Code: 20A03602 **R20**

B.Tech III Year II Semester (R20) Regular Examinations August 2023

FINITE ELEMENT METHODS (FEM)

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

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1 Answer the following: (10 X 02 = 20 Marks)

(a) Define shape function. 2M

(b) Write the stress and equilibrium relations. 2M

(c) How many DOFs does a two-nodal, planar truss element have in its local coordinate system, and in the global coordinate system? Indicate with a proper diagram. 2M

(d) A cantilever beam is subjected to a point load at the end along with a uniformly distributed load throughout its length. What are its essential and natural boundary conditions? 2M

(e) What is stress strain matrix for plane strain element? 2M

(f) Represent the degree of freedom for triangular axisymmetric element. 2M

(g) Differentiate among the Iso-parametric, Sub-parametric and super-parametric formulation. 2M

(h) State the governing differential equation of a one-dimensional heat transfer case. 2M

(i) Differentiate between the transient dynamic analysis and Eigenvalue analysis. 2M

(j) Enumerate the properties of Eigenvectors. 2M

PART – B

(Answer all the questions: 05 X 10 = 50 Marks)

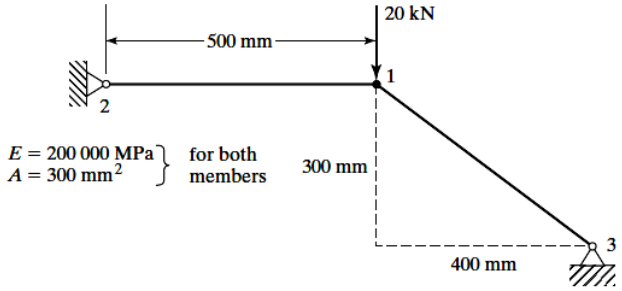
2 (a) Derive the strain displacement relation for a plane element. 4M

(b) A bar of uniform cross section and length L is fixed at one end and is subjected to an axial load of P. Develop the total potential energy expression and obtain the solution for deformation field using Rayleigh-Ritz method. 6M

OR

3 A copper bar ABCD of 1 m long and circular in cross section is fixed at end A and is subjected to a tensile load of 50 kN at other end D. It consists of 200 mm long bar AB of 40 mm diameter, 500 mm long bar BC of 15 mm diameter and 300 mm long bar CD of 30 mm diameter. Find the total extension of the bar. Take E = 100GPa. Find the stress in each bar. Also find the reaction at fixed support. 10M

4 For the two-bar truss shown in figure, determine the displacements of node 1 and the stress in elements 1–3. Also evaluate the reactions. 10M



OR

5 Calculate the maximum deflection and slope by using finite element method for the simply supported beam of length L, Young's modulus E and the moment of Inertia I, subjected to a point load of P at the centre. Compare the results with theoretical equations. 10M

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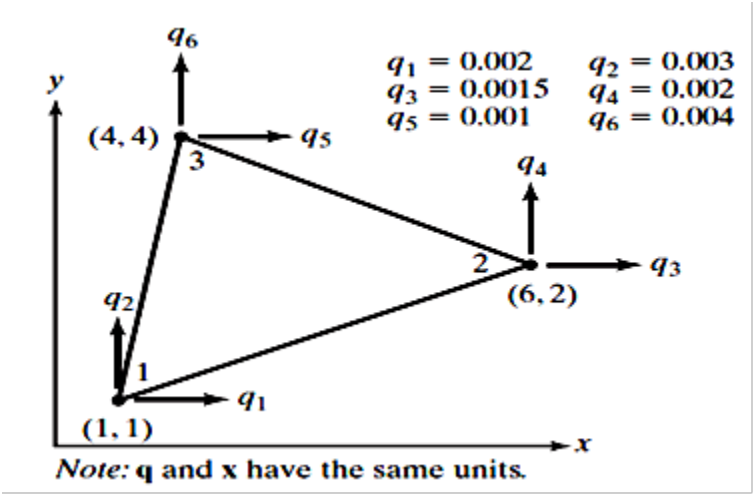
6 For the triangular element shown in figure, obtain the strain–displacement relation matrix B and determine the strains. The nodal deformations are represented by q. 10M



OR

7 A cylinder is subjected to an internal pressure of 5 MPa. The inner diameter of the cylinder is 100 mm. The outside diameter of the cylinder is 150 mm. Formulate the element stiffness matrix and load vector for the cylinder using two axisymmetric triangular elements. Take Young's modulus as 200 GPa and Poisson's ratio as 0.25. 10M

8 (a) The vertices of a quadrilateral element are A (0, 0), B (20, 0), C (20, 30) and D (0, 30). All the dimensions are in mm only. Evaluate the shape functions and Jacobian matrix at the intersection of the diagonals. 6M

(b) Using two point Gauss Quadrature method evaluate the following integral and compare with the exact solution. 4M

$I = \int_{-1}^{1}(2x^2 + 3x + 5)dx.$

OR

9 Heat is generated in a large plate at the rate of 5 kW/m^3. The plate is 250 mm thick. The outside surfaces of the plate are exposed to ambient air at 20°C with a Convective heat transfer coefficient of 20 W/m^2 °C. Determine the temperature distribution in the wall with spacing of 50 mm each. Thermal conductivity, k = 0.8 W/m °C. 10M

10 Derive the relation between the shear stress and angle of twist (B Matrix) for a prismatic member fixed at one end subjected to torsion at other end. Use a triangular element. Assume other data. 10M

OR

11 Consider a bar of length L, modulus of elasticity E, mass density ρ, and cross-sectional area A. Determine the first two natural frequencies using both consistent mass matrix and lumped mass matrix. Comment on the results. 10M

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