KUMARAGURU
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Register Number:…………….

M.E DEGREE EXAMINATIONS: NOV/DEC 2024

(Regulation 2018)

First Semester

STRUCTURAL ENGINEERING

P18MAI1201**:** Applied Numerical Methods for Structural Engineering

COURSE OUTCOMES

CO1: Solve a set of algebraic equations representing steady state models formed in engineering problems

CO2: Fit smooth curves for the discrete data connected to each other or to use interpolation methods over these data tables

CO3: Find the trend information from discrete data set through numerical differentiation

CO4: Estimate integrals from discrete data through numerical methods.

CO5: Predict the system dynamic behavior through solution of ODEs modeling the system

CO6: Solve PDE models representing spatial and temporal variations in physical systems through numerical methods.

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. One of the roots of algebraic equation $f(x) = 2x^3 - 3x - 6 = 0$ lies between CO1 [K_2]

a) 0 and 1 b) -1 and 1

c) 1 and 2 d) 2 and 3

2. Rate of convergence of the Newton-Raphson method is generally CO1 [K_2]

a) 1 b) 2

c) 3 d) 4

3. Consider the following statements. CO2 [K_2]

1) First and the last control points of the Bezier curve should not lie on the curve.
2) Bezier curves are defined by the control points.
3) Intermediate control points of the Bezier curve must lie on the curve.
4) Bezier curve must lie within the convex hull.

Which of the above statements are true?

a) 1,2,3 b) 2,4

c) 1,4 d) 1,3,4

4. Match List I with List II with suitable codes given below. CO2 [K_2]

List I	List II
A. $y = ax + b$	i. Parabolic fit
B. $y = ax^2 + bx + c$	ii. Polynomial fit

C. $y = ae^{bx}$	iii. Straight line fit
D. $y = ax^{b}$	iv. Exponential fit

a) A-i, B-iii, C-iv, D-ii   b) A-iii, B-i, C-ii, D-iv

c) A-iv, B-i, C-iii, D-ii   d) A-iii, B-i, C-iv, D-ii

5. Examine the following statement and choose the correct option from the given codes. CO3 [K_4]
Assertion (A) : The 2rd divided difference of a polynomial $3x^2 - 5x + 2$ is zero.
Reason(R) : The nth divided differences of polynomial of degree n are zero.
a) Both A and R are individually true and R is the correct explanation of A   b) Both A and R are individually true and R is not the correct explanation of A
c) A is true but R is false   d) A is false but R is true

6. Simpson's 3/8 th rule is applicable if the number of subintervals is CO4 [K_2]

a) Multiples of 3   b) Even

c) Odd   d) Multiples of 6

7. Examine the following statement and choose the correct option from the given codes. CO6 [K_4]

Assertion (A): The PDE $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$ is elliptic.

Reason (R): A PDE $Au_{xx} + Bu_{xy} + Cu_{yy} = 0$ is elliptic if $B^2 - 4AC < 0$

a) Both A and R are individually true and R is the correct explanation of A   b) Both A and R are individually true and R is not the correct explanation of A
c) A is true but R is false   d) A is false but R is true

8. To identify the path of the projectile the method used is CO5 [K_2]

a) Finite difference method   b) Shooting method

c) Collocation method   d) Interpolation method

9. A boundary value problem (BVP) is said to be linear if the differential equation and the boundary conditions are CO4 [K_2]
a) linear, linear   b) linear, non linear

c) non linear, linear   d) non linear, non linear

10. Crank Nicholson explicit formula can be used for solving one dimensional heat equation, when $\lambda = \frac{k}{ah^2}$ is CO5 [K_2]

a) $\lambda = \frac{1}{2}$ b) $\lambda \le \frac{1}{2}$

c) $0 < \lambda < \frac{1}{2}$ d) $\lambda = 1$

PART B (10 x 2 = 20 Marks)

11. Identify the interval in which one of the positive root lies for $e^x - 3x = 0$ CO1 [K_3]

12. Explain why Brent's Algorithm is a hybrid method?. CO1 [K_4]

13. Test whether $P_1(x) = x^2 - x + 1,\ 1 \le x \le 2$ and $P_2(x) = 3x - 1,\ 2 \le x \le 3$ are Cubic Spline functions. CO2 [K_2]

14. Write down the normal equations to fit the parabola $y = ax^2 + bx + c$ CO2 [K3]

15. Form the divide difference table for the following data. CO3 [K3]

x:	1	2	7	8
y:	1	5	5	4

16. Evaluate $\int y\,dx$ using Simpson's3/8 rule. CO4 [K3]

x	-3	-2	-1	0	1	2	3
y	-81	16	1	0	1	16	81

17. Split the BVP $y'' = -xy' + y + 2x + \frac{2}{x}, \quad y(1) = 0,\ y(2) = 4\log 2$ in to two IVP's using linear shooting method. CO5 [K2]

18. Write down the basis functions that are used in Collocation method. CO5 [K2]

19. Classify the PDE $u_{xx} + u_{yy} = 0$ CO6 [K4]

20. Write down one dimensional heat equation and the explicit formula for solving it. CO6 [K2]

PART C (6 x 5 = 30 Marks)

21. Solve the equation $x^3 - 2x - 5 = 0$ by using Secant method. Given the initial values $x_{-1} = 2,\ x_0 = 3$.(correct to 2 decimals) 5 CO1 [K3]

22. Fit a straight line $y = ax + b$ by using method of least squares for the data 5 CO2 [K3]

x:	0	1	2	3	4
y:	1	1.8	3.3	4.5	6.3

23. Estimate the displacement y of an object at x = 6 using Newton's divided difference formula. 5 CO3 [K3]

x	1	2	7	8
y	1	5	5	4

24. Evaluate $\int_{-3}^{3} x^4\,dx$ by using 1). Simpson's 1/3 rd rule 2) Simpson's 3/8 th rule. 5 CO4 [K5]

25. Solve the boundary value problem $y''(x) = y(x),\ y(0) = 0,\ y(1) = 1.1752$ using linear shooting method through Taylor's series method. 5 CO5 [K4]

26. Solve the one dimensional heat equation $u_{xx} = u_t$ with the boundary and initial values $u(0,t) = 0,\ u(1,t) = t,\ u(x,0) = 0$ for 2 time steps with h = 0.25 using Crank Nicholson method. 5 CO6 [K3]

Answer any FOUR Questions

PART D (4 x 10 = 40 Marks)

27. Determine one of the positive root of the equation $3x = \cos x + 1$ by Newton Raphson method. Also estimate the error in each iteration. 10 CO1 [K_4]

28. Find the cubic spline approximation curve for the data given below with guesses $M_0 = 0,\ M_3 = 0$. Also find y(2.5) 10 CO2 [K_3]

x	0	1	2	3
y= f(x)	1	2	33	244

29. a) Evaluate $\int_1^{1.4}\int_2^{2.4} \frac{dxdy}{xy}$, using trapezoidal and Simpsons rule h = k = 0.1 5 CO4 [K_5]

b) Find the value of $f'(8), f''(9)$, from the following data, using an approximate interpolation formula. 5 CO3 [K3]

x	4	5	7	10	11
y	48	100	294	900	1210

30. Solve the ordinary differential equation $y'' - y = 0$ with the boundary values $y_0 = y(0) = 0,\ y_1 = y(2) = 3.6$ by using finite difference method. Subdivide the range of x into 4 equal parts. CO5 [K_3]

31. Solve the one dimensional heat equation $u_{xx} = u_t$ with the boundary and initial values $u(0,t) = 0,\ u(4,t) = 0,\ u(x,0) = x(4-x)$ up to t = 5 by using Bender Schmidt explicit formula. Assume h = k = 1 10 CO6 [K_3]

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