This question paper contains 7 printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **7725**

Unique Paper Code : **32355402** **HC**

Name of the Paper : **Numerical Methods**

Name of the Course : **Generic Elective Mathematics**

Semester : **IV**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

All the six questions are compulsory.

Attempt any *two* parts from each question.

Use of Scientific Calculator is allowed.

1. (*a*) Define floating-point representation, Global error and Truncation error with examples.

(*b*) Explain the Newton method for computing the roots of equation $f(x) = 0$. Perform *three* iterations of the Newton

method to find the smallest positive roots of the equation :

$$f(x) = x^3 - 5x + 1 = 0.$$

(*c*) Define rate of convergence. Determine the rate of convergence for the Regula-Falsi method. 12

2. (*a*) Perform *four* iterations of the Bisection method to obtain a root in the interval (0,1) of the equation :

$$f(x) = \cos x - xe^x = 0.$$

(*b*) Perform three iterations to find the cube root of 17 by Newton's method with the initial approximation $x_0 = 2$.

(*c*) Perform two iterations of Newton's method to solve the non-linear system of equations with initial approximation (1, 1).

$$f(x, y) = x^2 - y^2 - 4 = 0 \quad \text{and}$$

$$g(x, y) = x^2 + y^2 - 16 = 0.$$ 12

3. (*a*) Solve the linear system $Ax = b$ using Gaussian elimination with pivoting where :

$$A = \begin{bmatrix} 6 & 2 & 2 \\ 6 & 2 & 1 \\ 1 & 2 & -1 \end{bmatrix} \text{ and } b = \begin{bmatrix} 0 \\ 5 \\ 0 \end{bmatrix}.$$

(*b*) Starting with initial vector $(x, y, z) = (0, 0, 0)$, perform three iterations of Gauss-Seidel method to solve the following system of equations :

$$6x + 15y + 2z = 72,$$

$$x + y + 54z = 110,$$

$$27x + 6y - z = 85$$

(*c*) Explain Thomas Algorithm and solve the following Tridiagonal system $Ax = b$ using the Thomas Method :

$$A = \begin{bmatrix} 1 & 2 & 0 \\ 1 & 3 & 3 \\ 0 & 3 & 10 \end{bmatrix}, \quad b = \begin{bmatrix} 10 \\ 17 \\ 22 \end{bmatrix}$$

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4. (*a*) Construct the divided difference table for the data :

x	$f(x)$
–1	–2
1	0
4	63
7	342

Hence, find the Newton divided difference interpolating polynomial and an approximation to the value of $f(6)$. 5

(*b*) Prove the following relations :

(*i*) $\mu = (1+\frac{1}{2}\Delta)\sqrt{(1+\Delta)}$

(*ii*) $\Delta = \frac{1}{(1-\nabla)} - 1$

(*c*) For the following data, obtain the backward difference polynomials using Gregory-Newton Backward difference interpolation. Also, interpolate at

$x = 0.35$. 13

x	$f(x)$
0.1	1.40
0.2	1.56
0.3	1.76
0.4	2.00
0.5	2.28

(*a*) Obtain the piecewise linear interpolating polynomial for the function $f(x)$ defined by the given data :

x	$f(x)$
0	1
1	2
2	5
3	10

Interpolate at $x = 0.5$ and 1.5.

(*b*) By use of Richardson extrapolation, find $f'(1)$ using the approximate formula :

$$f'(x_0) = \frac{f(x_0 + h) - f(x_0 - h)}{2h}$$

with h = 0.4, 0.2 and 0.1, from the following values :

x	$f(x)$
0.6	0.707178
0.8	0.859892
0.9	0.925863
1.0	0.984007
1.1	1.033743
1.2	1.074575
1.4	1.127986

(*c*) Find the approximate value of :

$$I = \int_0^1 \frac{dx}{1+x^2}$$

using :

(*i*) Trapezoidal rule

(*ii*) Simpson's rule.

6. (*a*) Apply Euler's method to approximate the solution of the initial value problem and calculate $y(0.3)$ by using $h = 0.1$

$$\frac{dy}{dx} = 1 + xy, \quad y(0) = 2$$

(*b*) Apply R.K. fourth order to solve the initial value problem and calculate $y(0.1)$ by using $h = 0.1$

$$\frac{dy}{dx} = x^2 - y, \quad y(0) = 1.$$

(*c*) Apply finite difference method to solve the problem : 13

$$\frac{d^2y}{dx^2} = y + x, \quad y(0) = 2, \quad y(1) = 2.5 \quad \text{with} \quad h = 0.25.$$

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