Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 80853

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Sixth/Seventh Semester

Mechanical Engineering

ME 2353/10122 ME 605/ME 63 — FINITE ELEMENT ANALYSIS

(Common to Mechanical Engineering (Sandwich)/ Automobile Engineering/Industrial Engineering and Management/Mechanical and Automation Engineering)

(Regulations 2008/2010)

Time : Three hours Maximum : 100 marks

(Any missing data may be suitably assumed)

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. What is meant by node?

2. What is Rayleigh- Ritz method?

3. Differentiate global and local coordinates.

4. What are the types of problems treated as one dimensional problems?

5. Give the application of plane stress and plane strain problems.

6. List the applications of axisymmetric elements.

7. Define dynamic analysis.

8. What is meant by transverse vibrations?

9. Derive the convection matrix for a 1 D linear bar element.

10. Write down the conduction matrix for a three noded linear triangular element.

PART B — (5 × 16 = 80 marks)

11. (a) Solve the following differential equation using Galerkin's method of weighted residuals

$$\frac{d^2y}{dx^2} + y = 4x \; ; \; 0 \le x \le 1 \text{ with boundary conditions } y(0) = 0, \; y(1) = 1. \quad (16)$$

Or

(b) A simply supported beam is subjected to uniformly distributed load over entire Span as shown in Fig. 11(b). Determine the bending moment and deflection at midspan by using Rayleigh Ritz method. (16)

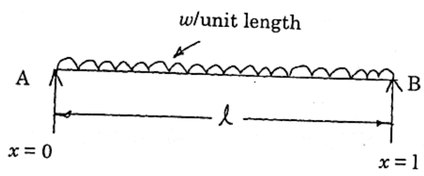

Fig 11 (b).

12. (a) Derive the shape functions for one dimensional linear element using direct method.

Or

(b) The loading and other parameters for a two bar truss element is shown in fig 12 (b). Determine

(i) the element stiffness matrix for each element (4)

(ii) global stiffness matrix (3)

(iii) nodal displacements (3)

(iv) reaction forces (3)

(v) the stresses induced in the elements, Assume E = 200 GPa. (3)

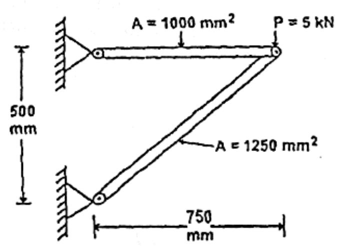

Fig. 12 (b)

13. (a) For the constant strain triangular element shown in Fig. 13 (a) assemble strain-displacement matrix. Take $t = 20\,\text{mm}$ and $E = 2 \times 10^5$ N/mm². (16)

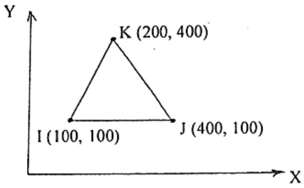

Fig 13 (a)

Or

(b) For the isoparametric four noded quadrilateral element shown in figure 13 (b), determine the Cartesian co-ordinates of point P which has local co-ordinate $\varepsilon = 0.5$ and $\eta = 0.5$. (16)

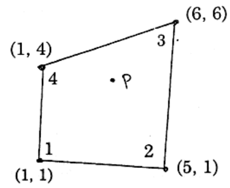

Fig 13 (b)

14. (a) Set up the system of equations governing the free transverse vibrtations of a simply supported beam modeled by two finite elements. Determine the natural frequency of a system.

Or

(b) Find the eigen value and the corresponding eigen vector of $A = \begin{bmatrix} 1 & 6 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix}$.

15. (a) A composite wall consists of three materials as shown in Fig.15(a). The inside wall temperature is 200°C and the outside air temperature is 50°C with a convection coefficient of 10 W/cm² °C. Determine the temperature along the composite wall.

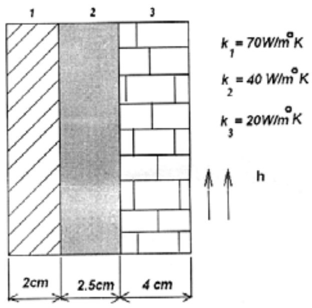

Fig.15(a)

Or

(b) A two dimensional fin is subjected to heat transfer by conduction and convection. It is discretised as shown in Fig.15(b), into two elements using linear triangular elements. Derive the conduction, and thermal load vector. How is convection accounted for in solving the problem using Finite element method?

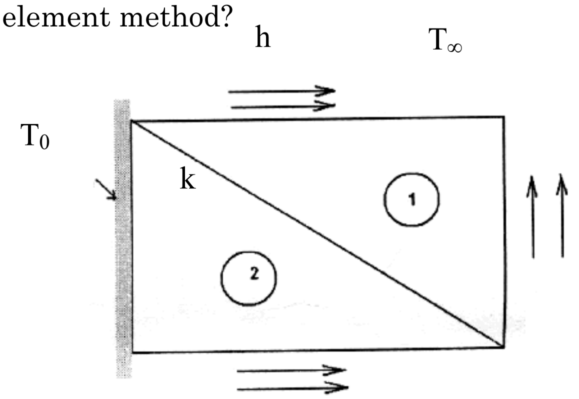

Fig 15 (b)

$$Stiffness\ Matrix\ [K]^e = \frac{EI}{l^3}\begin{bmatrix} 12 & 6l & -12 & 6l \\ 6l & 4l^2 & -6l & 2l^2 \\ -12 & -6l & 12 & -6l \\ 6l & 2l^2 & -6l & 4l^2 \end{bmatrix}$$

$$\{f\}^e = \frac{ql}{2}\begin{Bmatrix} 1 \\ l/6 \\ 1 \\ -l/6 \end{Bmatrix}$$

$$[M] = \frac{\rho A\ell}{420}\begin{bmatrix} 156 & 22\ell & 54 & -13\ell \\ 22\ell & 4\ell^2 & 13\ell & -3\ell^2 \\ 54 & 13\ell & 156 & -22\ell \\ -13\ell & -3\ell^2 & -22\ell & 4\ell^2 \end{bmatrix}$$

No. of points	Location	Weight W_i
1	$\xi_1 = 0.00000$	2,00000
2	$\xi_1,\ \xi_2 \pm 0.57735$	1.000000
3	$\xi_1,\ \xi_3 \pm 0.77459$	0.55555
	$\xi_2 = 0.00000$	0.00000