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Question Paper Code : 31352

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Sixth Semester

Mechanical Engineering

ME 2353 — FINITE ELEMENT ANALYSIS

(Common to Mechanical Engineering (Sandwich)/ Automobile Engineering/ Industrial Engineering and Management and Mechanical and Automation Engineering)

(Regulation 2008)

(Also common to PTME 2353 — Finite Element Analysis for B.E. (Part-Time) Sixth Semester — Mechanical Engineering — Regulation 2009)

Time : Three hours　　　　　　　　　　Maximum : 100 marks

(Any missing data may be suitably assumed)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Distinguish between Error in solution and Residual.

2. What are the advantages of weak formulation?

3. Give the Lagrangean equation of motion and obtain the shape functions for quadratic coordinate transformation.

4. Write about the effective global nodal forces of beam element.

5. What is the salient feature of an isoparametric element? Give an example.

6. Define Jacobian.

7. Define dynamic analysis.

8. What is meant by transverse vibrations?

9. Define element capacitance matrix for unsteady state heat transfer problems.

10. Define the stream function for a two dimensional incompressible flow.

PART B — (5 × 16 = 80 marks)

11. (a) Determine using any Weighted Residual technique the temperature distribution along a circular fin of length 6 cm and radius 1 cm. The fin is attached to a boiler whose wall temperature if 140°C and the free end is insulated. Assume convection coefficient $h = 10\,W/cm^2\,°C$. Conduction coefficient $K = 70\,W/cm^2\,°C$ and $T_\infty = 40°C$. The Governing Equation for the heat transfer through the fin is given by $-\frac{d}{dx}\left[KA(x)\frac{dT}{dx}\right] + hp(x)(T - T_\infty) = 0$.

Assume appropriate boundary conditions and calculate the temperatures at every 1 cm from the left end.

Or

(b) Derive the governing equation for a tapered rod fixed at one end and subjected to its own self weight and a force P at the other end as shown in Fig. 11 (b). Let the length of the bar be l and let the cross section vary linearly from A_1 at the top fixed end to A_2 at the free end. E and γ represent the Young's modulus and specific weight of the material of the bar. Convert this equation into its weak form and hence determine the matrices for solving using the Ritz technique.

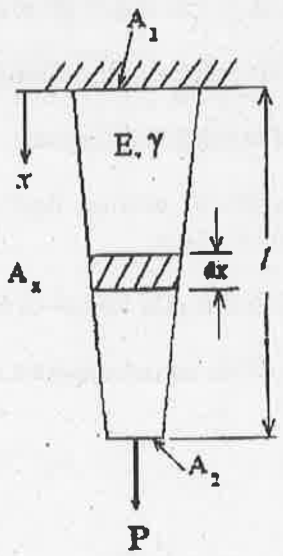

Fig.11(b)

12. (a) A steel bar of length 800 mm is subjected to an axial load of 3 kN as shown in fig. Q. 12(a). Find the elongation of the bar, neglecting self weight. (16)

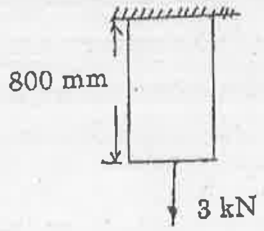

Fig.Q.12 (a)

Or

(b) Derive the stiffness matrix for 2D truss element. (16)

13. (a) Calculate the value of pressure at the point A which is inside the 3 noded triangular element as shown in Fig 13(a). The nodal values are $\phi_1 = 40$ MPa, $\phi_2 = 34$ MPa and $\phi_3 = 46$ MPa, Point A is located at (2, 1.5) Assume pressure is linearly varying in the element. Also determine the location of 42 MPa contour line.

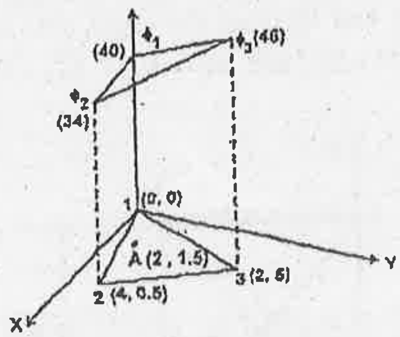

Fig.13(a)

Or

(b) For the plane stress element whose coordinates are given by (100, 100), (400, 100) and (200, 400), the nodal displacements are $u1$ = 2.0 mm, $v1$ = 1.0 mm, $u2$ = 1.0 mm, $v2$ = 1.5 mm, $u3$ = 2.5 mm, $v3$ = 0.5 mm. Determine the element stresses. Assume $E = 200$ GN/m^2, $\mu = 0.3$ and $t = 10\,mm$. All coordinates are in mm.

14. (a) A vertical plate of thickness 40 mm is tapered with widths of 0.15 m and 0.075 m at top and bottom ends respectively. The plate is fixed at the top end. The length of the plate is 0.8 m. Take Young's modulus as 200 GPa and density as 7800 kg/m^3. Model the plate with two spar elements Determine the natural frequencies of longitudinal vibration and the mode shapes.

Or

(b) Explain the direct integration method using central difference scheme for predicting the transient dynamic response of a structure.

15. (a) The figure 15 (a) shows a uniform Aluminum fin of diameter 25 mm. The root (left end) of the fin is maintained at a temperature of $T_0 = 120^\circ C$, convection takes place from the lateral (circular) surface and the right (flat) edge of the fin. Assuming $k = 200\ W/m^\circ C$, $h = 1000\ W/m^{2\circ}C$ and $T = 20^\circ C$, determine the temperature distribution in the fin using one dimensional element, considering two elements.

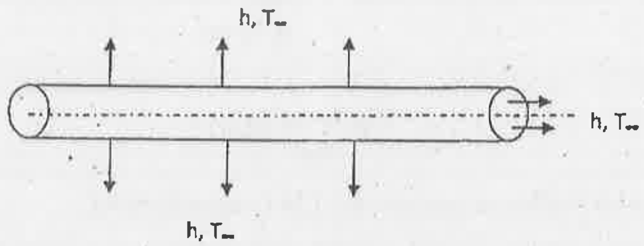

Figure.15(a)

Or

(b) For the two dimensional sandy soil region shown in the figure 15 (b), determine the potential distribution. The potentional (fluid head) on the left side is 10 m and that on the right side is 0.0 m. The permeabilities are $K_{41} = K_{32} = 25 \times 10^{-5} m/s$ and $K_{34} = K_{12} = 0$. Assume unit thickness.

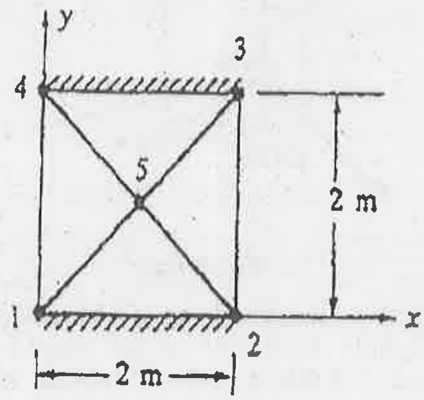

Figure.15(b)