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Question Paper Code: BST003



# INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

M.Tech I Semester End Examinations (Regular) - February, 2018

Regulation: IARE-R16

## COMPUTER ORIENTED NUMERICAL METHODS

(Structural Engineering)

Time: 3 Hours

Max Marks: 70

Answer ONE Question from each Unit

All Questions Carry Equal Marks

All parts of the question must be answered in one place only

### UNIT – I

1. (a) Solve the following system of equations using Gauss-Seidel method starting with  $\mathbf{x}^{(0)} = (0.5, 0.5, 0.5, 0.5)^T$ . [7M]

$$\begin{bmatrix} -8 & 1 & 1 \\ 1 & -5 & -1 \\ 1 & 1 & -4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 1 \\ 16 \\ 7 \end{bmatrix}$$

- (b) Use the Givens method to find the Eigen values of the matrix

$$\begin{bmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{bmatrix} \quad [7M]$$

2. (a) Use the LU decomposition method to solve the following simultaneous linear equations. [7M]

$$\begin{bmatrix} 25 & 5 & 1 \\ 64 & 8 & 1 \\ 144 & 12 & 1 \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix} = \begin{bmatrix} 106.8 \\ 177.2 \\ 279.2 \end{bmatrix}$$

- (b) Solve the following system of equations by using Cramer's rule [7M]

$$x_1 + 2x_2 + x_3 = 2$$

$$3x_1 + 6x_2 + x_3 = 1$$

$$3x_1 + 3x_2 + 2x_3 = 3$$

## UNIT – II

3. (a) A robot arm with a rapid laser scanner is doing a quick quality check on holes drilled in a  $15'' \times 10''$  rectangular plate. The centers of the holes in the plate describe the path the arm needs to take, and the hole centers are located on a Cartesian coordinate system (with the origin at the bottom left corner of the plate) given by the specifications in Table 1. [7M]

Table 1

x(in.)	2.00	4.25	5.25	7.81	9.20	10.60
y(in.)	7.2	7.1	6.0	5.0	3.5	5.0

Find the path traversed through the six points using a fifth order Lagrange polynomial.

- (b) Construct Newtons forward difference interpolating polynomial for the following data given in Table 2 hence evaluate  $f(4)$  [7M]

Table 2

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

4. (a) Given the following values of  $f(x)$  and  $f'(x)$  estimate the values of  $f(-0.5)$  using the Hermite interpolation [7M]

Table 3

x	f(x)	$f'(x)$
-1	1	-5
1	3	7

- (b) For linear interpretation, in the case of equispaced tabular data, shows that the error does not exceed  $1/8$  of the second difference. [7M]

## UNIT – III

5. (a) A rod is rotating in a plane. The Table 4 below gives the angle  $\theta$  (in radians) through which the rod has turned for various values of the time  $t$  (in seconds). [7M]

Table 4

t	0	0.2	0.4	0.6	0.8	1.0	1.2
$\theta$	0	0.12	0.49	1.12	2.02	3.20	4.67

Calculate the angular velocity when  $t=0.6$ .

- (b) Compute  $f'(4)$  from the following Table 5 using appropriate interpolating polynomial [7M]

Table 5

x	1	2	4	8	10
f(x)	0	1	5	21	27

6. (a) By repeated application of Richardson extrapolation find  $f'(1)$  from the following Table 6 values. [7M]

Table 6

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

Use the formula  $f'(x) = \frac{f(x+h)-f(x-h)}{2h}$  and  $h=0.4,0.2,0.1$ .

- (b) Find  $f(32)$  by applying central difference formula given that  $f(25) = 0.2707$ ,  $f(30) = 0.3027$ ,  $f(35) = 0.3386$ ,  $f(40) = 0.3794$ . [7M]

#### UNIT – IV

7. (a) For the method  $f'(x) = \frac{1}{6}[2f(x_1) - 3f(x_2) + 6f(x_3) - f(x_4)] + TE + RE$  determine the optimum value of  $H$ , using the criteria  $|RE| = |TE|$ , where TE and RE are respectively the truncation error and round error. [7M]
- (b) Find the jacobian matrix for the system of equations [7M]  
 $f_1(x, y) = x^2 + y^2 - x = 0$   
 $f_2(x, y) = x^2 - y^2 - y = 0$  at the point (1,1) using the second order differentiation method.
8. (a) A solid of revolution is formed by rotating about X-axis, The area between the X-axis and the lines  $x=0$  and  $x=1$  is a curve through the points with the following coordinates shown in Table 7. [7M]

Table 7

x	0	2.5	5.0	7.5	10.0	12.5	15.0
y	5	5.5	6.0	6.75	6.25	5.5	4.0

Estimate the volume of the solid so generated.

- (b) Determine a, b and c such that the formula  $\int_0^h f(x)dx = h\{af(0) + bf(\frac{h}{3}) + cf(h)\}$  is exact for polynomial of as high order as possible. [7M]

## UNIT – V

9. (a) Using Euler's method solve for y at x=2 from  $y' = 3x^2 + 1, y(1) = 2$  taking h=0.25 [7M]  
(b) Apply the fourth order Runge Kutta method to find y at x=1.2 from  $y' = x^2 + y^2, y(1) = 1.5$  taking h=0.1 [7M]
10. (a) Using shooting method solve the boundary value problem  $u'' = u + 1, 0 < x < 1; u(0) = 0, u(1) = e - 1$  [7M]  
(b) given the boundary value problem  $x^2y'' + xy' - y = 0, y(1) = 1, y(2) = 0.5$  apply the cubic spline method to determine the value of y (1.5). [7M]