Reg. No. :

**Question Paper Code : 11029**

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 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. Explain the principle used in the Rayleigh-Ritz method.

2. Define the stiffness coefficient and flexibility coefficient.

3. Explain the procedure followed in the finite element analysis.

4. Derive the shape function expressions for a bar element with two nodes.

5. Write down the stiffness matrix for a beam element.

6. Explain the plane stress and plane strain problem with suitable example.

7. Derive the shape function for any one node of a linear strain triangular element in terms of area coordinates.

8. Write down the shape function expressions for a four nodded quadrilateral isoparametric element.

9. Explain the numerical integration used for evaluation of element matrices.

10. Write down the element matrices used for 1-D heat transfer problem.

## PART B — (5 × 16 = 80 marks)

11. (a) A beam of length L and uniform section is simply supported at its ends and subjected to uniformly distributed load of intensity $q_0$ throughout the length of the beam. Compute the maximum deflection and maximum bending moment using Rayleigh-Ritz method.

Or

(b) A beam of length L and uniform section is fixed at its ends and is subjected to uniformly distributed load of intensity $q_0$ over the entire span of the beam. Compute the maximum deflection using Galerkin method.

12. (a) A bar ABCD of length 1550 mm is fixed at its ends. The segment AB is made of bronze for which $E_b$ = 83 GPa, length is 750 mm and area is 2400 mm$^2$. The material of segment BC is aluminum and the modulus of elasticity $E_a$= 70 GPa. The length and area of BC are 500 mm and 1200 mm$^2$ respectively. The length of CD is 300 mm and its area is 600 mm$^2$. The material in CD is steel and the modulus of elasticity is 200 GPa. An axial load of 50 kN is applied at B acting towards left and a load of 80 kN is applied at C acting towards left. Compute the stresses developed in the three segments of the bar.

Or

(b) A beam AB of uniform section and length 10 m is fixed at A and is on roller support at B. The beam is subjected to uniformly distribute load of intensity 50 kN/m over the entire length of the beam. Using two element idealisation compute the nodal displacements. EI = 25 × 10$^6$ N-m$^2$.

13. (a) Derive the shape function expressions for a constant strain triangular element and derive the strain displacement matrix for the same.

Or

(b) Consider a linear strain triangular element subjected to uniform pressure along one of its edges. The pressure with respect to global reference axis x is $P_{xo}$ and that with respect to y axis is $P_{yo}$. Derive the consistent load vector.

14. (a) Compute the strain displacement matrix for a four nodded quadrilateral isoparametric element Fig. 1 at the point whose natural coordinates are r = 0.57735 and s = –0.57735.

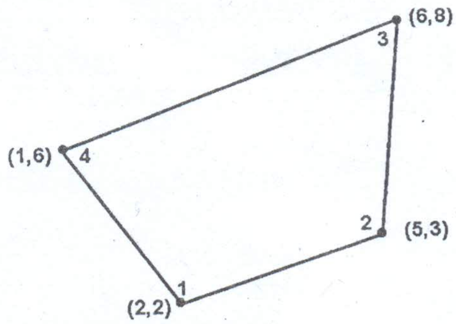


Fig. 1

Or

(b) (i) Derive all the shape function expressions for a eight nodded isoparametric element. (8)

(ii) Derive the shape function expressions for all the nodes of a nine nodded isoparametric element. (8)

15. (a) A furnace wall is made of 8 cm thick fire-clay (k =1.2 W/m –°C) and 0.6 cm thick mild steel (k = 35 W/m –°C). The surface of fire-clay is at 600°C and steel surface is exposed to air at 30°C and heat transfer coefficient for steel surface is 5 W/m$^2$ –°C. Using two element idealization compute the temperature on the surface of the steel.

Or

(b) A fin used for heat transfer is of length 10 cm and its cross section is circle of diameter 1.6 cm. The surface heat transfer coefficient is 25 W/m$^2$ –°K and conductivity of fin material is 40 W/ m –°K. The base temperature of the fin is 300°C and the surrounding air temperature is 30°C. Using two element idealization compute the temperature distribution along the length of the fin.

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