Question Paper Code : 31043

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Sixth Semester

Mechanical Engineering

080120032 — FINITE ELEMENT ANALYSIS

(Common to Automobile Engineering)

(Regulation 2008)

Time : Three hours — Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. State the advantages of Gaussian elimination technique.

2. What is Ritz method?

3. State the significance of shape function.

4. What is post processing? Give an example.

5. What is meant by primary and secondary node?

6. Distinguish between CST and LST elements.

7. Write the finite element equation used to analyse a two dimensional heat transfer problem.

8. State the applications of axisymmetric elements.

9. When are isoparameteric elements used?

10. What are force vectors? Give an example.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Discuss the importance of FEA in assisting design process. (6)

(ii) Solve the ordinary differential equation

$$\left(\frac{d^2y}{dx^2}\right) + 10x^2 = 0 \text{ for } 0 \le x \le 1$$

Subject to the boundry conditions $y(0) = y(1) = 0$ using the Galerkin method with the trial functions $N_0(x) = 0$; $N_1(x) = x(1 - x^2)$. (10)

Or

(b) (i) Discuss the factors to be considered in descretisation of a domain. (10)

(ii) Solve the following equations using the gauss elimination method.

$2x_1 + 3x_2 + x_3 = 9$

$x_1 + 2x_2 + 3x_3 = 6$ (6)

$3x_1 + x_2 + 2x_3 = 0.$

12. (a) Fig.1 shows the pin-jointed configuration. Determine the nodal displacements and stresses in each element. (16)

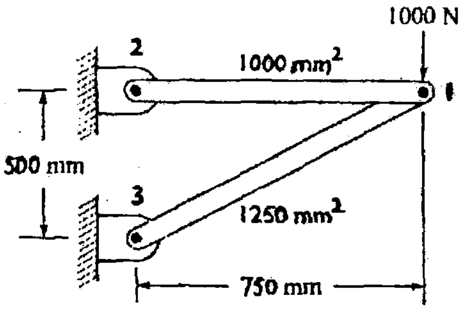


Fig.1

Or

(b) For the beam shown in Fig.2, determine

(i) The slopes at node 2 and 3 and

(ii) Vertical deflection at the mid-point of the distributed load. All the lemenets have E = 200 GPa and I = 5 × 10^6 mm^4. (16)

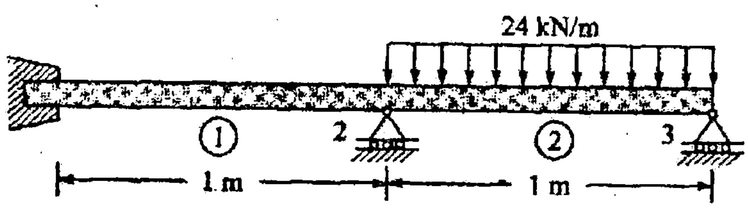
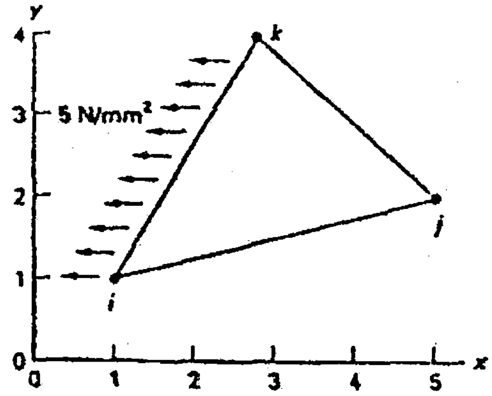


Fig. 2

13. (a) Compute the finite element equation for the LST element shown in Fig.3. (16)



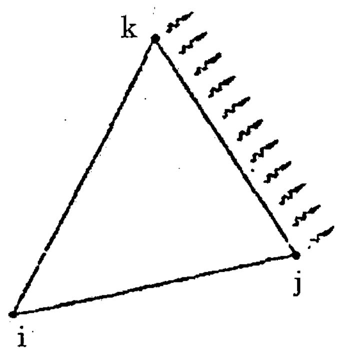
Thickness = 2 mm
E = 200 GPa
$\upsilon = 0.3$

Plane stress

Fig. 3

Or

(b) Determine the element matrices and vectors for the LST element shown in Fig.4.The nodal coordinates are i (1, 1), j (5, 2) and k (3, 5). Convection takes place along the edge jk.



K = 7.5 W/mm°C
h = 0.15 W/mm²°C
T_∞ = 30°C

Fig. 4

14. (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 (2, 3), (4, 1), and (4, 5) mm respectively. The nodal displacements are given as :

u_1 = 2.0 mm, u_2 = 0.5 mm, u_3 = 3.0 mm

v_1 = 1.0 mm, v_2 = 0.0 mm, v_3 = 0.5 mm

Determine element stresses. Let E = 160 GPa, Poisson's ratio = 0.25 and thickness of the element t = 10 mm. (16)

Or

(b) (i) What are the non-zero strain and stress components of axisymmetric element? Explain. (4)

(ii) Derive the stiffness matrix of an axisymmetric element using potential approach. (12)

15. (a) (i) Consider the isoparametric quadrilateral element with nodes 1 – 4 at (5, 5), (11, 7), (12, 15), and (4, 10) respectively. Compute the Jacobian matrix and its determinant at the element centroid. (10)

(ii) Use Gaussian quadrature with two points to evaluate the integral

$$\int_{-1}^{1} \left(\cos x / \left(1 - x^2\right)\right) dx$$

The Gaussian points are ± 0.5774 and weights at the two points are equal to unity. (6)

Or

(b) The nodal displacements of a rectangular element having nodal coordinates (0, 0), (4, 0), (4,2) and (0,2) are : u_1 = 0 mm, v_1 = 0 mm, u_2 = 0.1 mm, v_2 = 0.05 mm, u_3 = 0.05 mm, v_3 = – 0.05, u_4 = 0 and v_4 = 0 mm respectively. Determine the stress matrix at r = 0 and s = 0 using the isoparametric formulation. Take E = 210 GPa and Poisson's ratio = 0.25.

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