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B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2010

SEVENTH SEMESTER

MECHANICAL ENGINEERING

ME1401 FINITE ELEMENT ANALYSIS

(REGULATION 2007)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the basic approaches to improve a finite element model?
2. What is a weighted residual method?
3. Plot the variation of shape function for 1 -D beam element.
4. State the properties of stiffness matrix.
5. Distinguish plane stress and plane strain conditions.
6. Why is a 3 noded triangular element called a constant strain triangular element?
7. State the applications of axi-symmetric elements.
8. What is a Jacobian?
9. Define static condensation.
10. Distinguish subparametric and superparametric elements.

PART B — (5 × 16 = 80 marks)

11. (a) Explain the step by step procedure of FEA. (8)

    (b) What are initial and boundary value problems? Explain. (8)

Or

12. (a) Solve the following equation by Gaussian elimination method (10)

$$X_1 - X_2 + X_3 = 1$$
$$-3X_1 + 2X_2 - 3X_3 = -6$$
$$2X_1 - 5X_2 + 4X_3 = 5.$$

(b) Define discretization. Explain mesh refinement. (6)

13. (a) A steel rod of length 1 m is subjected to an axial load of 5 kN as shown in Fig. 1. Area of cross section of the rod is 250 mm². Using 1 - D element equation solve for the deflection of the bar, $E = 2 \times 10^5$ N/mm². Use four elements. (12)

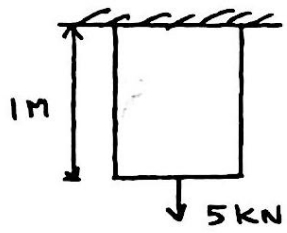

Fig. 1

(b) Explain the Potential Energy approach. (4)

Or

14. (a) What are the different types of elements? Explain the significance of each. (12)

(b) Compare FEM with other methods of analysis. (4)

15. (a) Determine the temperature and the heat fluxes at a location (2, 1) in a square plate shown in Fig. 2. Draw the isothermal for 125°C. $T_1 = 100$ °C, $T_2 = 150$ °C, $T_3 = 200$ °C, $T_4 = 50$ °C. (12)

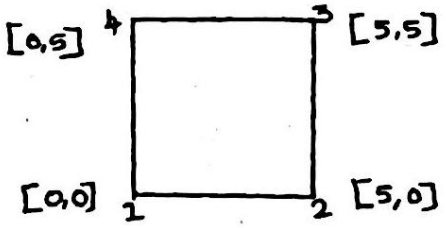

Fig. 2

(b) What is dynamic analysis? Give examples. (4)

Or

16. Consider a bar as shown in Fig. 3. Young's modulus $E = 2 \times 10^5$ N/mm². $A_1 = 2$ cm², $A_2 = 1$ cm² and a force of 100 N. Determine the nodal displacement. (16)

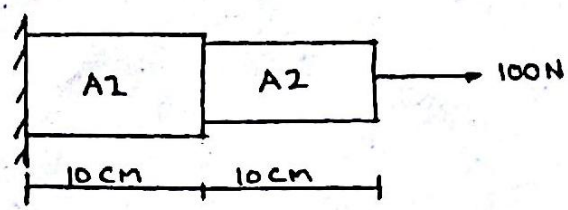

Fig. 3

17. (a) For a axi-symmetric triangular element, obtain the $[B]$ matrix and constitutive matrix. (10)

(b) For a thick cylinder subjected to internal and external pressure, indicate the steps of finding the radial stress. (6)

Or

18. Calculate the consistent and lumped load vector for the element shown in Fig. 4 (16)

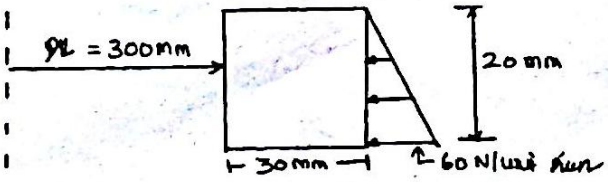

Fig. 4

19. (a) Derive the isoparametric representation for a triangular element. (12)

(b) What are higher order elements? (4)

Or

20. Consider the quadrilateral element shown in Fig. 5. Evaluate $\delta N_i / \delta_x$ and $\delta N_i / \delta_y$ at (ε, η), (0, 0) and $\left(\frac{1}{2}, \frac{1}{2}\right)$ using isoparametric formulation. (16)

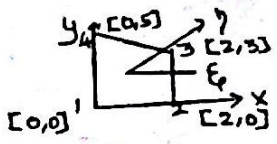

Fig. 5