Reg. No. : ☐☐☐☐☐☐☐☐☐☐☐☐

K 4392

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2009.

Seventh Semester

Automobile Engineering

ME 1401 — INTRODUCTION OF FINITE ELEMENT ANALYSIS

(Common to Mechanical Engineering and Mechatronics Engineering)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write down the boundary conditions of a cantilever beam AB of span L fixed at A and free at B subjected to a uniformly distributed load of P throughout the span.

2. Write down the potential energy function for a three dimensional deformable body in terms of strains and displacements.

3. Draw the shape functions of a two noded line element.

4. Draw the shape functions of a one dimensional line element with three nodes.

5. Write down the lumped mass matrix for the truss element.

6. Consider a wall of a tank containing a hot liquid at a temperature T_O with an air stream of temperature T_X passed on the outside, maintaining a wall temperature of T_L at the boundary. Specify the boundary conditions.

7. Write down the constitutive relationship for the axi-symmetric problem.

8. Distinguish between Lagrange and Hermition interpolation functions.

9. Define superametic element.

10. Write down the Gauss Integration formula for triangular domains.

11. (a) A simply supported beam (span L and flexural rigidity EI) carries two equal concentrated loads at each of the quarter span points. Using Raleigh-Ritz method determining the deflections under the two loads and the two end slopes.

Or

(b) Use the Gaussian elimination method to solve the following simultaneous equations :

$$4X_1 + 2X_2 - 2X_3 - 8X_4 = 4$$
$$X_1 + 2X_2 + X_3 = 2$$
$$0.5X_1 - X_2 + 4X_3 + 4X_4 = 10$$
$$-4X_1 - 2X_2 - X_4 = 0.$$

12. (a) A column of length 500 mm is loaded axially as shown in fig. 12 (a). Analyze the column and evaluate the stress and strains at salient points. The Young's modulus can be taken as E.
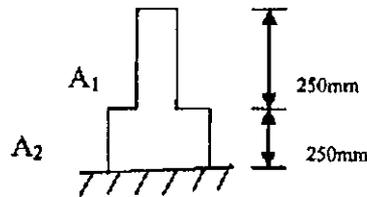
$A1 = 62.5$ mm^2

$A2 = 125$ mm^2

Fig. 12 (a)

Or

(b) For the prinmatic bar shown in Fig. 12 (b), generate the stiffness matrix corresponding to the three coordinates indicated. Use the following shape functions.

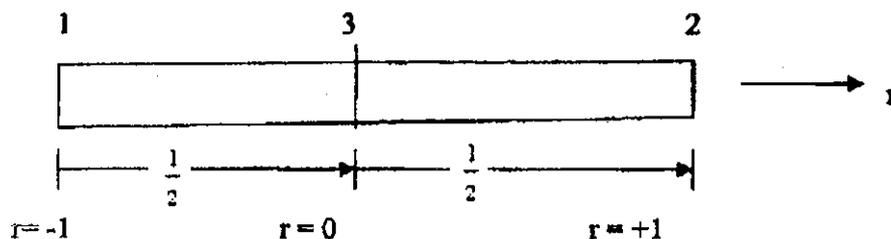$N1 = (-1/2)r(1-r)$

$N2 = (1/2)r(1-r)$

$N3 = 1 - r^2$

Fig. 12 (b)

13. (a) Develop stiffness coefficients due to torsion for a three dimensional beam element.

Or

(b) Calculate the temperature distribution in stainless steel fin shown in Fig. 13 (b). The region can be discretized into 5 elements and 6 nodes.

$h = 0.0025 \text{ w/cm}^2 \text{c}$ $T\alpha = 25 \text{ c}$

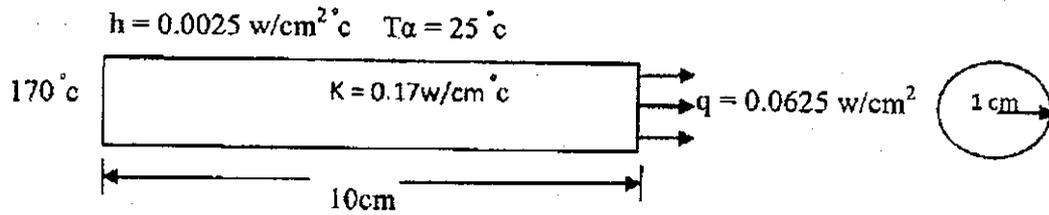170 c $K = 0.17 \text{w/cm c}$ $q = 0.0625 \text{ w/cm}^2$ 1 cm

10cm

Fig. 13 (b)

14. (a) Develop shape functions for the nine noded rectangular element belonging to the Lagrange family.

Or

(b) Develop the shape function for an eight noded brick element.

15. (a) For a triangular element shown in figure 15 (a), compute the stiffness matrix by using isoparametric formulation and numerical integration with one point quadrature rule. $E = 2 \times 10^3 \text{ kN/cm}^2$, $\mu = 0$.
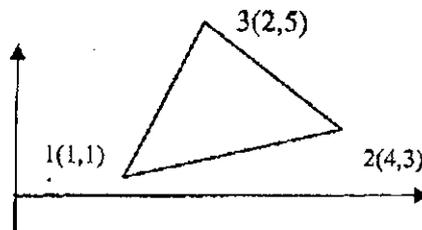
3(2,5)

1(1,1)   2(4,3)

Fig. 15 (a)

Or

(b) Evaluate the following integral using two point Gaussian quadrature :

$$I = 2 \int\limits_{\tau=-1}^{1} \int\limits_{\epsilon=-1}^{1} (1-2\epsilon)^2 (4-\tau-5) \, d\epsilon \, d\tau$$

$\tau_i = \epsilon_i = \dfrac{1}{\sqrt{3}}, -\dfrac{1}{\sqrt{3}}$; $W_i = 1$, $i = 1, 2$.

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