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Question Paper Code : 40928

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2025.

Sixth/Seventh Semester

Mechanical Engineering

ME 8692 — FINITE ELEMENT ANALYSIS

(Common to : Automobile Engineering/Manufacturing Engineering/Mechanical Engineering (Sandwich)/Mechanical and Automation Engineering/Production Engineering)

(Regulations 2017)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define is discretization?
2. What is a truss element?
3. Define the shape function.
4. What is the difference between static and dynamic analysis?
5. State the assumptions that are made while finding the forces in a truss.
6. Distinguish between CST and LST elements.
7. What is an axisymmetric element?
8. Write down the stress-strain relationship matrix for the plane stress condition.
9. State the purpose of isoparametric elements.
10. List the advantages of using natural coordinates in finite element methods.

PART B — (5 × 13 = 65 marks)

11. (a) A beam AB of span length 'l' is simply supported at ends and carries a concentrated load W at the centre 'C' as shown in Figure 1. Determine the deflection at midspan by using the Rayleigh Ritz method and compare with the exact solution.

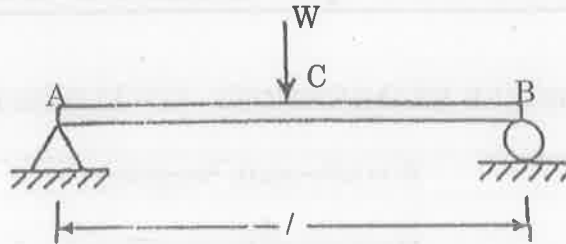


Fig. 1

Or

- (b) Describe the general steps involved in the finite element method and write the merits, demerits, and applications of the finite element method.
12. (a) Consider a bar as shown in Figure 2. The cross-sectional area of the bar is 750 mm^2 and Young's modulus is $2 \times 10^5 \text{ N/mm}^2$. If $u_1 = 0.5 \text{ mm}$ and $u_2 = 0.625 \text{ mm}$. Calculate the following ;

- (i) Displacement at point (P) (3)
- (ii) Strain (e) (3)
- (iii) Stress (σ) (3)
- (iv) Element stiffness matrix (k) (2)
- (v) Strain energy (U) (2)

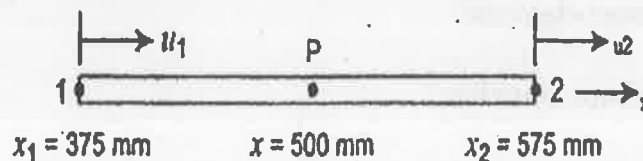


Fig. 2

Or

- (b) Find the deflection at the point load and slope at the ends for the steel shaft, which is simply supported at the bearing and B as shown in Figure 3. Take $E = 200 \text{ GPa}$.

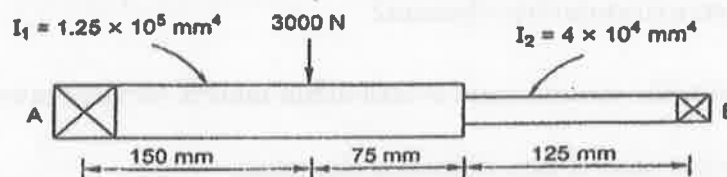


Fig. 3

13. (a) Determine the stiffness matrix for the CST element shown in Figure 4. The coordinates are given in units of millimetres. Assume plane stress conditions. Consider $E = 210 \text{ GPa}$, $\nu = 0.25$ and $t = 10 \text{ mm}$.

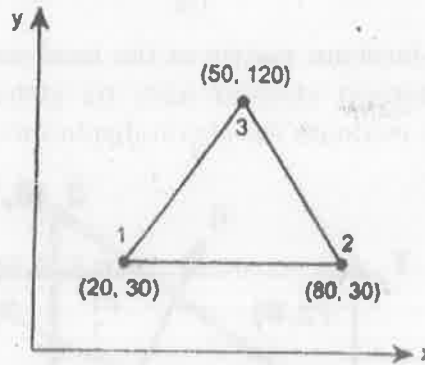


Fig. 4

Or

- (b) For a 4-noded rectangular element shown in Figure 5, estimate the temperature point (7, 4). The nodal values of the temperatures are $T_1 = 42^\circ\text{C}$, $T_2 = 54^\circ\text{C}$, $T_3 = 56^\circ\text{C}$ and $T_4 = 46^\circ\text{C}$. Also, determine the 3 Points on the 50°C contour line.

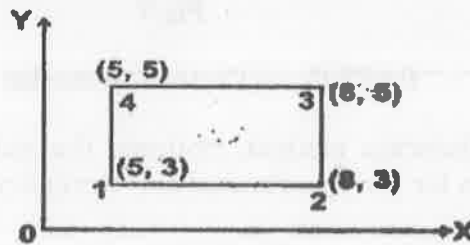


Fig. 5

14. (a) The nodal coordinates for an axisymmetric triangular element are given below. $r_1 = 15 \text{ mm}$, $z_1 = 15 \text{ mm}$, $r_2 = 25 \text{ mm}$, $z_2 = 15 \text{ mm}$ and $r_3 = 35 \text{ mm}$, $z_3 = 50 \text{ mm}$. Determine $[B]$ matrix for the element.

Or

- (b) For an axisymmetric triangular element, as shown in Figure 6. Evaluate the stiffness matrix. Take modulus of elasticity $E = 210 \text{ GPa}$. Poisson's ratio $= 0.25$. The coordinates are given in millimetres.

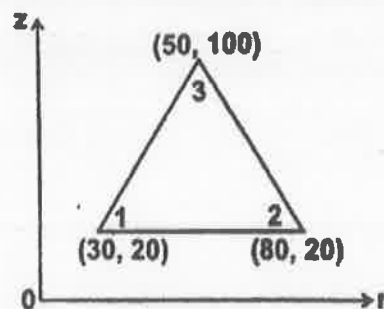


Fig.6

15. (a) Derive the shape functions for a 4-noded rectangular element by using the natural coordinate system.

Or

- (b) Evaluate the Jacobian matrix at the local coordinates $\xi = \eta = 0.5$ for the linear quadrilateral element with its global coordinates as shown in Figure 7. Also, evaluate the strain-displacement matrix.

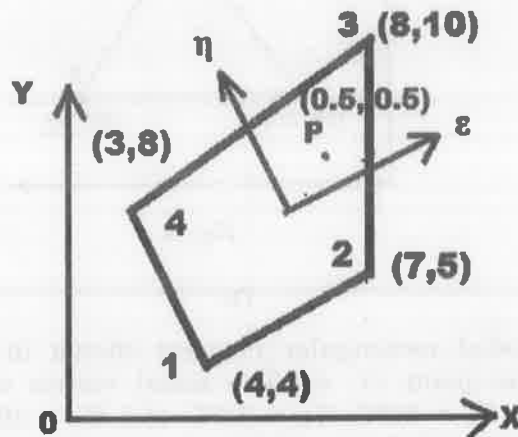


Fig.7

PART C — (1 × 15 = 15 marks)

16. (a) Using the Galerkin method, evaluate the value of parameter C in the trial solution for the one-dimensional boundary value problem.

$$\frac{d^2 y}{dx^2} + y = 4x, \quad 0 \leq x \leq 1, \quad y(0) = 0, \quad y(1) = 1$$

Or

- (b) A cantilever beam is carrying a uniformly distributed load of "w per unit length" over the entire span of length L. Assuming the deflection $y(x) = C_1 \sin\left(\frac{\pi x}{2L}\right) + C_2 \sin\left(\frac{3\pi x}{2L}\right)$ determine the constants C_1 and C_2 using the Rayleigh-Ritz method.