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B.Tech.(CE) (2011 Onwards) (Sem.–6)

NUMERICAL METHODS IN CIVIL ENGINEERING

Subject Code : BTCE-604

Paper ID : [A2291]

Time : 3 Hrs. Max. Marks : 60

INSTRUCTIONS TO CANDIDATES :

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION-B contains FIVE questions carrying FIVE marks each and students have to attempt any FOUR questions.**
3. **SECTION-C contains THREE questions carrying TEN marks each and students have to attempt any TWO questions.**

SECTION-A

1. Write briefly :

a. Find the positive root between 0 and 1, of the equation $x = e^{-x}$ to a tolerance of 0.05%.

b. Evaluate $\Delta^n (e^{3x+5})$.

c. Find the Eigen vectors of the matrix

$$\begin{bmatrix} 3 & 2 & 1 \\ 2 & 3 & 1 \\ 1 & 2 & 3 \end{bmatrix}$$

d. Find the general solution of the differential equation

$$\Delta^2 u_{n-1} - \left(\frac{1}{3}\right)\Delta^2 u_n = 0$$

e. Solve the boundary value problem $u'' = x_u$

U (0) + u' (0) = 1, u (1) = 1 with h = 1/3. Use the second order method.

f. Fit a polynomial of second degree to the data prints (x, y) given by (0, 1), (1,6) and (2, 17).

g. Show that the set of functions [$\phi_n (x)$] are orthogonal on the interval $a<x<b$ where,

$$\phi_n (x) = \sin nx,\ n = 1,2,3\ldots\ldots[0, \pi]$$

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h. What is meant by saying that Runga-Kutta formula is of the fourth order?

i. Find the general solution of the difference equation :

$$\Delta^2 u_n - 3\Delta u_n + 2u_n = 0$$

j. Find the root of the equation $x \sin x + \cos x = 0$.

SECTION-B

2. Solve the system of equations

$u' = -3u + 2v \quad u(0) = 0$

$v' = 3u - 4v \quad v(0) = 0.5$

With $h = 0.2$ on the interval [0, 0.4], use the classical Runga-Kutta fourth order method.

3. Solve the boundary value problem

$u'' = u - 4xe^x \qquad 0 \le x \le 1$

$u(0) - u'(0) = -1 \qquad u(1) + u'(1) = -e$

Using the second order method with $h = 1/3$. Use suitable fourth order approximation to the boundary conditions. Compare with the exact solution $u(x) = x(1 - x)e^x$

4. The following values of the function

$F(x) = \sin x + \cos x$ are given

X	10°	20°	30°
F(x)	1.1585	1.2817	1.3660

Construct the quadratic interpolating polynomial that fits the data. Hence, find $F\left(\pi/12\right)$ and compare with the exact value.

5. Find a real root, correct to three decimal places of the equation

$2x - 3 = \cos x$

Lying in the interval $\left[\frac{3}{2}, \frac{\pi}{2}\right]$.

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6. Estimate Y at X = 5 by fitting a least square curve of the form $y = \frac{b}{x(x-a)}$ to the following data :

X	3.6	4.8	6.0	7.2	8.4	9.6	10.8
Y	0.83	0.31	0.17	0.10	0.07	0.05	0.04

SECTION-C

7. Find the inverse of the matrix $\begin{bmatrix} 1 & 2 & 1 \\ 2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$

Using the Gauss-Jordan method.

8. Design a computational algorithm to

a) Implement Lagrange's interpolation formula and use it to compute the value of F(5) from the following data for x and F(x) :

(2, 46), (7, 71), (10,110).

b) Fit a curve of the form $y = \frac{a}{x} + bx$

By the method of least squares to the following data of x and F(x) : (1, 5.43), (2, 6.28), (4, 10.32), (6, 14.86), (8, 19.51).

9. Apply Galerkin's method to solve the boundary value problem as

$$\frac{d^2y}{dx^2} - 64y + 10 = 0$$

$$y(0) = y(1) = 0$$

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