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Question Paper Code : 50885

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

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. List any four points that a user must know to use the FEA packages properly.

2. Illustrate your understanding about the term "convergence" in FEA.

3. Find the temperature at a distance of 25 mm from origin for an element of length 45 mm. The temperature is linearly varying and its values at nodes 1 and 2 are 90°C and 120°C, respectively.

4. Give the conduction, convection and thermal load matrices for 1 D heat transfer through compressor fin.

5. Evaluate the shape functions N_1, N_2 and N_3 at the interior point 'P' for the triangular element having coordinates (3, 2), (7, 4) and (5, 8).

6. Give your view about higher-order elements.

7. Distinguish between plane stress and plane strain conditions.

8. List the conditions to be satisfied for a problem to be treated as axisymmetric.

9. Compare isoparametric, super parametric and sub-parametric elements.

10. Differentiate dynamic analysis from static analysis.

PART B — (5 × 13 = 65 marks)

11. (a) Find the deflection at the centre of a simply supported beam of span length l subjected to uniformly distributed load throughout its length as shown in Figure 11 (a), using

   (i) Least squares method, and

   (ii) Galerkin's method.

   Use trigonometric series trial function.
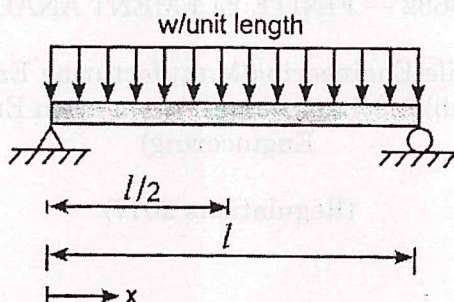

Figure 11 (a)

Or

(b) A bar of uniform cross-section is fixed at one end and left free at the other end and it is subjected to a uniform axial load F as shown in Figure 11 (b).

   Calculate the displacement and stress using Rayleigh's-Ritz procedure with two term polynomial function.
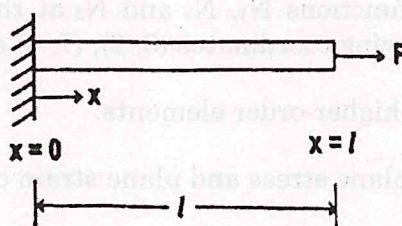

Figure 11 (b)

12. (a) A thin plate of uniform thickness 20 mm, is as shown in Figure 12 (a). In addition to the self-weight, the plate is subjected to a point load of 400 N at mid-depth. The Young's modulus $E = 2 \times 10^5$ N/mm^2 and density $\rho = 0.8 \times 10^{-4}$ N/mm^3. Analyze the plate after modeling it with two elements and find the stresses in each element. Determine the support reactions also.
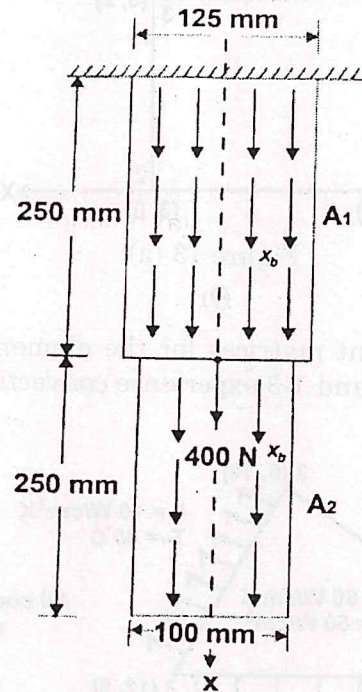

Figure 12 (a)

Or

(b) For the two-bar truss as shown in Figure 12 (b), determine the displacements at node 2 and the stresses in both elements.
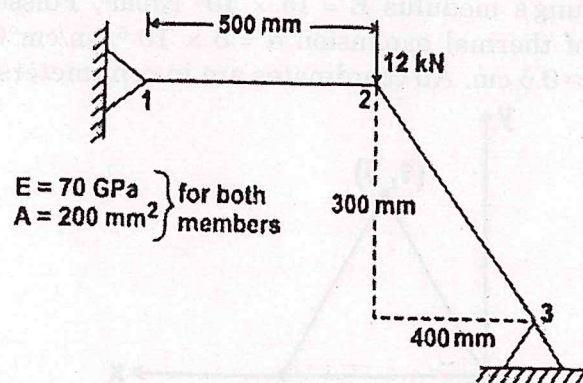

Figure 12 (b)

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13. (a) For a four noded rectangular element shown in Figure 13 (a), determine the temperature at the point (2, 1). The nodal temperatures are $T_1 = 42°C$, $T_2 = 54°C$ $T_3 = 56°C$ and $T_4 = 46°C$.
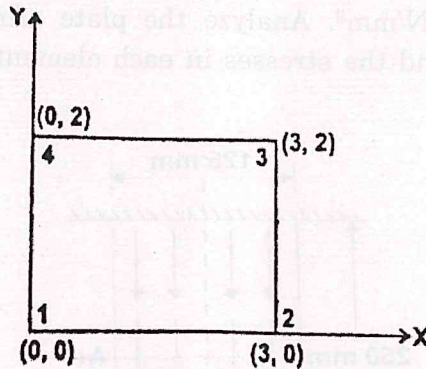

Figure 13 (a)

Or

(b) Compute the element matrices for the element shown in Figure 13 (b), when the edges 2-3 and 1-3 experience convection heat loss.
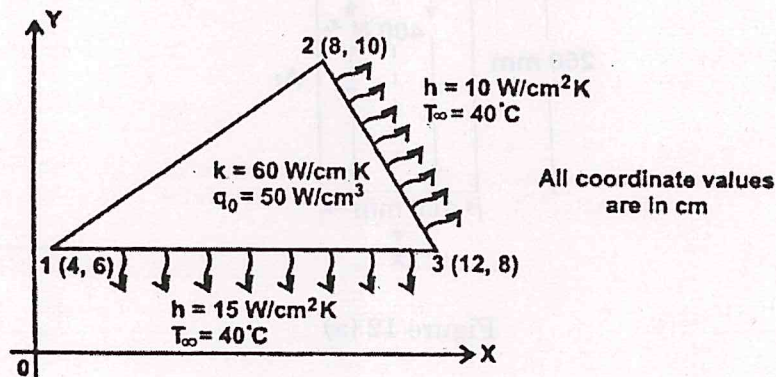

Figure 13 (b)

14. (a) Calculate the thermal force vector for the plane stress element shown in Figure 14 (a). The element experience a 10°C increase in temperature. Assume Young's modulus $E = 15 \times 10^6$ N/cm², Poisson's ratio $\mu = 0.25$, coefficient of thermal expansion $\alpha = 6 \times 10^{-6}$ cm/cm°C and the element thickness $t = 0.5$ cm. All coordinates are in centimeters.
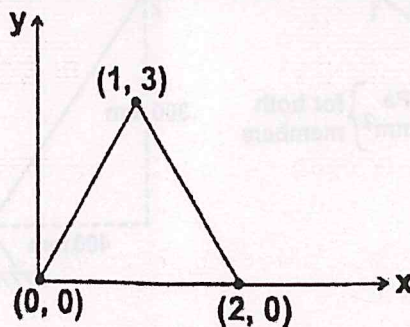

Figure 14 (a)

Or

(b) Derive the strain-displacement matrix for the axisymmetric triangular element shown in Figure 14 (b).
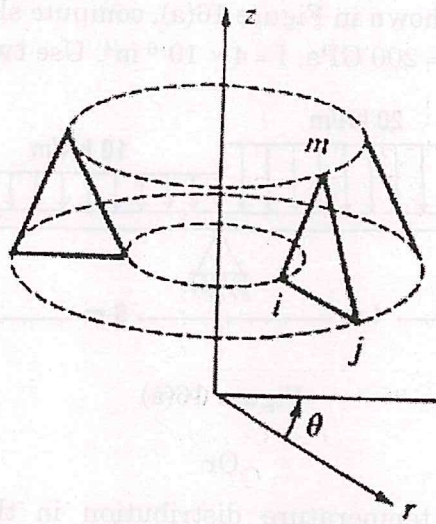

Figure 14 (b)

15. (a) Assemble Jacobian matrix and strain displacement matrix corresponding to the Gauss point (0.57735, 0.57735) for the element shown in Figure 15 (a).
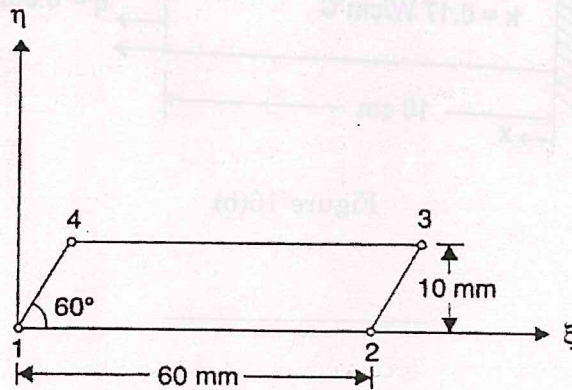

Figure 15 (a)

Or

(b) (i) Evaluate the integral (5)

$$f(r) = \int_{-1}^{1} (r^2 - 3r + 7)\,dr$$

Using Gaussian quadrature so that the result is exact. Take $r_i = \pm 0.5773503$ and $w_i = 1$.

(ii) Use Gaussian quadrature to obtain an exact value for the integral. Consider, r_i and $s_i = \pm\, 0.5773503$ and $w_i = 1$. (8)

$$I = \int_{-1}^{1}\int_{-1}^{1} (r^3 - 1)(s - 1)^2\,dr\,ds$$

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16. (a) For the beam shown in Figure 16(a), compute slope at the hinged support points, Take E = 200 GPa, I = 4 × 10⁻⁶ m⁴. Use two beam elements.
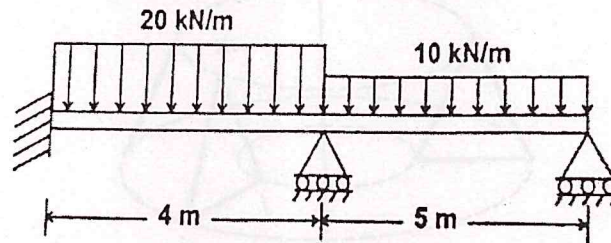

Figure 16(a)

Or

(b) Calculate the temperature distribution in the stainless steel fin of circular cross section shown in Figure 16(b). The cross section of the fin is circular with diameter of 2 cm. Discretize the fin into 5 elements.
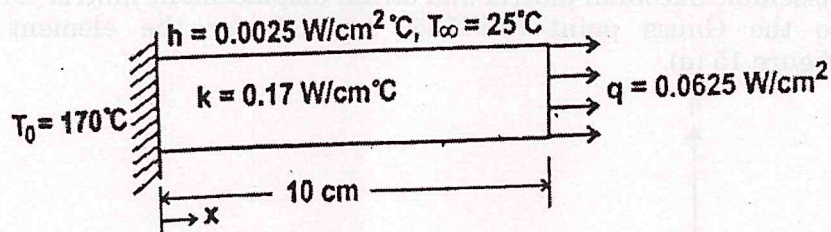

Figure 16(b)

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