Reg. No. :

Question Paper Code : 50086

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

Sixth Semester

Aeronautical Engineering

AE 8601 – FINITE ELEMENT METHODS

(Common to: Aerospace Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Mention any three weighted residual methods.

2. What is meant by convergence in FEA?

3. What is the basic difference between bar and beam elements?

4. Why polynomials are generally used as shape function?

5. Distinguish between plain strain and plain stress problem.

6. How is a CST element different from LST?

7. What is an isoparametric element?

8. Write down the Gaussian quadrature expression for numerical integration.

9. Define degree of freedom applied in thermal problems.

10. List out the sources of error considered in FEM.

PART B — (5 × 13 = 65 marks)

11. (a) Explain the steps involved in obtaining an approximate solution using finite element method.

Or

(b) A simply supported beam supported to uniformly distributed load over entire span and it is subjected to a point load at the centre of the span. Calculate the bending moment and deflection at midpan by using Rayleigh – Ritz method and compare with extact solution.

12. (a) Determine the nodal displacement and element stresses for axially loaded bar shown in the Fig.1.

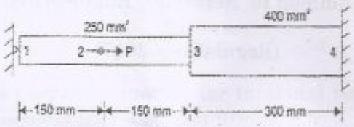

Fig. 1

Or

(b) Determine the deflection and slope of the cantilever beam for the loading conditions as shown in Fig. 2.

E = 200 GPa, $I_1 = 4 \times 10^{-6} m^4$, $I_2 = 2 \times 10^{-6} m^4$.

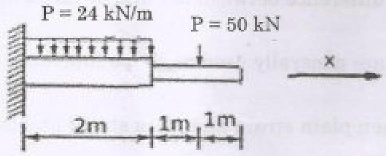

Fig. 2

13. (a) Evaluate the stiffness matrix for the triangular element having the global coordinates, A (20, 30), B (80, 30), C (50, 20). The coordinates are given in units of millimeters. Assume plane stress condition. Take Young's Modulus E = 210 GPa, Poisson's ratio v = 0.25 and thickness t = 10 mm.

Or

(b) For the axisymmetric element shown in Fig. 3 determine the element stresses. Take E = 210 GPa, γ = 0.20. The nodal displacements are U_1 = 0.05 mm, W_1 = 0.03 mm, U_2 = 0.02 mm W_2 = 0.02 mm, U_3 = 0 mm, W_3 = 0 mm. The co-ordinates are in millimeters.

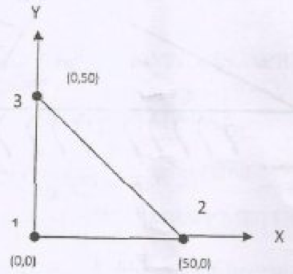

Fig. 3

14. (a) A four noded quadrilateral element has nodes placed at x-y coordinates as P(4, 1), Q(10, 2), R(8, 12) and S(6, 8). Derive the strain displacement matrix at r = –0.57735 and s = 0.57735 using isoparametric concept.

Or

(b) Derive the shape function of an eight node quadrilateral element and represent them graphically.

15. (a) An iron rod of length 400 mm, diameter 10 mm and thermal conductivity 65 W/m°C is attached to a large tank at a temperature of 330°C. The rod is dissipating heat by convection into ambient air at 30°C with a heat transfer coefficient of 17 W/m²°C. Determine the temperature distribution in the rod. Also estimate the temperature at a point 300 mm from the tank surface.

Or

(b) Find the temperature at point P (1, 1.5) inside the triangular element with coordinates as A (0, 0), B (2, 0) and C (1, 2). The nodal temperatures are given as T_A = 40°C, T_B = 34°C and T_C = 46°C. Also determine the location of the 42°C contour line for the triangular element.

PART C — (1 × 15 = 15 marks)

16. (a) Compute the element matrices and vectors for the element shown in Fig. 4, when the edges jk and ki experience convection heat loss.

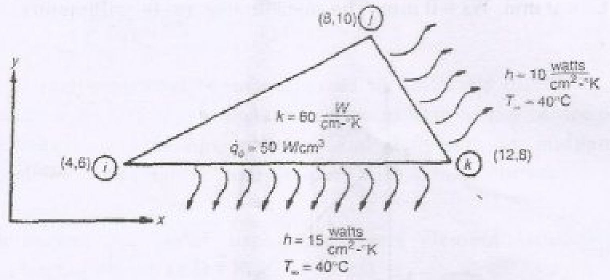

Fig. 4

Or

(b) Derive finite element equation for torsional bar element. Illustrate and explain the various boundary conditions.