

This question paper contains 4+2 printed pages]

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S. No. of Question Paper : 3103

Unique Paper Code : 32355402

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Name of the Paper : Numerical Methods

Name of the Course : Mathematics : Generic Elective for  
Honours

Semester : IV

Duration : 3 Hours

Maximum Marks : 75

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

All six questions are compulsory.

Attempt any two parts from each question.

Use of non-programmable scientific calculator is allowed.

1. (a) Define Truncation Error. Evaluate the sum  $\sqrt{3} + \sqrt{5} + \sqrt{7}$  to four significant digits and find its absolute and relative errors.

P.T.O.

- (b) Perform three iterations of the Bisection Method to obtain a root of the equation :

$$x^3 - 4x - 9 = 0.$$

- (c) Determine the rate of convergence for the Newton-Raphson Method.

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2. (a) Find a root of the equation :

$$x - e^{-x} = 0$$

correct to three decimal places by the Secant method.

Perform three iterations.

- (b) Perform three iterations using Newton-Raphson method to find a root of the equation :

$$f(x) = x \sin x + \cos x = 0$$

correct to three decimal places, assuming that the root is near  $x = \pi$ .

- (c) Perform two iterations of Newton's Method to solve the non-linear system of equations with initial approximation (0.5, 0.5):

$$f(x, y) = x^2 + 3x + y - 5 = 0$$

$$g(x, y) = x^2 + 3y^2 - 4 = 0.$$

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3. (a) Find the inverse of the following matrix using the Gauss-Jordan method :

$$\begin{pmatrix} 1 & 2 & 1 \\ 2 & 3 & -1 \\ 2 & -1 & 3 \end{pmatrix}$$

- (b) Perform three iterations of Gauss-Seidel method for the following system of equation :

$$-3x + y = -2,$$

$$2x - 3y + z = 0,$$

$$2y - 3z = -1,$$

assuming initial solution as  $(x, y, z) = (0, 0, 0)$ .

- (c) Solve the following linear system by using Gaussian elimination with row pivoting :

$$\begin{pmatrix} 1 & 2 & 3 \\ 2 & 4 & 10 \\ 3 & 14 & 28 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 1 \\ -2 \\ -8 \end{pmatrix}$$

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P.T.O.

4. (a) Find the unique polynomial of degree 2 which fits the given data :

$x$	0	1	3
$f(x)$	1	3	55

using Lagrange interpolation polynomial. Also estimate value of  $f$  at  $x = 0.5$  and  $x = 2.5$ .

- (b) Prove the following :

$$(1 - \nabla)^{-1} = 1 + \frac{1}{2}\delta^2 + \delta\sqrt{1 + \frac{1}{4}\delta^2}$$

- (c) Obtain the piecewise linear interpolating polynomials for the function  $f(x)$  defined by the given data :

$x$	0.5	1.5	2.5
$f(x)$	0.125	3.375	15.625

Also find  $f(1.0)$  and  $f(2.0)$ .

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5. (a) Using forward difference formulas, calculate  $f''(3)$  and  $f'''(3)$  from the following data set :

$x$	1	2	3	4	5
$f(x)$	2	4	8	16	32

- (b) Find an approximate value of the integral

$$I = \int_0^1 e^{-x} dx$$

using :

(i) Trapezoidal rule

(ii) Simpson's rule.

Also calculate the error in each case.

- (c) Apply Euler's Method to approximate the solution of the initial value problem

$$\frac{dy}{dx} = 1 + \frac{y}{x}, \quad 1 \leq x \leq 6, \quad y(1) = 1$$

using 5 steps.

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6. (a) Apply mid-point method (second order Runge-Kutta method) to solve the initial value problem using  $h = 0.5$

$$\frac{dy}{dx} = x + y, \quad 0 \leq x \leq 1$$

$$y(0) = 2$$

P.T.O.



- (b) Solve the initial value problem using Heun Method  
(modified Euler Method) :

$$\frac{dx}{dt} = 1 + \frac{x}{t}; \quad 1 \leq x \leq 2$$

$$x(1) = 1, \quad h = 1.$$

- (c) Apply Gaussian Quadrature two point formula to  
approximate the value of the integral :

$$I = \int_1^2 \frac{2x}{1+x^4} dx.$$

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