Register No.: .... Name: ....

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

SIXTH SEMESTER B.TECH DEGREE EXAMINATION (R), MAY 2023

(2020 SCHEME)

Course Code : 20CET392

Course Name: Finite Element Methods

Max. Marks : 100 **Duration: 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1. Illustrate the process of discretization in FEM.
2. What are boundary value problems? What are the physical and mathematical significances of boundary conditions in structural mechanics problems?
3. What is the main advantage of Galerkin method over Rayleigh –Ritz method which makes it suitable for use in certain specific applications?
4. Explain the principle of minimum potential energy with an example.
5. What are interpolation functions? On what all factors does an interpolation function depends on?
6. What are compatibility requirements? Show the importance of compatibility requirements in FEM?
7. Differentiate plane stress and plane strain elements.
8. What criterion gives LST and CST element its name? Illustrate with the help of an example.
9. What are axisymmetric elements? Explain.
10. How to determine the number of Gauss points to evaluate an integral exactly?

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. Consider a uniform bar fixed at one end subjected to a linearly varying load q=ax. The governing differential equation is given by (14)

AE $\frac{d^2u}{dx^2} + ax = 0$. Use Galerkin weighted residual procedure on a two-term trial function to get the solution of the governing equation.

OR

12. Obtain an approximate solution using least squares method for the boundary value problem.
$d^2u/dx^2 + x^2 = 0, 0<x<1$ (14)
$u(0) = 1$, $du(1)/dx + 2u(1) = 1$
Assume two parameter solution.

MODULE II

13. Using Rayleigh Ritz method, determine the central deflection of a simply supported beam carrying a point load at the midpoint. Use y= C1 Sin (π x/L). Compare it with theoretical solution. (14)

OR

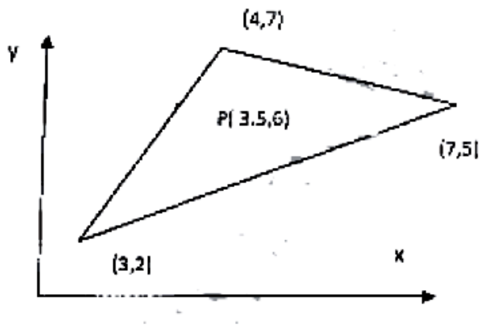
14. Using variational principles derive differential equation and boundary conditions for a bar extending by its own self weight and having a point load at its end. (14)

MODULE III

15. Derive shape function for a two noded beam element. (14)

OR

16. Evaluate shape function N1, N2, N3 at the interior point P for the triangular element shown in figure. (14)



MODULE IV

17. Displacement field for a body is given by $u = (x^2 + y)i + (3y + z)j + (x^2 + 2y)k$

(a) If the material parameters for the 3D body are $\mu = 0.3$, $E = 2\times10^9 N/mm^2$, determine the constitutive matrix. (4)

(b) At a point represented by the coordinates (2, 3, 1), compute the strain and stress components that develop on the body. (6)

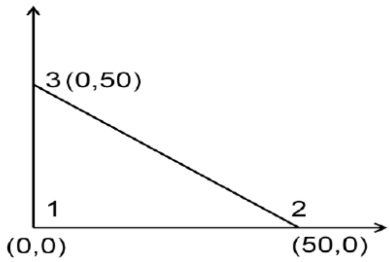
(c) Represent the stress and strain values in matrix form. (4)

OR

18. The cartesian coordinates of corner nodes of a quadrilateral element are given by (3,2), (9,4), (6,8), and (4,5). Derive an isoparametric mapping for this element and using this, determine the cartesian coordinates of the point defined by natural coordinates (0.6, 0.8). (14)

MODULE V

19. Determine the stiffness matrix for the axisymmetric element shown in figure. Take E = 2.1 x 10^6 N/mm^2 and Poisson's ratio as 0.3. All dimensions are in mm only. (14)



OR

20. Evaluate the following integral using two-point Gauss quadrature and compare with exact solution. (14)

$$I = \int_{-1}^{+1} \{ 3e^x + x^2 + (\frac{1}{x+2})\} dx$$

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