - 5y + 4z = 5 \) by Gauss Elimination method.

21. Solve the system of equations \( x + 3y + 10z = 24, \ 2x + 17y + 4z = 35, \ 28x + 4y - z = 32 \) by Gauss Elimination method.
22. Solve the system of equations \( x - 3y - z = -30 \), \( 2x - y - 3z = 5 \), \( 5x - y - 2z = 142 \) by Gauss Elimination method.

23. Solve the system of equations \( 10x + y + z = 12 \), \( x + 10y + z = 12 \), \( x + y + 10z = 12 \) by Gauss Elimination method.

24. Solve the system of equations \( 3x + y - z = 3 \), \( 2x - 8y + z = -5 \), \( x - 2y + 9z = 8 \) by Gauss Elimination method.

25. Solve the system of equations \( 3x - y + 2z = 12 \), \( x + 2y + 3z = 11 \), \( 2x - 2y - z = 2 \) by Gauss Elimination method.

26. Solve the system of equations \( 2x - 3y + z = -1 \), \( x + 4y + 5z = 25 \), \( 3x - 4y + z = 2 \) by Gauss Elimination method.

27. Solve the system of equations \( x + 2y + 3z = 6 \), \( 2x + 4y + z = 7 \), \( 3x + 2y + 9z = 14 \) by Gauss Elimination method.

28. Solve the system of equations \( 4x + y + 3z = 11 \), \( 3x + 4y + 2z = 11 \), \( 2x + 3y + z = 7 \) by Gauss Elimination method.

29. Solve the system of equations \( x + y + 2z = 4 \), \( 3x + y - 3z = -4 \), \( 2x - 3y - 5z = -5 \) by Gauss Elimination method.

30. Solve the system of equations \( 2x + 6y - z = -12 \), \( 5x - y + z = 11 \), \( 4x - y + 3z = 10 \) by Gauss Elimination method.

31. Solve the system of equations \( 6x - y + z = 13 \), \( x + y + z = 9 \), \( 10x + y - z = 19 \) by Gauss Elimination method.

32. Solve the system of equations \( 2x + 4y + z = 3 \), \( 3x + 2y - 2z = -2 \), \( x - y + z = 6 \) by Gauss Elimination method.

**PART C**

33. Solve the system of equations \( x + 2y + z = 3 \), \( 2x + 3y + 3z = 10 \), \( 3x - y + 2z = 13 \) by Gauss Jordon method.

34. Apply Gauss Jordon method to find the solution of the following system \( 10x + y + z = 12 \), \( 2x + 10y + z = 13 \), \( x + y + 5z = 7 \).
35. Solve the system of equations \( x - y + z = 1, -3x + 2y - 3z = -6, 2x - 5y + 4z = 5 \) by Gauss Jordon method.
36. Solve the system of equations \( x + 3y + 10z = 24, 2x + 17y + 4z = 35, 28x + 4y - z = 32 \) by Gauss Jordon method.
37. Solve the system of equations \( x - 3y - z = -30, 2x - y - 3z = 5, 5x - y - 2z = 142 \) by Gauss Jordon method.
38. Solve the system of equations \( 10x + y + z = 12, x + 10y + z = 12, x + y + 10z = 12 \) by Gauss Jordon method.
39. Solve the system of equations \( 3x + y - z = 3, 2x - 8y + z = -5, x - 2y + 9z = 8 \) by Gauss Jordon method.
40. Solve the system of equations \( 3x - y + 2z = 12, x + 2y + 3z = 11, 2x - 2y - z = 2 \) by Gauss Jordon method.
41. Solve the system of equations \( 2x - 3y + z = -1, x + 4y + 5z = 25, 3x - 4y + z = 2 \) by Gauss Jordon method.
42. Solve the system of equations \( x + 2y + 3z = 6, 2x + 4y + z = 7, 3x + 2y + 9z = 14 \) by Gauss Jordon method.
43. Solve the system of equations \( 4x + y + 3z = 11, 3x + 4y + 2z = 11, 2x + 3y + z = 7 \) by Gauss Jordon method.
44. Solve the system of equations \( x + y + 2z = 4, 3x + y - 3z = -4, 2x - 3y - 5z = -5 \) by Gauss Jordon method.
45. Solve the system of equations \( 2x + 6y - z = -12, 5x - y + z = 11, 4x - y + 3z = 10 \) by Gauss Jordon method.
46. Solve the system of equations \( 6x - y + z = 13, x + y + z = 9, 10x + y - z = 19 \) by Gauss Jordon method.
47. Solve the system of equations \( 2x + 4y + z = 3, 3x + 2y - 2z = -2, x - y + z = 6 \) by Gauss Jordon method.
48. Solve the system of equations \( 5x_1 + x_2 + x_3 + x_4 = 4, x_1 + 7x_2 + x_3 + x_4 = 12, x_1 + x_2 + 6x_3 + x_4 = -5, x_1 + x_2 + x_3 + 4x_4 = -6 \) by Gauss Jordon method.
49. Solve the system of equations $x + 2y + z - w = -2$, $2x + 3y - z + 2w = 7$, $x + y + 3z - 2w = -6$, $x + y + z + w = 2$ by Gauss Elimination method.

50. Solve the system of equations $w + x + y + z = 2$, $2w - x + 2y - z = -5$, $3w + 2x + 3y + 4z = 7$, $w - 2x - 3y + 2z = 5$ by Gauss Jordon method.

51. Solve the system of equations $x + 2y + z - w = -2$, $2x + 3y - z + 2w = 7$, $x + y + 3z - 2w = -6$, $x + y + z + w = 2$ by Gauss Jordon method.

52. Solve the system of equations $10x - 5y - 2z = 3$, $4x - 10y + 3z = -3$, $x + 6y + 10z = -3$ by Gauss Jacobi method.

53. Solve the system of equations $8x - 3y + 2z = 20$, $4x - 10y + 3z = -3$, $x + 6y + 10z = 72$ by Gauss Jacobi method.

54. Solve the system of equations $10x - 5y - 2z = 3$, $4x - 10y + 3z = -3$, $x + 6y + 10z = -3$ by Gauss Jacobi method.

55. Solve the system of equations $5x - 2y + z = -4$, $x + 6y - 2z = -1$, $3x + y + 5z = 13$ by Gauss Jacobi method.

56. Solve the system of equations $8x + y + z = 8$, $2x + 4y + z = 4$, $x + 3y + 3z = 5$ by Gauss Jacobi method.

57. Solve the system of equations $30x - 2y + 3z = 75$, $2x + 2y + 18z = 30$, $x + 17y - 2z = 48$ by Gauss Jacobi method.

58. Solve the system of equations $10x - 2y + z = 12$, $x + 9y - z = 10$, $2x - y + 11z = 20$ by Gauss Jacobi method.

59. Solve the system of equations $8x - y + z = 18$, $2x + 5y - 2z = 3$, $x + y - 3z = -16$ by Gauss Jacobi method.

60. Solve the system of equations $4x + 2y + z = 14$, $x + 5y - z = 10$, $x + y + 8z = 20$ by Gauss Jacobi method.

61. Solve the system of equations $x - 2y + 10z = 30.6$, $2x + 5y - z = 10.5$, $3x + y + z = 9.3$ by Gauss Jacobi method.

62. Solve the system of equations $83x + 11y - 4z = 95$, $7x + 52y + 13z = 104$, $3x + 8y + 29z = 71$ by Gauss Jacobi method.
63. Solve the system of equations $10x - 5y - 2z = 3$, $4x - 10y + 3z = -3$, $x + 6y + 10z = -3$ by Gauss Seidel method.

64. Solve the system of equations $8x - 3y + 2z = 20$, $4x - 10y + 3z = -3$, $x + 6y + 10z = -3$ by Gauss Seidel method.

65. Solve the system of equations $28x + 4y - z = 32$, $x + 3y + 10z = 24$, $2x + 17y + 4z = 35$ by Gauss Seidel method.

66. Solve the system of equations $x + y + 54z = 110$, $27x + 6y - z = 85$, $6x + 15y + 2z = 72$ by Gauss Seidel method.

67. Solve the system of equations $5x - 2y + z = -4$, $x + 6y - 2z = -1$, $3x + y + 5z = 13$ by Gauss Seidel method.

68. Solve the system of equations $8x + y + z = 8$, $2x + 4y + z = 4$, $x + 3y + 3z = 5$ by Gauss Seidel method.

69. Solve the system of equations $30x - 2y + 3z = 75$, $2x + 2y + 18z = 30$, $x + 17y - 2z = 48$ by Gauss Seidel method.

70. Solve the system of equations $10x - 2y + z = 12$, $x + 9y - z = 10$, $2x - y + 11z = 20$ by Gauss Seidel method.

71. Solve the system of equations $8x - y + z = 18$, $2x + 5y - 2z = 3$, $x + y - 3z = -16$ by Gauss Seidel method.

72. Solve the system of equations $4x + 2y + z = 14$, $x + 5y - z = 10$, $x + y + 8z = 20$ by Gauss Seidel method.

73. Solve the system of equations $x - 2y + 10z = 30.6$, $2x + 5y - z = 10.5$, $3x + y + z = 9.3$ by Gauss Seidel method.

74. Solve the system of equations $83x + 11y - 4z = 95$, $7x + 52y + 13z = 104$, $3x + 8y + 29z = 71$ by Gauss Seidel method.

**THINGS TO REMEMBER**
UNIT 3  Interpolation with equal intervals

PART A

1. What is interpolation and extrapolation?
2. Write the formula for forward and backward difference operator.
3. Write the formula for the shift operator.
4. Write the formula for central difference operator.
5. What is the relation between the forward and the shift operator?
6. Give any two central difference interpolation methods.
7. What is the relation between Gauss and Stirling’s formula?
8. When Gauss forward formula is useful for interpolation?
9. When Gauss backward formula is useful for interpolation?
10. When we apply Stirling’s central difference interpolation formula?
11. When Stirling’s formula is useful for interpolation?
12. When Bessel’s formula is useful for interpolation?
13. What is the other name of Bessel’s formula?
14. Write Newton Gregory forward difference interpolation formula.
15. Write Newton Gregory backward difference interpolation formula.
16. Write Gauss forward difference interpolation formula.
17. Write Gauss backward difference interpolation formula.
18. Write Stirling’s central difference interpolation formula.
19. Write Bessel’s central difference interpolation formula.
20. What is the error in polynomial interpolation?
21. What is the error in Newton’s forward interpolation formula?
22. What is the error in Newton’s backward interpolation formula?

PART B

23. Find a polynomial of degree four which takes the values
    \[ x : \quad 2 \quad 4 \quad 6 \quad 8 \quad 10 \]
    \[ y : \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \]
24. Find a polynomial of degree two which takes the values
    \[ x : \quad 0 \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6 \quad 7 \]
    \[ y : \quad 1 \quad 2 \quad 4 \quad 7 \quad 11 \quad 16 \quad 22 \quad 29 \]
25. Find the missing value of the table given below.
    \[ \text{Year} : \quad 1917 \quad 1918 \quad 1919 \quad 1920 \quad 1920 \]
    \[ \text{Export (in tons)} : \quad 443 \quad 384 \quad ---- \quad 397 \quad 467 \]
26. Find the missing value of the following table.
    \[ x : \quad 0 \quad 1 \quad 2 \quad 3 \quad 4 \]
    \[ y : \quad 1 \quad 2 \quad 4 \quad ---- \quad 16 \]
27. Find the annual premium at the age of 30, given
    \[ \text{Age} : \quad 21 \quad 25 \quad 29 \quad 33 \]
    \[ \text{Premium} : \quad 14.27 \quad 15.81 \quad 17.72 \quad 19.96 \]
28. Find the polynomial of least degree passing through the points \((0, -1), (1, 1), (2, 1), (3, -2)\).
29. Construct a polynomial for the data given below. Find also 
\( y (x = 5) \).
\[
\begin{array}{c|cccc}
  x & 4 & 6 & 8 & 10 \\
  y & 1 & 3 & 8 & 16 \\
\end{array}
\]
30. Given the following data, express \( y \) as a function of \( x \).
\[
\begin{array}{c|cccc}
  x & 0 & 1 & 2 & 3 & 4 \\
  y & 3 & 6 & 11 & 18 & 27 \\
\end{array}
\]
31. From the table given below find \( f (3.4) \).
\[
\begin{array}{c|cccc}
  x & 3 & 4 & 5 & 6 \\
  y & 31 & 69 & 131 & 223 \\
\end{array}
\]
32. Find \( f (2.5) \) given,
\[
\begin{array}{c|cccc}
  x & 1 & 2 & 3 & 4 & 5 & 6 \\
  y & 0 & 1 & 8 & 27 & 64 & 125 \\
\end{array}
\]
33. Find \( f (0.5) \), if \( f (-1) = 202 \), \( f (0) = 175 \), \( f (1) = 82 \), \( f (2) = 55 \).
34. Using Newton’s backward formula, find the polynomial of degree 3 passing through \( (3,6) \), \( (4, 24) \), \( (5, 60) \), \( (6, 120) \)
35. Find the value of \( f (x) \) at \( x = 9 \) from the following table:
\[
\begin{array}{c|cccc}
  x & 2 & 5 & 8 & 11 \\
  f (x) & 94.8 & 87.9 & 81.3 & 75.1 \\
\end{array}
\]
36. Calculate \( \sqrt[3]{x\sqrt{x}} \) given \( \sqrt[3]{x} = 2.236 \), \( \sqrt{x} = 2.449 \), \( \sqrt{10} = 2.646 \) and \( \sqrt{2} = 2.828 \).
37. Derive Stirling’s central difference interpolation formula for equal intervals.
38. Apply Gauss forward formula to obtain \( f (x) \) at \( x = 3.5 \) from the table below.
\[
\begin{array}{c|cccc}
  x & 2 & 3 & 4 & 5 \\
  f (x) & 2.626 & 3.454 & 4.784 & 6.986 \\
\end{array}
\]
39. Given \( f (2) = 10 \), \( f (1) = 8 \), \( f (0) = 5 \), \( f (-1) = 10 \), find \( f (½) \) by Gauss forward formula.
40. Apply central difference formula to find \( f (12) \) given,
\[
\begin{array}{c|cccc}
  x & 5 & 10 & 15 & 20 \\
\end{array}
\]
\[ f(x) : \quad 54.14, 60.54, 67.72, 75.88 \]

41. From the table below, find \( y(5) \) given, using Bessel’s formula.

<table>
<thead>
<tr>
<th>( x )</th>
<th>0</th>
<th>4</th>
<th>8</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>143</td>
<td>158</td>
<td>177</td>
<td>199</td>
</tr>
</tbody>
</table>

42. Apply Bessel’s formula to get the value of \( y_{25} \) given \( y_{20} = 2854, \ y_{24} = 3162, \ y_{28} = 3844, \ y_{32} = 3992 \).

43. Using Bessel’s formula, estimate \( \frac{y}{x^4} \) given,

\[
\begin{array}{cccc}
\frac{y}{x^4} & 3.4482 & 3.5569 & 3.6593 & 3.7563 \\
\end{array}
\]

44. Apply Bessel’s formula to get the value of \( y(45) \) given,

<table>
<thead>
<tr>
<th>( x )</th>
<th>40</th>
<th>44</th>
<th>48</th>
<th>52</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y )</td>
<td>51.08</td>
<td>63.24</td>
<td>70.88</td>
<td>79.84</td>
</tr>
</tbody>
</table>

45. Using Bessel’s formula obtain the value of \( y(5) \) given,

<table>
<thead>
<tr>
<th>( x )</th>
<th>0</th>
<th>4</th>
<th>8</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y )</td>
<td>14.27</td>
<td>15.81</td>
<td>17.72</td>
<td>19.96</td>
</tr>
</tbody>
</table>

**PART C**

46. Find the values of \( y \) at \( x = 21 \) and \( x = 28 \) from the following data.

\[
\begin{array}{cccc}
\frac{y}{x} & 20 & 23 & 26 & 29 \\
\frac{y}{x^2} & 0.3420 & 0.3907 & 0.4384 & 0.4848 \\
\end{array}
\]

47. From the following table of half-yearly premium for policies maturing at different ages, estimate the premium for policies maturing at age 46 and 63:

<table>
<thead>
<tr>
<th>Age ( x )</th>
<th>45</th>
<th>50</th>
<th>55</th>
<th>60</th>
<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premium ( y )</td>
<td>111.84</td>
<td>96.16</td>
<td>83.32</td>
<td>74.48</td>
<td>68.68</td>
</tr>
</tbody>
</table>

48. From the following table, find the value of tan \( 45^\circ 15'\).
49. The population of a town is as follows.
   Population in lakhs : 20 24 29 36 46 51
   Estimate the population increase during the period 1946 to 1976.

50. From the following data, find \( \theta \) at \( x = 43 \) and \( x = 84 \).
   \[
   \begin{array}{c|c|c|c|c|c|c}
   x & 40 & 50 & 60 & 70 & 80 & 90 \\
   \theta & 184 & 204 & 225 & 250 & 276 & 304 \\
   \end{array}
   \]

51. From the data given below, find the number of students whose weight is between 60 & 70.
   Weight in lbs : 0-40 40-60 60-80 80-100 11-120
   No. of students: 250 120 100 70 50

52. The following data are taken from the steam table.
   Temp. °C : 140 150 160 170 180
   Pressure kgf/cm² : 3.685 4.854 6.302 8.076 10.225
   Find the pressure at temperature \( t = 142° \) and \( t = 175° \).

53. From the table given below, find \( \sin 52° \) by using Newton’s forward interpolation formula. Also estimate the error.
   \[
   \begin{array}{c|c|c|c}
   x & 45 & 50 & 55 \\
   y = \sin x & 0.7071 & 0.7660 & 0.8192 \\
   \end{array}
   \]

54. Find the value of \( e^{1.85} \) given \( e^{1.7} = 5.4739, \ e^{1.8} = 6.0496, \ e^{1.9} = 6.6859, \ e^{2.0} = 7.7891, \ e^{2.1} = 8.1662, \ e^{2.2} = 9.0250, \ e^{2.3} = 9.9742. \)

55. Find \( \log_{10} \pi \) given, \( \log 3.141 = 0.4970679364, \ log 3.142 = 0.4972061807, \ log 3.143 = 0.4973443810, \ log 3.144 = 0.4974825374, \ log 3.145 = 0.4976206498 \) where \( \pi = 3.14159. \)
56. Find the value of y at x = 1.05 from the table given below:
   \[
   \begin{array}{c|c|c|c|c|c|c}
   x & 1.0 & 1.1 & 1.2 & 1.3 & 1.4 & 1.5 \\
   \hline
   y & 0.841 & 0.891 & 0.932 & 0.964 & 0.985 & 1.015 \\
   \end{array}
   \]

57. Find the value of f (1.02) at x = 1.05 from the table given below:
   \[
   \begin{array}{c|c|c|c|c|c|c}
   x & 1.0 & 1.1 & 1.2 & 1.3 & 1.4 \\
   \hline
   y & 0.841 & 0.891 & 0.932 & 0.964 & 0.985 \\
   \end{array}
   \]

58. Find y at x = 105 from the following data:
   \[
   \begin{array}{c|c|c|c|c|c|c|c|c|c}
   x & 80 & 85 & 90 & 95 & 100 \\
   \hline
   y & 5026 & 5674 & 6362 & 7088 & 7854 \\
   \end{array}
   \]

59. Find y (42) from the data given below.
   \[
   \begin{array}{c|c|c|c|c|c|c|c|c|c}
   x & 20 & 25 & 30 & 35 & 40 & 45 \\
   \hline
   y & 354 & 332 & 291 & 260 & 231 & 204 \\
   \end{array}
   \]

60. Find y (0.47) from the data given below.
   \[
   \begin{array}{c|c|c|c|c|c|c|c|c|c}
   x & 0 & 0.1 & 0.2 & 0.3 & 0.4 & 0.5 \\
   \hline
   y & 1.0000 & 1.1103 & 1.2428 & 1.3997 & 1.5836 & 1.7974 \\
   \end{array}
   \]

61. Find f (0.2) if f (0) = 176, f (1) = 185, f (2) = 194, f (3) = 203, f (4) = 212, f (5) = 220, and f (6) = 229.

62. For the following data, find the forward and backward difference polynomials. Interpolate at x = 0.25 and x = 0.35.
   \[
   \begin{array}{c|c|c|c|c|c}
   x & 0.1 & 0.2 & 0.3 & 0.4 & 0.5 \\
   \hline
   f (x) & 1.40 & 1.56 & 1.76 & 2.00 & 2.28 \\
   \end{array}
   \]

63. From the following table, find the value of tan 45° 15′.
   \[
   \begin{array}{c|c|c|c|c|c|c}
   x° & 0 & 4 & 8 & 12 & 16 & 20 \\
   \hline
   \tan x° & 0 & 0.0699 & 0.1405 & 0.2126 & 0.2167 & 0.3640 & 0.4402 \\
   \end{array}
   \]

64. Estimate e^{1.9} from the given data.
   \[
   \begin{array}{c|c|c|c|c|c|c}
   x & 1.00 & 1.25 & 1.50 & 1.75 & 2.00 \\
   \end{array}
   \]
65. The population of a town is given below. Estimate the population in the year 1895 & 1925.

Year x: 1891 1901 1911 1921 1931

66. Find y (32) if y (10) = 35.3, y (15) = 32.4, y (20) = 29.2, y (25) = 26.1, y (30) = 23.2, y (30) = 20.5.

67. Estimate sin 38° from the data given below.

x: 0 10 20 30 40
sin x: 0 0.17365 0.34202 0.50000 0.64279

68. Find y (8) given,

x: 0 5 10 15 20 25
y: 7 11 14 18 24 32

69. Find y (1.02) given,

x: 1.00 1.05 1.10 1.15 1.20
y: 0.3413 0.3531 0.3643 0.3749 0.3849

70. Apply Gauss’s forward central difference formula and estimate f (32) from the table:

x: 25 30 35 40
y = f(x): 0.2707 0.3027 0.3386 0.3794

71. Using the following table, apply Gauss’s forward formula to get f (3.75).

x: 2.5 3.0 3.5 4.0 4.5 5.0

72. Using Gauss’s backward interpolation formula find the population for the year 1936 given that

Year: 1901 1911 1921 1931 1941 1951
Population (in thousand) : 12 15 20 27 39 52

73. Find the value of \( \cos 51^\circ 42' \) by using Gauss’s backward interpolation formula from the table given below.

<table>
<thead>
<tr>
<th>( x )</th>
<th>50°</th>
<th>51°</th>
<th>52°</th>
<th>53°</th>
<th>54°</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y = \cos x )</td>
<td>0.6428</td>
<td>0.6293</td>
<td>0.6157</td>
<td>0.6018</td>
<td>0.5878</td>
</tr>
</tbody>
</table>

74. If \( \sqrt[3]{12500} = 111.803399, \sqrt[3]{12510} = 111.848111, \sqrt[3]{12520} = 111.892805, \sqrt[3]{12530} = 111.937483 \), find \( \sqrt[3]{12516} \) by Gauss’s backward formula.

75. Use Gauss’s interpolation formula to get \( y_{16} \) given

<table>
<thead>
<tr>
<th>( x )</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y )</td>
<td>26.782</td>
<td>19.951</td>
<td>14.001</td>
<td>8.7624</td>
<td>1.63</td>
</tr>
</tbody>
</table>

76. Use Gauss’s forward formula to get \( y_{30} \) given that, \( y_{21} = 18.4708, \ y_{25} = 17.8144, \ y_{29} = 17.1070, \ y_{33} = 16.3432, \ y_{37} = 15.5154 \).

77. Apply Gauss’s backward formula to obtain \( \sin 45^\circ \) given the table below:

<table>
<thead>
<tr>
<th>( x^\circ )</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \sin x^\circ )</td>
<td>0.34202</td>
<td>0.50200</td>
<td>0.64279</td>
<td>0.76604</td>
<td>0.86603</td>
<td>0.93969</td>
</tr>
</tbody>
</table>

78. The values of \( e^{-x} \) for various values of \( x \) are given below. Find \( e^{-1.7425} \) by Gauss forward formula.

<table>
<thead>
<tr>
<th>( x )</th>
<th>1.72</th>
<th>1.73</th>
<th>1.74</th>
<th>1.75</th>
<th>1.76</th>
</tr>
</thead>
<tbody>
<tr>
<td>( e^{-x} )</td>
<td>0.17907</td>
<td>0.17728</td>
<td>0.17552</td>
<td>0.17377</td>
<td>0.17204</td>
</tr>
</tbody>
</table>

79. Using Stirling’s formula, find \( y(1.22) \) from the following table.

<table>
<thead>
<tr>
<th>( x )</th>
<th>1.0</th>
<th>1.1</th>
<th>1.2</th>
<th>1.3</th>
<th>1.4</th>
<th>1.5</th>
<th>1.6</th>
<th>1.7</th>
<th>1.8</th>
</tr>
</thead>
</table>
80. From the following table estimate \( e^{0.644} \) correct to five decimals using Stirling’s formula.

<table>
<thead>
<tr>
<th>( x )</th>
<th>0.61</th>
<th>0.62</th>
<th>0.63</th>
<th>0.64</th>
<th>0.65</th>
</tr>
</thead>
<tbody>
<tr>
<td>( e^x )</td>
<td>1.840431</td>
<td>1.858928</td>
<td>1.877610</td>
<td>1.896481</td>
<td>1.915541</td>
</tr>
</tbody>
</table>

81. From the following table estimate \( e^{0.644} \) correct to five decimals using Bessel’s formula.

<table>
<thead>
<tr>
<th>( x )</th>
<th>0.61</th>
<th>0.62</th>
<th>0.63</th>
<th>0.64</th>
<th>0.65</th>
</tr>
</thead>
<tbody>
<tr>
<td>( e^x )</td>
<td>1.840431</td>
<td>1.858928</td>
<td>1.877610</td>
<td>1.896481</td>
<td>1.915541</td>
</tr>
</tbody>
</table>

82. The following table gives the values of the probability integral \( f(x) = \frac{1}{\sqrt{\pi}} \int_{-x}^{x} e^{-\frac{t^2}{x}} \, dt \), for certain values of \( x \). Find the value of this integral when \( x = 0.5437 \) using Stirling’s formula.

<table>
<thead>
<tr>
<th>( x )</th>
<th>0.51</th>
<th>0.52</th>
<th>0.53</th>
<th>0.54</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y = f(x) )</td>
<td>0.5292437</td>
<td>0.5378987</td>
<td>0.5464641</td>
<td>0.5549392</td>
</tr>
</tbody>
</table>

83. The following table gives the values of the probability integral \( f(x) = \frac{1}{\sqrt{\pi}} \int_{-x}^{x} e^{-\frac{t^2}{x}} \, dt \), for certain values of \( x \). Find the value of this integral when \( x = 0.5437 \) using Bessel’s formula.
Given the following table, find $y(35)$ by using Stirling’s formula and Bessel’s formula.

<table>
<thead>
<tr>
<th>$x$</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$</td>
<td>512</td>
<td>439</td>
<td>346</td>
<td>243</td>
</tr>
</tbody>
</table>

From the following table, using Stirling’s formula, estimate the value of $\tan 16^\circ$.

<table>
<thead>
<tr>
<th>$x$ (degree)</th>
<th>0°</th>
<th>5°</th>
<th>10°</th>
<th>15°</th>
<th>20°</th>
<th>25°</th>
<th>30°</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y = \tan x$</td>
<td>0.0</td>
<td>0.0875</td>
<td>0.1763</td>
<td>0.2679</td>
<td>0.3640</td>
<td>0.4663</td>
<td>0.5774</td>
</tr>
</tbody>
</table>

Using Stirling’s formula, estimate $f(1.22)$ from the following table.

<table>
<thead>
<tr>
<th>$x$</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y = f(x)$</td>
<td>49225</td>
<td>48316</td>
<td>47236</td>
<td>45926</td>
<td>44306</td>
</tr>
</tbody>
</table>

Estimate $\sqrt{34}$ using Stirling’s formula from the following table.

<table>
<thead>
<tr>
<th>$x$</th>
<th>1.0</th>
<th>1.05</th>
<th>1.10</th>
<th>1.15</th>
<th>1.20</th>
<th>1.25</th>
<th>1.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x)$</td>
<td>1.00000</td>
<td>1.02470</td>
<td>1.04881</td>
<td>1.07238</td>
<td>1.09544</td>
<td>1.11803</td>
<td>1.14019</td>
</tr>
</tbody>
</table>

Find $f(1.2)$ using Bessel’s formula.

<table>
<thead>
<tr>
<th>$x$</th>
<th>0.2</th>
<th>0.6</th>
<th>1.0</th>
<th>1.4</th>
<th>1.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x)$</td>
<td>0.39104</td>
<td>0.33322</td>
<td>0.24197</td>
<td>0.14973</td>
<td>0.07895</td>
</tr>
</tbody>
</table>

Using Bessel’s formula find $y(62.5)$ given,

<table>
<thead>
<tr>
<th>$x$</th>
<th>60</th>
<th>61</th>
<th>62</th>
<th>63</th>
<th>64</th>
<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y(x)$</td>
<td>7782</td>
<td>7853</td>
<td>7924</td>
<td>7993</td>
<td>8062</td>
<td>8129</td>
</tr>
</tbody>
</table>

Obtain the value of $y(27.4)$ using Bessel’s formula, given,
91. From the table below, find $f(2.73)$ using Bessel's formula.

<table>
<thead>
<tr>
<th>$x$</th>
<th>25</th>
<th>26</th>
<th>27</th>
<th>28</th>
<th>29</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y(x)$</td>
<td>4.000</td>
<td>3.846</td>
<td>3.704</td>
<td>3.571</td>
<td>3.448</td>
<td>3.333</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$x$</th>
<th>2.5</th>
<th>2.6</th>
<th>2.7</th>
<th>2.8</th>
<th>2.9</th>
<th>3.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x)$</td>
<td>0.4938</td>
<td>0.4953</td>
<td>0.4965</td>
<td>0.4974</td>
<td>0.4981</td>
<td>0.4987</td>
</tr>
</tbody>
</table>

**THINGS TO REMEMBER**

________________________________________________________________________________________

________________________________________________________________________________________

________________________________________________________________________________________

________________________________________________________________________________________

________________________________________________________________________________________

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UNIT 4 Interpolation with un-equal intervals and Numerical Integration
PART A

1. Define the first divided difference.
2. State any two properties of a divided difference.
3. Write Newton’s divided difference formula for unequal intervals.
4. Write Lagrange’s formula for unequal intervals.
5. Write Trapezoidal rule for integration.
6. What is the order of error in Trapezoidal rule?
7. What is the truncation error in Trapezoidal rule?
8. Write Simpson’s 1/3 rd rule for integration.
9. What is the order of error in Simpson’s 1/3 rd rule?
10. What is the truncation error in Simpson’s 1/3 rd rule?
11. When Simpson’s 1/3 rd rule is applicable?
13. When Simpson’s 3/8 th rule is applicable?
14. Write Weddle’s rule for numerical integration.
15. When Weddle’s rule is applicable?

PART B

16. Find the equation y = f (x) of least degree and passing through the points (-1, -21), (1, 15), (2, 12), (3, 3). Find also y at x = 0 using Newton’s divided difference formula.
17. From the following table find f (x) and hence f (6) using Newton’s interpolation formula.

<table>
<thead>
<tr>
<th>x</th>
<th>1</th>
<th>2</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>f (x)</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

18. The following table gives same relation between steam pressure and temperature. Find the pressure at temperature 372.1° using Newton’s divided difference formula.

<table>
<thead>
<tr>
<th>T</th>
<th>361°</th>
<th>367°</th>
<th>378°</th>
<th>387°</th>
<th>399°</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>154.9</td>
<td>167.9</td>
<td>191.0</td>
<td>212.5</td>
<td>244.2</td>
</tr>
</tbody>
</table>

19. Using the following table, find f (x) as a polynomial by using Newton’s formula.

<table>
<thead>
<tr>
<th>x</th>
<th>-1</th>
<th>0</th>
<th>3</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>f (x)</td>
<td>3</td>
<td>-6</td>
<td>39</td>
<td>822</td>
<td>1611</td>
</tr>
</tbody>
</table>

20. Find y (x = 20) using Newton’s divided difference formula, given,
21. Find a cubic polynomial of \( x \) given,
\[
\begin{array}{c|c|c|c|c}
\hline
x & 0 & 1 & 2 & 5 \\
\hline
f(x) & 2 & 3 & 12 & 147 \\
\hline
\end{array}
\]

22. Find the third divided difference of \( f(x) \) with arguments 2, 4, 9, 10 where \( f(x) = x^3 - 2x \).

23. Given the data, find \( f(x) \) as a polynomial of degree 2 by using divided difference method.
\[
\begin{array}{c|c|c|c}
\hline
x & 1 & 2 & -4 \\
\hline
f(x) & 3 & -5 & 4 \\
\hline
\end{array}
\]

24. Find a polynomial \( f(x) \) of lowest degree using divided difference method, which takes the values 3, 7, 9 and 19 when \( x = 2, 4, 5, 10 \).

25. Find \( \log_{10} 323.5 \) using Newton’s divided difference method, given,
\[
\begin{array}{c|c|c|c|c}
\hline
x & 321.0 & 322.8 & 324.2 & 325.0 \\
\hline
\log_{10} x & 2.50651 & 2.50893 & 2.51081 & 2.51188 \\
\hline
\end{array}
\]

26. From the following table, find \( f(5) \) using divided difference method.
\[
\begin{array}{c|c|c|c|c}
\hline
x & 0 & 1 & 3 & 6 \\
\hline
f(x) & 1 & 4 & 88 & 1309 \\
\hline
\end{array}
\]

27. Using divided difference table, find \( f(x) \) which takes the values 1, 4, 40, 85 as \( x = 0, 1, 3 \) and 4.

28. Using Lagrange’s formula, prove \( y_1 = y_3 - 0.3(y_5 - y_3) + 0.2(y_3 - y_5) \) nearly.

29. Using Lagrange’s interpolation formula, find \( y(10) \) from the following table:
\[
\begin{array}{c|c|c|c|c}
\hline
x & 5 & 6 & 11 & 21 \\
\hline
y & 12 & 13 & 14 & 16 \\
\hline
\end{array}
\]
30. Using Lagrange’s formula to fit a polynomial to the data.

\[
\begin{array}{c|c|c|c|c}
  x & -1 & 0 & 2 & 3 \\
y & -8 & 3 & 1 & 12 \\
\end{array}
\]

31. Use Lagrange’s formula to find the parabola of the form \( y = ax^2 + bx + c \) passing through the points (0, 0), (1, 1) and (2, 20).

32. Find the value of \( \theta \) given \( f(\theta) = 0.3887 \) where \( f(\theta) = \int_{\theta}^{\theta} \frac{d\theta}{\sqrt{x^2 - \sin^2 \theta}} \) using the table.

\[
\begin{array}{c|c|c|c}
  \theta & 21^\circ & 23^\circ & 25^\circ \\
f(\theta) & 0.3706 & 0.4068 & 0.4433 \\
\end{array}
\]

33. From the table given below, find \( y(x = 2) \), using Lagrange’s formula.

\[
\begin{array}{c|c|c|c|c}
  x & 0 & 1 & 3 & 4 \\
y & 5 & 6 & 50 & 105 \\
\end{array}
\]

34. Use Lagrange’s formula to find \( f(6) \) given,

\[
\begin{array}{c|c|c|c|c}
  x & 14 & 17 & 31 & 35 \\
f(x) & 68.7 & 64.0 & 44.0 & 39.1 \\
\end{array}
\]

35. If \( y_1 = 4, y_3 = 120, y_4 = 340, y_6 = 2544 \), find \( y_5 \) using Lagrange’s formula.

36. Find \( y(6) \) using Lagrange’s formula, given, \( y(1) = 4, y(2) = 5, y(7) = 5, y(8) = 4 \).

37. Find \( y(10) \) using Lagrange’s formula, given, \( y(5) = 12, y(6) = 13, y(9) = 14, y(11) = 16 \).

38. If \( y_0 = 1, y_3 = 19, y_4 = 49, y_6 = 181 \), then find \( y_5 \) using Lagrange’s formula.

39. Find \( f(0) \) using Lagrange’s method, given,

\[
\begin{array}{c|c|c|c|c}
  x & -1 & -2 & 2 & 4 \\
f(x) & -1 & -9 & 11 & 69 \\
\end{array}
\]
40. The following are the measurements made on a curve recorded by the oscillograph representing a change of current due to a change in the conditions of an electric current.

<table>
<thead>
<tr>
<th>t</th>
<th>1.2</th>
<th>2.0</th>
<th>2.5</th>
<th>3.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>1.36</td>
<td>0.58</td>
<td>0.34</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Using Lagrange’s formula, find I at t = 1.6.

41. Using Lagrange’s formula, find x given y = 0.3 from the data.

<table>
<thead>
<tr>
<th>x</th>
<th>0.4</th>
<th>0.6</th>
<th>0.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>0.3683</td>
<td>0.3332</td>
<td>0.2897</td>
</tr>
</tbody>
</table>

42. If log 300 = 2.4771, log 304 = 2.4829, log 305 = 2.4843, log 307 = 2.4871, find log 301 using Lagrange’s formula.

43. Use Lagrange’s formula to find the value of x when y (x) = 19 given,

<table>
<thead>
<tr>
<th>x</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>0</td>
<td>1</td>
<td>20</td>
</tr>
</tbody>
</table>

44. Given \( u_0 = -12, u_1 = 0, u_3 = 6, u_4 = 12 \), find \( u_2 \) using Lagrange’s formula.

45. If \( f (0) = 6, f (1) = 9, f (3) = 33, f (7) = -15 \), then find \( f (2) \) using Lagrange’s formula.

46. Given \( f (30) = -30, f (34) = -13, f (38) = 3 \) and \( f (42) = 18 \). Find x so that \( f (x) = 0 \).

47. Use Lagrange’s formula to find \( f (x) \), given the table:

<table>
<thead>
<tr>
<th>x</th>
<th>0</th>
<th>1</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>f (x)</td>
<td>4</td>
<td>3</td>
<td>24</td>
<td>39</td>
</tr>
</tbody>
</table>

48. Find the value of \( \tan 33^o \) by using Lagrange’s formula of interpolation given,

<table>
<thead>
<tr>
<th>x</th>
<th>30°</th>
<th>32°</th>
<th>35°</th>
<th>38°</th>
</tr>
</thead>
<tbody>
<tr>
<td>tan x</td>
<td>0.5774</td>
<td>0.6249</td>
<td>0.7002</td>
<td>0.7813</td>
</tr>
</tbody>
</table>
49. Use Lagrange’s formula to find \( x \) corresponding to \( y = 85 \), given,
\[
\begin{array}{c|c|c|c|c}
  x & 2 & 5 & 8 & 14 \\
  f(x) & 94.8 & 87.9 & 81.3 & 68.7 \\
\end{array}
\]
50. Using Lagrange’s formula, fit a polynomial to the following data.
\[
\begin{array}{c|c|c|c|c}
  x & 0 & 1 & 3 & 4 \\
  y & -12 & 0 & 6 & 12 \\
\end{array}
\]
51. Find the parabola passing through the points \((0, 1)\), \((1, 3)\) and \((3, 55)\) using Lagrange’s interpolation formula.
52. Use Lagrange’s formula to find \( y(2) \) from the following table.
\[
\begin{array}{c|c|c|c|c}
  x & 0 & 1 & 3 & 4 \\
  y & -6 & 0 & 0 & 6 \\
\end{array}
\]
53. Evaluate \( \int \frac{dx}{x^3 + x^2} \) using Trapezoidal rule with \( h = 0.2 \). Hence obtain the value of \( \pi \).
54. From the following table, find the area bounded by the curve and the x-axis from \( x = 7.47 \) to \( x = 7.52 \).
\[
\begin{array}{c|c|c|c|c|c|c|c}
  x & 7.47 & 7.48 & 7.49 & 7.50 & 7.51 & 7.52 \\
  y = f(x) & 1.93 & 1.95 & 1.98 & 2.01 & 2.03 & 2.06 \\
\end{array}
\]
55. Evaluate \( \int e^x \, dx \) by Simpson’s one-third rule correct to five decimal places, by proper choice of \( h \).
56. A curve passes through the points \((1, 2), (1.5, 2.4), (2.0, 2.7), (2.5, 2.8), (3, 3), (3.5, 2.6)\) and \((4.0, 2.1)\). Obtain the area bounded by the curve, the x-axis and \( x = 1 \) and \( x = 4 \). Also find the volume of solid of revolution got by revolving this area about the x-axis.
57. A river is 80 metres wide. The depth ‘d’ in metres at a distance x metres from one bank is given by the following table. Calculate the area of cross-section of the river using Simpson’s rule.

<table>
<thead>
<tr>
<th>x</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>d</td>
<td>0</td>
<td>4</td>
<td>7</td>
<td>9</td>
<td>12</td>
<td>15</td>
<td>14</td>
<td>8</td>
<td>3</td>
</tr>
</tbody>
</table>

58. The table below gives the velocity v of a moving particle at time t seconds. Find the distance covered by the particle in 12 seconds and also the acceleration at t = 2 seconds.

<table>
<thead>
<tr>
<th>t</th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>v</td>
<td>4</td>
<td>6</td>
<td>16</td>
<td>34</td>
<td>60</td>
<td>94</td>
<td>136</td>
</tr>
</tbody>
</table>

59. Evaluate \( \int_{0}^{1} \frac{dx}{x^{2} + x^2} \) taking h = 0.2, using Trapezoidal rule. Can you use Simpson’s rule? Give reasons.

60. Evaluate \( \int_{0}^{1} \frac{dx}{x^{2} + x + x^2} \) to three decimals, dividing the range of integration into 8 equal parts using Simpson’s rule.

61. Evaluate \( \int_{0}^{1} \sqrt{\sin x + \cos x} \) dx correct to two decimal places using seven ordinates.

62. Find the value of \( \log_{3} \frac{1}{2} \) from \( \int_{0}^{1} \frac{x^{2}}{x^{2} + x^2} \) dx using Simpson’s one-third rule with h = 0.25.

63. When a train is moving at 30 m/sec, steam is shut off and brakes are applied. The speed of the train per second after t seconds is given by

<table>
<thead>
<tr>
<th>Time (t)</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed (v)</td>
<td>30</td>
<td>24</td>
<td>19.5</td>
<td>16</td>
<td>13.6</td>
<td>11.7</td>
<td>10</td>
<td>8.5</td>
<td>7</td>
</tr>
</tbody>
</table>
Using Simpson’s rule, determine the distance moved by the train in 40 seconds.

64. Given \( e^0 = 1, e^1 = 2.72, e^2 = 7.39, e^3 = 20.09, e^4 = 54.60 \), use Simpson’s rule to evaluate \( \int e^x \, dx \). Compare your result with exact value.

65. A solid of revolution is formed by rotating about the x-axis, the area between x-axis, \( x = 0, x = 1 \) and the curve through the points \((0, 1), (0.25, 0.9896), (0.5, 0.9589), (0.75, 0.9089) \) and \((1, 0.8415)\). Find the volume of solid.

66. Evaluate \( \int_{\frac{x}{4}}^{x} \log x \, dx \) taking 4 strips.

67. Evaluate \( \int_{x}^{x} e^{-x} \, dx \) taking \( h = 0.05 \), using Trapezoidal rule.

68. Compute \( \int_{\frac{x}{h}}^{x} \frac{dx}{x} \).

69. Evaluate \( \int_{\frac{x}{h}}^{x} \frac{dx}{x^2 - x} \) by dividing the range into 8 equal parts.

70. Evaluate \( \int_{\frac{x}{h}}^{x} e^{\sin x} \, dx \) taking \( h = \frac{\pi}{6} \).

71. Evaluate \( \int_{\frac{x}{h}}^{x} e^{-x} \, dx \) taking 6 intervals.

72. Calculate \( \int_{\frac{x}{h}}^{x} \sin \frac{\pi x}{h} \, dx \) taking \( h = \frac{\pi}{6} \).

73. From the following table, calculate \( \int_{\frac{x}{h}}^{x} y \, dx \).

<table>
<thead>
<tr>
<th>x</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>0.146</td>
<td>0.161</td>
<td>0.176</td>
<td>0.190</td>
<td>0.204</td>
<td>0.217</td>
<td>0.230</td>
</tr>
</tbody>
</table>
74. Evaluate \( \int_{-2}^{1} \frac{dx}{\sqrt{x^4 - x^2}} \) by Weddle’s rule, taking \( n = 6 \).

75. A curve passes through the points (1, 0.2), (2, 0.7), (3, 1), (4, 1.3), (5, 1.5), (6, 1.7), (7, 1.9), (8, 2.1), (9, 2.3). Find the volume of the solid generated by revolving the area between the curve, the x-axis and \( x = 1, x = 0 \) about the x-axis.

76. The velocity of a train which starts from rest is given by the following table, time being reckoned in minutes from the start and speed in miles per hour.

<table>
<thead>
<tr>
<th>Minutes</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miles/hr:</td>
<td>10</td>
<td>18</td>
<td>25</td>
<td>29</td>
<td>32</td>
<td>20</td>
<td>11</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Find the total distance covered in 20 minutes.

77. The velocity \( v \) of a particle moving in a straight line covers a distance \( x \) in time \( t \). They are related as follows:

<table>
<thead>
<tr>
<th>( x )</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>( v )</td>
<td>45</td>
<td>60</td>
<td>65</td>
<td>54</td>
<td>42</td>
</tr>
</tbody>
</table>

Find the time taken to traverse the distance of 40 units.

78. Find the distance traveled by the train between 11.50 am and 12.30 pm from the data given below:

<table>
<thead>
<tr>
<th>Time</th>
<th>11.50 am</th>
<th>12.00 noon</th>
<th>12.10 pm</th>
<th>12.20 pm</th>
<th>12.30 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed in km/h</td>
<td>48.2</td>
<td>70.0</td>
<td>82.6</td>
<td>85.6</td>
<td>78.4</td>
</tr>
</tbody>
</table>

79. Evaluate \( \int_{\pi/4}^{\pi/2} \sqrt{x} \, dx \) taking \( h = 0.05 \).

80. Evaluate \( \int_{\pi/4}^{\pi/2} \sqrt{\sin \theta} \, d\theta \), using Simpson’s rule taking six equal intervals.
81. Apply Simpson’s rule to find the value of \[ \int_{1}^{3} \frac{dx}{x^2 + x^3} \] by dividing the range into 4 equal parts.

82. The speed of a train at various times are given by:

<table>
<thead>
<tr>
<th>t (hour)</th>
<th>0</th>
<th>0.5</th>
<th>1</th>
<th>1.5</th>
<th>2</th>
<th>2.5</th>
<th>3</th>
<th>3.25</th>
<th>3.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>v (in km/h)</td>
<td>0</td>
<td>13</td>
<td>33</td>
<td>39.5</td>
<td>40</td>
<td>40</td>
<td>36</td>
<td>15</td>
<td>0</td>
</tr>
</tbody>
</table>

Find the total distance covered.

**PART C**

1. Find the polynomial equation \( y = f(x) \) passing through \((5, 1335), \) \((2, 9), \) \((0, 5), \) \((-1, 33)\) and \((-4, 1245)\) using Newton’s divided difference method.

2. Using Newton’s divided difference formula, find the values of \( f(2), f(8) \) and \( f(15) \) given the following table:

<table>
<thead>
<tr>
<th>( x )</th>
<th>4</th>
<th>5</th>
<th>7</th>
<th>10</th>
<th>11</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>48</td>
<td>100</td>
<td>294</td>
<td>900</td>
<td>1210</td>
<td>2028</td>
</tr>
</tbody>
</table>

3. If \( y(0) = -18, y(1) = 0, y(3) = 0, y(5) = -248, y(6) = 0, y(9) = 13104, \) find \( y = f(x) \) using Newton’s divided difference method.

4. Find the polynomial equation of degree four passing through the points \((8, 1515), (7, 778), (5, 138), (4, 43)\) and \((2, 3)\) using Newton’s divided difference method.

5. Find the pressure of steam at 142°C using Newton’s divided difference formula.

<table>
<thead>
<tr>
<th>Temp °C</th>
<th>140</th>
<th>150</th>
<th>160</th>
<th>170</th>
<th>180</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure kgf/cm²</td>
<td>3.685</td>
<td>4.854</td>
<td>6.302</td>
<td>8.076</td>
<td>10.225</td>
</tr>
</tbody>
</table>

6. Obtain the value of \( \log_{10} 656 \) using divided difference formula, given \( \log_{10} 654 = 2.8156, \log_{10} 658 = 2.8182, \log_{10} 659 = 2.8189, \log_{10} 666 = 2.8202. \)
7. Find \( y (x = 5.60275) \) using Newton’s divided difference formula, from the table.

\[
\begin{array}{cccccc}
    x & 5.600 & 5.602  & 5.605  & 5.607  & 5.608 \\
    y & 0.77556588 & 0.77682686 & 0.77871250 & 0.77996571 & 0.78059114 \\
\end{array}
\]

8. From the data given below, find the value of \( x \) when \( y = 13.5 \), using Lagrange’s formula.

\[
\begin{array}{ccc}
    x & 93.0 & 96.2 & 100.0 & 104.2 & 108.7 \\
    y & 11.38 & 12.80 & 14.70 & 17.07 & 19.91 \\
\end{array}
\]

9. Find the age corresponding to the annuity value 13.6 using Lagrange’s formula, given:

\[
\begin{array}{cccccc}
    Age (x) & 30 & 35 & 40 & 45 & 50 \\
    Annuity value (y) : & 15.9 & 14.9 & 14.1 & 13.3 & 12.5 \\
\end{array}
\]

10. Using Lagrange’s formula find \( f (6) \) given,

\[
\begin{array}{cccccc}
    x & 2 & 5 & 7 & 10 & 12 \\
    f (x) & 18 & 180 & 448 & 1210 & 2028 \\
\end{array}
\]

11. The following table gives the values of the probability integral \( f (x) = \frac{e^{-x^2}}{\sqrt{\pi}} \int_{-\infty}^{x} e^{-u^2} du \) corresponding to certain values of \( x \). For what value of \( x \) is this integral equal to 0.5?

\[
\begin{array}{cccc}
    x & 0.46 & 0.47 & 0.48 & 0.49 \\
    f (x) & 0.4846555 & 0.4937452 & 0.5027498 & 0.5116683 \\
\end{array}
\]

12. Interpolate \( y \) at \( x = 5 \) using Lagrange’s formula, given

\[
\begin{array}{cccc}
    x & 1 & 2 & 3 & 4 & 7 \\
    y & 2 & 4 & 8 & 16 & 128 \\
\end{array}
\]

13. Find \( y (15) \) from the following table, using Lagrange’s method.

\[
\begin{array}{cccccc}
    x & 10 & 12 & 14 & 16 & 18 & 20 \\
\end{array}
\]
14. Use Lagrange’s method to find \( x \) corresponding to \( y = 100 \), given
\[
\begin{array}{c|c|c|c|c|c}
   x & 3 & 5 & 7 & 9 & 11 \\
   y & 6 & 24 & 58 & 108 & 174 \\
\end{array}
\]

15. Find \( y (1.50) \) using Lagrange’s formula, given
\[
\begin{array}{c|c|c|c|c|c|c}
   x & 1.0 & 1.2 & 1.4 & 1.6 & 1.8 & 2.0 \\
   y & 0.2420 & 0.1942 & 0.1497 & 0.1109 & & \\
      & 0.0790 & 0.0540 & & & \\
\end{array}
\]

16. Evaluate \( \int_{-3}^{3} x^2 \, dx \) by using (a) Trapezoidal rule (b) Simpson’s rule.
Verify your results by actual integration.

17. Evaluate the integral \( I = \int_{0}^{\pi} \log_e x \, dx \) using Trapezoidal, Simpson’s and Weddle’s rules.

18. Evaluate \( I = \int_{0}^{\pi} \frac{dx}{\sqrt{x^2 - x}} \) using (a) Trapezoidal rule (b) Simpson’s rule (c) Weddle’s rule. Also, check up by direct integration.

19. By dividing the range into 10 equal parts, evaluate \( \int_{0}^{\pi} \sin x \, dx \) by Trapezoidal rule and Simpson’s rule. Verify your answer with integration.

20. Evaluate \( \int_{0}^{\pi} \frac{dx}{x+1} \) by (a) Trapezoidal rule (b) Simpson’s rule (c) Weddle’s rule. Also check up the results by actual integration.

21. Compute the value of \( \int_{0}^{\pi} \frac{dx}{x} \) using Simpson’s rule and Trapezoidal rule. Take \( h = 0.25 \).
22. Calculate \( \int_{0}^{\pi} \sin x \, dx \) by dividing the interval into ten equal parts, using Trapezoidal rule and Simpson’s rule.

23. Compute the value of \( \int_{\pi/4}^{\pi/2} (\sin x - \log x + e^x) \, dx \) taking \( h = 0.2 \) and using Trapezoidal rule, Simpson’s rule and Weddle’s rule. Compare your result by integration.

24. The velocity \( v \) of a particle at distance \( S \) from a point on its path is given by the table below.

\[
\begin{array}{|c|c|c|c|c|c|c|c|}
\hline
S \text{ in metre} & 0 & 10 & 20 & 30 & 40 & 50 & 60 \\
\hline
v \text{ m/sec} & 47 & 58 & 64 & 65 & 61 & 52 & 38 \\
\hline
\end{array}
\]

Estimate the time taken to travel 60 metres by using Simpson’s one-third rule. Compare your answer with Simpson’s 3/8 th rule and Weddle’s rule.

25. Evaluate \( \int_{x=0}^{x=6} \frac{dx}{x^2 + x} \) by taking \( n = 6 \) using (a) Trapezoidal rule (b) Simpson’s one-third and three-eight rule (c) Weddle’s rule.

26. Evaluate \( \int_{x=0}^{x=2} e^{-x} \, dx \) by dividing the range into 4 equal parts using (a) Trapezoidal rule and (b) Simpson’s one-third rule.

27. Evaluate \( \int_{x=0}^{x=5} e^{-x^2} \, dx \) by taking \( h = 0.1 \) using Simpson’s rule.

28. Calculate \( \int_{x=0}^{x=1} e^{-x^2} \, dx \) by taking 5 ordinates by Simpson’s rule.

29. Evaluate \( \int_{x=0}^{x=\pi} \frac{\sin x}{x} \, dx \), dividing into six equal parts using Simpson’s rule, Weddle’s rule and Trapezoidal rule.

30. A river is 40 m wide. The depth \( d \) in metres at a distance \( x \) metres from one bank is given by the table below:

\[
\begin{array}{|c|c|c|c|c|c|c|c|c|}
\hline
x & 0 & 5 & 10 & 15 & 20 & 25 & 30 & 35 & 40 \\
\hline
\end{array}
\]
Find the cross-section of the river by Simpson’s rule.

31. Evaluate \( \int_{-1}^{0} e^{-x} \, dx \) with 10 intervals by Trapezoidal and Simpson’s methods.

**THINGS TO REMEMBER**

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UNIT 5 Solution of First Order Differential Equations of the form $y' = f(x, y)$

PART A

1. Write Euler’s formula to solve a differential equation.
2. Write Taylor’s series formula to solve a differential equation.
3. Write Modified Euler’s formula to solve a differential equation.
4. Write Improved Euler’s formula to solve a differential equation.
5. Write the iterative formula of 2nd order Runge-Kutta method.
6. Write the iterative formula of 3rd order Runge-Kutta method.
7. Write the iterative formula of 4th order Runge-Kutta method.

PART B
8. Using Taylor's series method, find, correct to four decimal places, the value of \( y(0.1) \), given \( \frac{dy}{dx} = x^2 + y^2 \) and \( y(0) = 1 \).

9. Using Taylor's series method, find \( y(0.1) \) given, \( \frac{dy}{dx} = x + y \), \( y(0) = 1 \).

10. Using Taylor's series method find \( y(0.1) \) given, \( y' = x^2 - y \), \( y(0) = 1 \).

11. Using Taylor's series method solve, \( y' = x + \frac{x}{\sqrt{x}} y \), \( y(1.8) = 0 \) for \( y(2) \).

12. Using Taylor's series method find \( y(0.1) \) given, \( y' = x - y^2 \) and \( y(0) = 1 \).

13. Using Taylor's series method find \( y(1.1) \) given, \( y' = \sqrt{x} - y \) and \( y(1) = 3 \).

14. Given \( y' = y \) and \( y(0) = 1 \), determine the values of \( y \) at \( x = 0.01 \) (0.01) 0.04 by Euler method.

15. Using Euler’s method, solve numerically the equation, \( y' = x + y \), \( y(0) = 1 \), for \( x = 0.0 \) (0.2) 1.0.

16. Solve numerically, \( y' = y + e^x \), \( y(0) = 0 \), for \( x = 0.2 \), 0.4 by Improved Euler’s method.

17. Compute \( y \) at \( x = 0.25 \) by Modified Euler method, given, \( y' = \sqrt{x} y \), \( y(0) = 1 \).

18. Given, \( y' = x^2 - y \), \( y(0) = 1 \), find correct to four decimal places the value of \( y(0.1) \), by using Improved Euler method.

19. Using Modified Euler method, find \( y(0.2) \), \( y(0.1) \) given, \( \frac{dy}{dx} = x^2 + y^2 \), \( y(0) = 1 \).

20. Use Euler’s method to find \( y(0.4) \) given, \( y' = xy \), \( y(0) = 1 \).
21. Use Improved Euler method to find $y(0.1)$ given, $y' = \frac{y - x}{y + x}$, $y(0) = 1$.

22. Use Modified Euler method and obtain $y(0.2)$ given,
\[ \frac{dy}{dx} = \log(x + y), \ y(0) = 1, \ h = 0.2. \]

23. Find $y(0.01)$ given, $y' = x^r + y$, $y(0) = 1$, using Improved Euler method.

24. Find $y(1.5)$ taking $h = 0.5$ given, $y' = y - x$, $y(0) = 1.1$.

25. If $y' = x + y^r$, $y(0) = 1$, $h = 0.1$, find $y(0.4)$.

26. Find by Improved Euler to get $y(0.2)$, $y(0.4)$ given, $\frac{dy}{dx} = \frac{1}{x} + x^r$ if $y(1) = 0.5$.

27. Find $y(0.2)$ by Improved Euler method, given $y' = -xy^r$, $y(0) = 2$ if $h = 0.1$.

28. Obtain the values of $y$ at $x = 0.1, 0.2$ using RK method of second order for the differential equation $y' = -y$, given $y(0) = 1$.

29. Obtain the values of $y$ at $x = 0.1, 0.2$ using RK method of third order for the differential equation $y' = -y$, given $y(0) = 1$.

30. Find $y(0.2)$ given, $\frac{dy}{dx} = -2y$, $y(0) = 1$ taking $h = 0.2$ by RK method of fourth order.

31. Find $y(0.1)$, $y(0.2)$ given $y' = x - 2y$, $y(0) = 1$ taking $h = 0.1$ using RK method of second order.

32. Find $y(0.1)$, $y(0.2)$ given $y' = x - 2y$, $y(0) = 1$ taking $h = 0.1$ using RK method of third order.

**PART C**

33. Solve: $\frac{dy}{dx} = x + y$, given $y(1) = 0$ and get $y(1.1), y(1.2)$ by Taylor series method. Compare your result with the explicit solution.
34. Using Taylor's method, compute $y(0.2)$ and $y(0.4)$ correct to 4 decimal places given $\frac{dy}{dx} = x^2 - x^3$ and $y(0) = 0$.

35. Using Taylor's series method, find $y(1.1)$ and $y(1.2)$ correct to four decimal places given $\frac{dy}{dx} = x^2$ and $y(1) = 1$.

36. Using Taylor's series method, find $y$ at $x = 0.1 (0.1) 0.4$ given $\frac{dy}{dx} = x^2 - y$, $y(0) = 1$, correct to four decimal places.

37. By means of a Taylor's series expansion, find $y$ at $x = 0.1, 0.2$ correct to three significant digits given, $\frac{dy}{dx} = x^2 - y$, $y(0) = 0$.

38. Using Taylor's series method, find $y(0.1), y(0.2)$ given, $y' = x^2 + y$ and $y(0) = 1$.

39. Solve using Taylor's series method given, $y' = xy + y^2$, $y(0) = 1$ at $x = 0.1, 0.2, 0.3$.

40. Obtain $y(4.2)$ and $y(4.4)$ using Taylor's series method, given, $\frac{dy}{dx} = \frac{x^2}{x^2 + y}$, $y(4) = 4$ taking $h = 0.2$.

41. Using Taylor's series method find $y(0.1)$ and $y(0.2)$ given, $y' = xy + y$, $y(0) = 1$.

42. Using Taylor's series method, Solve $\frac{dy}{dx} = y + x^2$ for $x = 1.1, 1.2, 1.3$ given, $y(1) = 1$.

43. Using Taylor's series method find $y(0.1), y(0.2), y(0.3)$ given $y' = \frac{x^2 + xy}{e^x}$, $y(0) = 1$. 

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44. Using Taylor’s series method find \( y(0.2), y(0.4) \) given \( \frac{dy}{dx} = xy^2 + y \), \( y(0) = 1 \).

45. Using Taylor’s series method find \( y(0.4) \) if \( y' = y + xy \) given, \( y(0) = 2 \) taking \( h = 0.2 \).

46. Using Taylor’s series method find \( y(0.2) \) and \( y(0.4) \) given \( y' = x - y \) and \( y(0) = 1 \).

47. Solve the equation \( \frac{dy}{dx} = x - y \) given \( y(0) = 0 \) using Modified Euler’s method and tabulate the solutions at \( x = 0.1, 0.2 \) and \( 0.3 \). Compare your result with exact solution.

48. Solve the equation \( \frac{dy}{dx} = x - y \) given \( y(0) = 0 \) using Improved Euler’s method and tabulate the solutions at \( x = 0.1, 0.2 \) and \( 0.3 \). Compare your result with exact solution.

49. Using Improved Euler method find \( y \) at \( x = 0.1 \) and \( 0.2 \) given,
\[
\frac{dy}{dx} = y - \frac{Ex}{y}, \quad y(0) = 1.
\]

50. Compute \( y(0.3) \) taking \( h = 0.1 \) given, \( \frac{dy}{dx} = y - \frac{Ex}{y}, \quad y(0) = 1 \) using Improved Euler method.

51. Find \( y(0.6), y(0.8), y(1.0) \) given, \( \frac{dy}{dx} = x + y \), \( y(0) = 0 \) taking \( h = 0.2 \) by Improved Euler method.

52. Using Improved Euler method, find \( y(0.2), y(0.4) \) given,
\[
\frac{dy}{dx} = y + x^2, \quad y(0) = 1.
\]

53. Using Modified Euler method, get \( y(0.2), y(0.4), y(0.6) \) given,
\[
\frac{dy}{dx} = y - x^2, \quad y(0) = 1.
\]
54. Use Euler’s Improved method, find \( y (0.2) \) and \( y (0.4) \) given,
\[
\frac{dy}{dx} = x + \sqrt{y}, \quad y (0) = 1.
\]
55. Use Euler’s Improved method to calculate \( y (0.5) \), taking \( h = 0.1 \), and \( y' = y + \sin x \),
\( y (0) = 2 \).
56. Find \( y (1.6) \) if \( y' = x \log y - y \log x \), \( y (1) = 1 \) if \( h = 0.1 \).
57. Given, \( y' = \frac{y}{x} - \frac{2}{H} x^2 y^3, \) \( y (1) = \frac{\sqrt{H}}{\sqrt{2}} \) find \( y (2) \) if \( h = 0.125 \).
58. Apply the fourth order Runge-Kutta method to find \( y (0.2) \) given that \( y' = x + y \), \( y (0) = 1 \).
59. Obtain the values of \( y \) at \( x = 0.1, 0.2 \) using RK method of fourth order for the differential equation \( y' = -y \), given \( y (0) = 1 \).
60. Computer \( y (0.3) \) given \( \frac{dy}{dx} + y + xy' = 0 \), \( y (0) = 1 \) by taking \( h = 0.1 \) using RK method of fourth order correct to 4 decimal places.
61. Find \( y \) for \( x = 0.2 \) \( (0.2) \) \( 0.6 \) by RK method of fourth order given,
\[
\frac{dy}{dx} = \frac{y}{x}, \quad y (0) = 0.
\]
62. Using RK method of fourth order, find \( y (0.8) \) correct to 4 decimal places if \( y' = y - x y' \),
\( y (0.6) = 1.7379 \).
63. Using RK method of fourth order, solve \( \frac{dy}{dx} = \frac{y^2 - x^2}{y^2 + x^2} \) given \( y (0) = 1 \) at \( x = 0.2, 0.4 \).
64. Using RK method of fourth order, find \( y (0.2) \) given \( \frac{dy}{dx} = y - x \), \( y (0) = 2 \) taking \( h = 0.1 \).
65. Using RK method of fourth order, evaluate \( y (0.4) \) given \( \frac{dy}{dx} = x + y \),
\( y (1.2) = 2 \).
66. Using RK method of fourth order, obtain the value of $y$ at $x = 0.2$
if $y$ satisfies $\frac{dy}{dx} - x^2 y = x$, $y(0) = 1$ taking $h = 0.1$.

67. Using RK method of fourth order, solve $\frac{dy}{dx} = xy$ for $x = 1.4$, taking
$y(1) = 2$, $h = 0.2$.

68. Using RK method of fourth order, solve $\frac{dy}{dx} = \frac{y - x}{y + x}$ given $y(0) = 1$
to obtain $y(0.2)$.

69. Solve the initial value problem, $\frac{du}{dt} = -i\alpha u^2$, $u(0) = 1$ with $h = 0.2$
on the interval $(0, 0.6)$ by using fourth order RK method.

70. Using RK method of fourth order, evaluate for $y(0.1)$, $y(0.2)$, $y(0.3)$ given, $y' = \frac{\kappa}{\lambda^2} (x^2 + x)y^2$, $y(0) = 1$.

71. Using RK method of fourth order, solve, $\frac{dy}{dx} + \frac{y}{x} = \frac{\kappa}{x^2}$, $y(1) = 1$ for
$y(1.1)$ taking
$h = 0.05$.

72. Using RK method of fourth order, find $y(0.5)$, $y(1)$, $y(1.5)$, $y(2)$
taking $h = 0.5$ given, $y' = \frac{\kappa}{x + y}$, $y(0) = 1$.

73. Using RK method of fourth order, evaluate $y(1.2)$, $y(1.4)$ given

$y' = \frac{I_2 y + e^x}{x^2 + xe^x}$, $y(1) = 0$.

74. Find $y(0.1)$, $y(0.2)$ given, $y' = x - \frac{\kappa}{x^2} y$, $y(0) = 1$ taking $h = 0.1$
using RK method of fourth order.

75. Determine $y$ at $x = 0.2$ $(0.2)$ $0.6$ by RK method of fourth order
given, $\frac{dy}{dx} = \kappa + y$, given
$y(0) = 0$. 

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76. Find \( y(0.2) \) given, \( y' = \frac{3y}{x} + \frac{y}{x^2} \), \( y(0) = 1 \) by using RK method of fourth order.

77. Solve \( y' = xy + \frac{y}{x} \) as \( x = 0.2, 0.4, 0.6 \) given \( y(0) = 2 \), taking \( h = 0.2 \) using RK method of fourth order.

78. Solve \( y' = x^2 + \frac{y}{x^2} \) given \( y(1) = 2 \) for \( y = 1.1, 1.2 \) using RK method of fourth order.

79. Using RK method of fourth order, solve \( xy' = x^2 + y^2 \), given \( y(0) = 1 \) for \( x = 0.1 (0.1) 0.3 \).

80. Using RK method of fourth order, solve \( xy' = x + y^2 \), given \( y(0) = 0.5 \) for \( x = 0.1 (0.1) 0.4 \).

**THINGS TO REMEMBER**

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## UNIT 1 - Theory of Equations

### ASSIGNMENT SCHEDULE

<table>
<thead>
<tr>
<th>SL. Number</th>
<th>Assignment Topic (s)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reciprocal Equations</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Transformation of Equations,</td>
<td></td>
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<tr>
<td></td>
<td>Multiple Roots</td>
<td></td>
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<tr>
<td>3</td>
<td>Relation between roots &amp;</td>
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</tr>
<tr>
<td></td>
<td>Coefficients (3)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Relation between roots &amp;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coefficients (4)</td>
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<tr>
<td>5</td>
<td>Symmetric Functions of the Roots</td>
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## TEST SCHEDULE

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<tbody>
<tr>
<td>1</td>
<td>Reciprocal Equations, Multiple Roots and Transformation of Equations</td>
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<td>2</td>
<td>Relation between roots and Coefficients (Both Third and Fourth order equations)</td>
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<td>Symmetric Functions of the Roots</td>
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## UNIT 1 - Numerical Solution of Algebraic and Transcendental Equations

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<td>1</td>
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<td>2</td>
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<td>Horner’s Method to solve Algebraic Equations</td>
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### UNIT 2 - Solution of Simultaneous Linear Algebraic Equations

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<td>Gauss Jacobi and Gauss Seidel Method (Iterative Method)</td>
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### UNIT 3 - Interpolation

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<td>Central Difference Methods</td>
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<td>Stirling’s Interpolation Formula</td>
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<td>Newton Gauss Forward &amp; Backward Difference Interpolation Formula</td>
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<td>Stirling’s and Bessel’s Central Difference Interpolation Formula</td>
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### UNIT 4 - Interpolation with un-equal intervals & Numerical Integration

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<td>Weddle’s Rule</td>
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<td>3</td>
<td>Simpson’s $\frac{f''}{h}$ and $\frac{f^{iv}}{h^2}$ Rules</td>
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**UNIT 5 - Differential Equation of First Order of the form $y' = f(x, y)$**

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<td>Improved Euler’s Method</td>
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<tr>
<td>2</td>
<td>Euler’s Method, Improved Euler’s Method, Modified Euler’s Method</td>
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<td>Runge-Kutta Method</td>
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