PART C — (1 × 15 = 15 marks)

16. (a) Derive the shape functions for an eight noded rectangular element using intrinsic coordinate system.

Or

(b) For the two bar truss shown in the Figure 16(b), estimate the displacements of node one and the stress in element 1-3.

Take Young's modulus E = 70GPa and area of each element A= 200 mm^2.

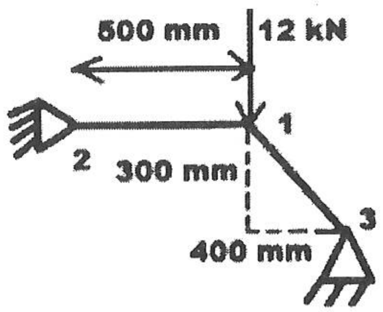

Figure 16(b)

08/12/2022 - AN

Reg. No. :

Question Paper Code : 90868

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

Sixth/Seventh Semester

Mechanical Engineering

ME 8692 — FINITE ELEMENT ANALYSIS

(Common to : Automobile Engineering/Manufacturing Engineering/Mechanical Engineering/Mechanical Engineering (Sandwich)/Mechanical and Automation Engineering/Production Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define the term discretization.

2. Differentiate between essential boundary condition and natural boundary condition.

3. What are higher order elements?

4. List any two properties of shape functions.

5. Draw any two higher order elements used in FEM.

6. List any two advantages of variational formulation.

7. Write any two conditions for a problem to be axi-symmetric.

8. Differentiate between plane stress and plane strain.

9. What are called as serendipity elements? Give an example.

10. List any two advantages of using isoparametric elements in FEM.

PART B — (5 × 13 = 65 marks)

11. (a) A cantilever beam is carrying a uniformly distributed load of "w per unit length" over the entire span of length L.

Assuming the deflection $y(x) = C_1 \sin(\pi x/2L) + C_2 \sin(3\pi x/2L)$, determine the constants C_1 and C_2 using Rayleigh-Ritz method.

Or

(b) The following differential equation is available for a physical phenomenon. $d^2y/dx^2 + y = 4x,\ 0 \le x \le 1$.

Boundary conditions are $y(0) = 0$ and $y(1) = 1$.

Obtain one term approximate solution using Galerkin method of weighted residuals.

12. (a) A bar is subjected to an axial force $P = 30$ kN as shown in figure 12(a). Determine the nodal displacement, stresses in each element and reaction forces.

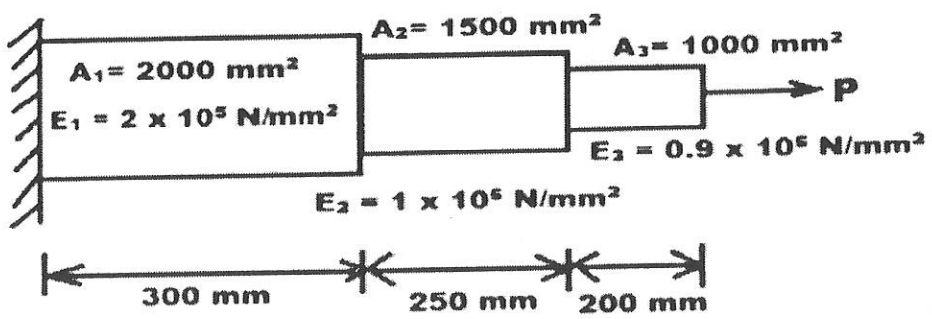

Figure 12(a)

Or

(b) Derive the shape function for 1D linear bar element using global coordinate system.

13. (a) Compute the element matrices and vectors for the element shown in figure 13(a) when the edges 2-3 and 1-3 experience convection heat loss.

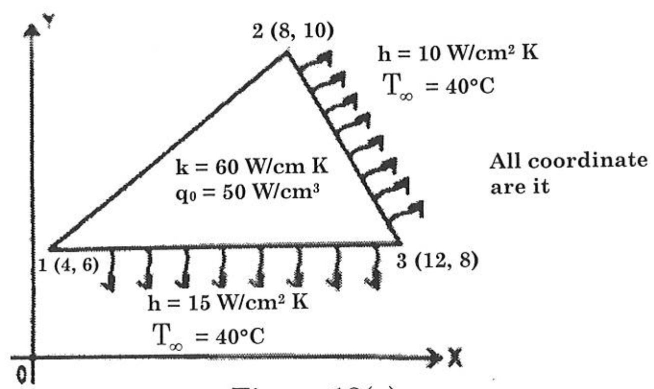

Figure 13(a)

Or

(b) The figure 13(b) below shows a shaft having rectangular cross section with 8 cm × 4 cm sides. The material has shear modulus 90 × 10^5 N/mm^2. Shaft length is 200 cm. The shaft is fixed at one end and subjected to torque T at the other end. Determine the total angle of twist if the applied torque is 20 × 10^3 N-cm.

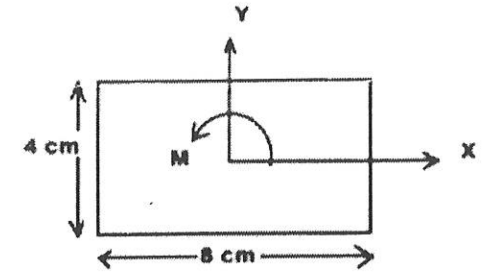

Figure 13(b)

14. (a) The nodal coordinates for an axisymmetric triangular element are given below. $r_1 = 15$ mm, $z_1 = 15$ mm, $r_2 = 25$ mm, $z_2 = 15$ mm and $r_3 = 35$ mm, $z_3 = 50$ mm. Determine [B] matrix for the element.

Or

(b) Triangular element is used for the stress analysis of a plate subjected to in-plane loads. The (*x*, *y*) coordinates of nodes *i*, *j*, and *k* of the 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. Examine element stress under plane stress condition. Let Young's modulus E = 160 GPa, Poisson's ratio = 0.25 and thickness of the element t = 10 mm.

15. (a) Evaluate the Jacobian matrix at the local coordinates $\varepsilon = \eta = 0.5$ for the linear quadrilateral element with its global coordinates as shown in figure 15(a).

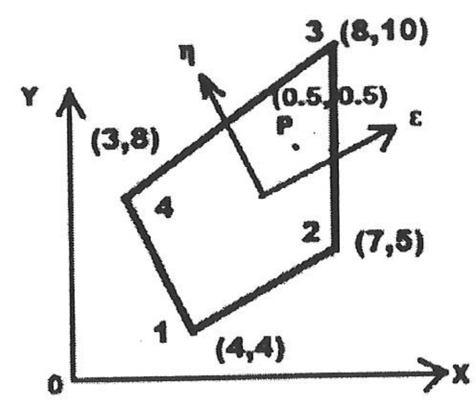

Figure 15(a)

Or

(b) Evaluate the following function by applying 3 point Gaussian quadrature $\int_{-1}^{1} e^{-x} dx$.