Reg. No. :

Question Paper Code : 10118

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2012.

Sixth Semester

Aeronautical Engineering

AE 2351/AE 61/AE 1007 — FINITE ELEMENT METHOD

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the basic concept of finite element method?

2. What are convergence criteria?

3. What are complex elements? Give an example.

4. State any two applications of beam element.

5. State whether the strain is constant, linear or zero in a linear triangular element.

6. What are axisymmetric problems?

7. Distinguish between super parametric and sub parametric elements.

8. Why is in isoparametric element formulation, the transformation of element stiffness matrix is not necessary?

9. What is a conductance matrix?

10. Name any two methods of FEA used to solve incompressible fluid problems.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Show that the stiffness matrix for a finite element may be obtained in the form of $[K] = \int_V [B]^T [D][B] dV$. (6)

(ii) Explain clearly the various steps involved in finite element analysis while solving a problem in structural mechanics for stress analysis. (10)

Or

(b) (i) Explain how the energy principles are applied to find the deflection at the end of a cantilever beam subjected to an axial force F. (10)

(ii) Discuss the merits and limitations of FEM. (6)

12. (a) A two-step, bar subjected to loading condition as shown in Fig.1 is fixed at one end and the free end is at a distance of 3.5 mm from the support. Determine

(i) displacement at nodal points

(ii) the stresses in elements and

(iii) the reactions at support. (16)

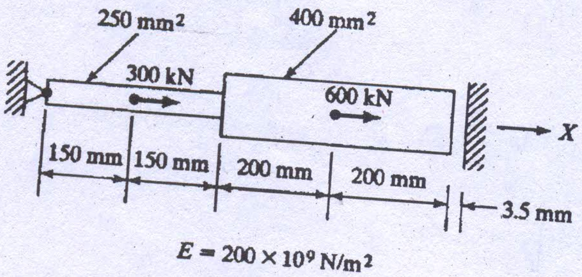

Figure 1

Or

(b) For a plane truss shown in Fig. 2, determine the horizontal and vertical displacement of node 1 and the stresses in each element. The cross sectional area and Young's modulus of truss elements are 4.0×10^{-4} m^2 and 210 GPa respectively. (16)

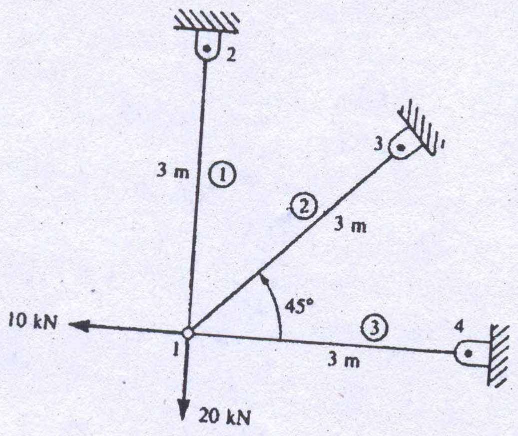

Figure 2

13. (a) Triangular elements are used for the stress analysis of plate subjected to inplane loads. The (x, y) coordinates of nodes i, j and k of an element are given by (0,0), (4, 0) and (2, 5) mm respectively. Determine the element stiffness matrix. Take young's modulus = 210 GPa, Poisson ratio = 0.25 and thickness of the element = 5 mm. (16)

Or

(b) For the linearly varying distributed load on the axisymmetric conical surface shown in Fig. 3, prove that the equivalent point load vector T is given by

$$T = [aT_{r1} + bT_{r2}, aT_{z1} + bT_{z2}, bT_{r1} + cT_{r2}, bT_{z1} + cT_{z2}]^T$$

Where $a = 2\pi l(3r_1 + r_2)/12$, $b = 2\pi l(r_1 + r_2)/12$ and $c = 2\pi l(r_1 + 3r_2/12)$. (16)

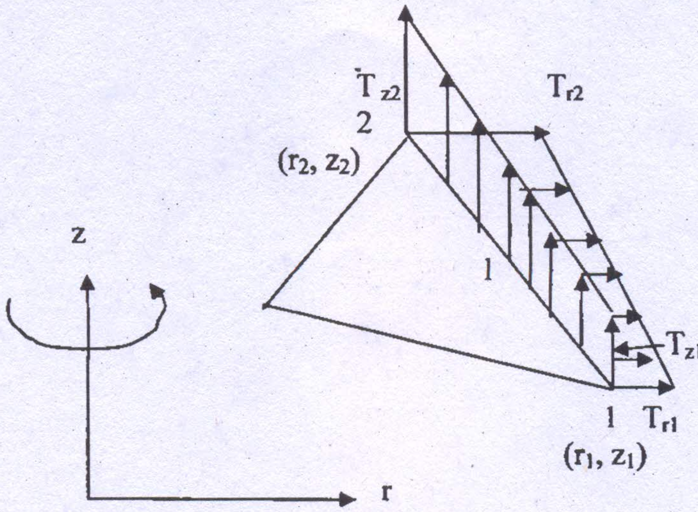

Figure 3

14. (a) Derive the Jacobian and strain displacement matrices of a linear brick element.

Or

(b) Consider the isoparametric quadrilateral element with nodes 1 – 4 at (3, 1), (6, 1), (8, 6), and (2, 5) respectively. If loads 20 kN and 22 kN are acting in x and y directions respectively on a point P which has coordinates (7, 4). Compute the nodal equivalent forces. (16)

15. (a) Considering a tapered fin receiving conduction heat flux from one end and convective heat transfer through its other surfaces exposed to air, deduce the system of finite element equations. The area of cross section of the fin varies linearly from one end to other. Apply suitable heat transfer equation and thermal properties. (16)

Or

(b) Explain the finite element procedure for determining the flow field along the nodal points for a flow of fluid in a two dimensional duct. (16)
