PART C — (1 × 15 = 15 marks)

16. (a) For the two bar truss as shown in Fig. 5 determine the displacements at node 2 and the stresses in both elements.

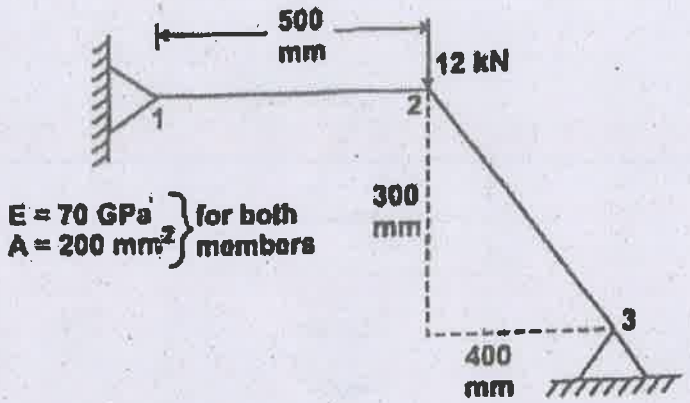

Fig. 5

Or

(b) Solve the following simultaneous equations using Gaussian elimination method.

$2a + b + 2c - 3d = -2$

$2a - 2b + c - 4d = -15$

$1a + 2c - 3d = -5$

$4a + 4b - 4c + d = 4.$

Reg. No. :

Question Paper Code : 20819

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Sixth/Seventh Semester

Mechanical Engineering

ME 6603 — FINITE ELEMENT ANALYSIS

(Common to Mechanical Engineering (Sandwich), Automobile Engineering, Manufacturing Engineering, Mechanical and Automation Engineering)

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are h and p versions of finite element method?

2. Why is variational formulation referred to as weak formulation?

3. Polynomials are generally used in shape function, why?

4. Differentiate between longitudinal vibration and transverse vibration.

5. Classify elements, based on their dimensions.

6. What is steady state heat transfer and write its governing equation.

7. Differentiate CST and LST elements.

8. Give four applications where axisymmetric elements can be used.

9. What is meant by 'Isoparametric element'?

10. With example, define Serendipity elements?

PART B — (5 × 13 = 65 marks)

11. (a) Explain the steps involved in finite element formulation.

Or

(b) For the differential equation $-\frac{d}{dx}\left[(1+x)\frac{dy}{dx}\right]=0$ for $0<x<1$ with the boundary conditions $y(0)=0$ and $y(1)=1$, obtain an approximate solution using Rayleigh-Ritz method.

12. (a) The beam is loaded as shown in Fig. 1; determine

(i) The slopes at 2 and 3 and

(ii) The vertical deflection at the midpoint of the distributed load.

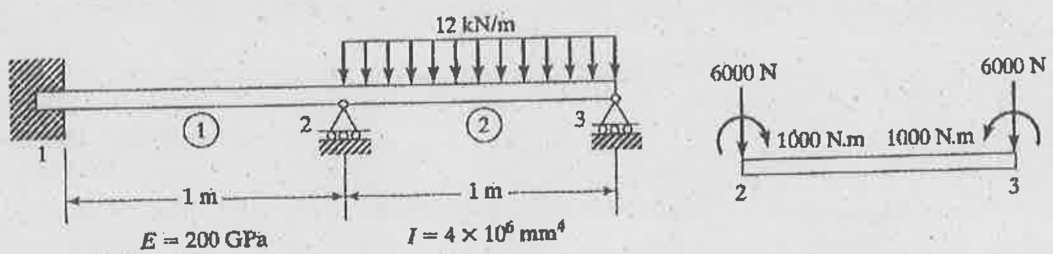

Fig. 1

Or

(b) Determine the natural frequencies of transverse vibration for a beam fixed at both ends. The beam may be modeled by two elements, each of length L and cross sectional area A. The use of symmetry boundary condition is optional.

13. (a) Using two finite elements, find the stress distribution in a uniformly tapering bar of cross sectional area 300 mm² and 200 mm² at their ends, length 100 mm, subjected to an axial tensile load of 50 N at smaller end and fixed at larger end. Take E = 2 × 10⁵ N/mm².

Or

(b) A composite wall through which heat inside layer with k_1 = 0.02 W/cm°C, middle layer k_2 = 0.005 W/cm°C, outer layer k_3 = 0.0035 W/cm°C. The thickness of each layer 13 mm, 80 mm and 25 mm respectively. Inside temperature, of the wall is 20°C and outside temperature of the wall is –15°C. Determine the nodal temperatures.

14. (a) For a plane stress element shown in Fig.2, the nodal displacements $((u_1, v_1), (u_2, v_2)$ and $(u_3, v_3))$ are ((2, 1) (1, 1.5) and (2.5, 0.5)) respectively. Determine the element stress. Assume (E = 200 GN/m², μ = 0.3 and t = 10 mm) all coordinates are in millimeters.

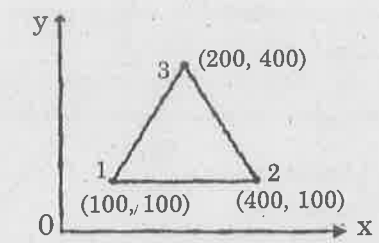

Fig. 2

Or

(b) Calculate the element stresses for the axisymmetric element shown in Fig. 3. The nodal displacements are

u1 = 0.02 mm w1 = 0.03 mm

u2 = 0.01 mm w2 = 0.06 mm

u3 = 0.04 mm w3 = 0.01 mm

Take E = 210 Gpa, μ = 0.25

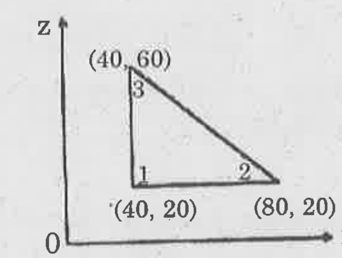

Fig. 3

15. (a) For the element shown in Fig. 4, determine the Jacobian matrix.

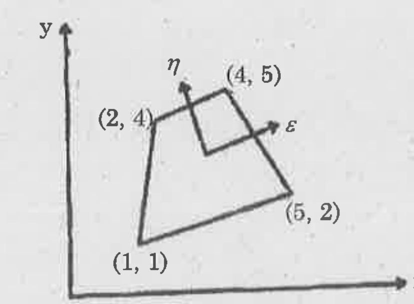

Fig. 4

Or

(b) Evaluate the integral using Gaussian quadrature method with two point scheme.

$$I = \int_{1}^{-1}\int_{1}^{-1}(2x^2+3xy+4y^2)\,dxdy.$$