

Sixth Semester B.E. Degree Examination, Dec.2024/Jan.2025
Finite Element Methods

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Explain different steps involved in Finite Element Analysis. (08 Marks)
 b. State the principle of minimum potential energy. Using principle of minimum potential energy, determine the nodal displacements for the spring system shown in the Fig.Q.1(b). Take $F_1 = 75 \text{ N}$ and $F_2 = 100 \text{ N}$. (12 Marks)

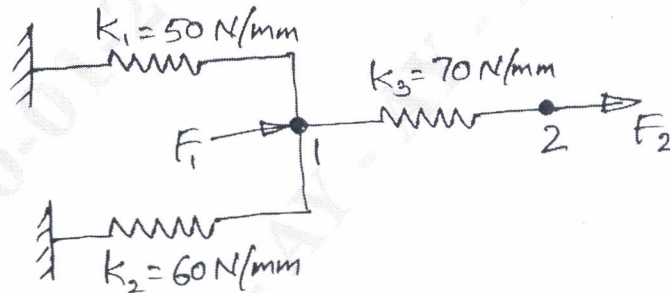


Fig.Q.1(b)

OR

- 2 a. Briefly explain the node numbering scheme in finite element analysis. (06 Marks)
 b. Use Rayleigh-Ritz method to find stress at mid point of a bar shown in the Fig.Q.2(b). Take $E = 70 \text{ GPa}$, $A = 100 \text{ mm}^2$. Assume the displacement model to be a second order polynomial. (14 Marks)

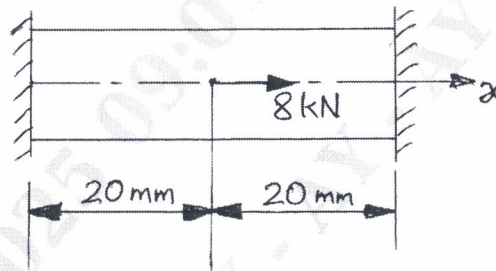


Fig.Q.2(b)

Module-2

- 3 a. Derive the shape functions for Constant Strain Triangular (CST) element in global coordinates. (08 Marks)
 b. Fig.Q.3(b) shows a one dimensional bar subjected to an axial load. Taking it as a two bar element, determine the nodal displacements. Take $E = 200 \text{ GPa}$ and $A = 10^4 \text{ mm}^2$. (12 Marks)

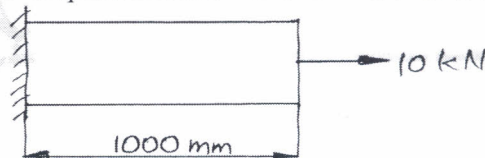


Fig.Q.3(b)

OR

- 4 a. Derive the shape functions for an isoparametric linear bar element in natural coordinate system. (06 Marks)
- b. Determine the nodal displacements and stresses in each element for the two bar truss shown in the Fig.Q.4(b). (14 Marks)

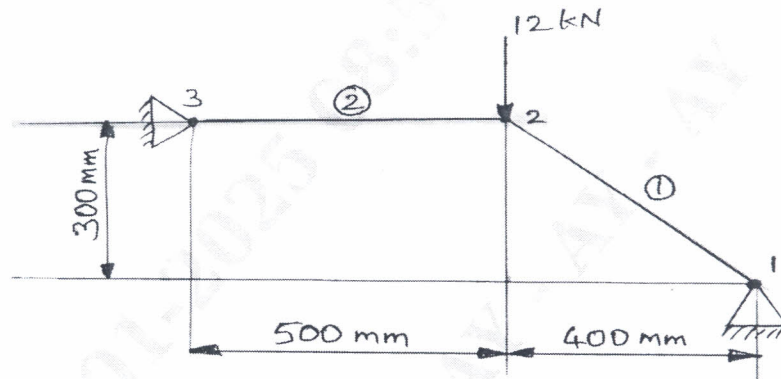


Fig.Q.4(b)

Module-3

- 5 a. Derive the elemental stiffness matrix for a beam element. (10 Marks)
- b. For the beam element shown in Fig.Q.5(b) determine deflection under the given load. Take $E = 2 \times 10^5 \text{ N/mm}^2$ and $I = 4 \times 10^{-6} \text{ m}^4$. (10 Marks)

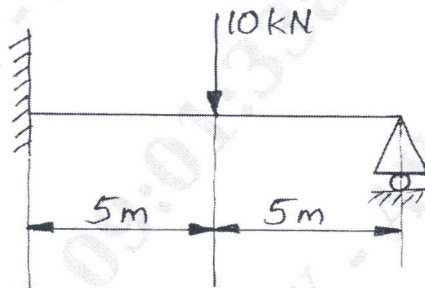


Fig.Q.5(b)

OR

- 6 a. Derive the shape function of a shaft element under pure torsion. (06 Marks)
- b. Determine the angle of twist at the free end of a shaft subjected to a torque of 100 kN-m as shown in the Fig.Q.6(b). Given $G = 80 \text{ GPa}$. Also determine the angle of twist at the center. (14 Marks)

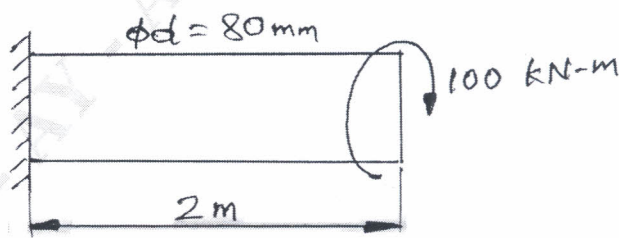


Fig.Q.6(b)

Module-4

- 7 a. Explain the rate equations for three modes of heat transfer. (06 Marks)
 b. Find the temperature distribution in the one dimensional fin shown in Fig.Q.7(b).

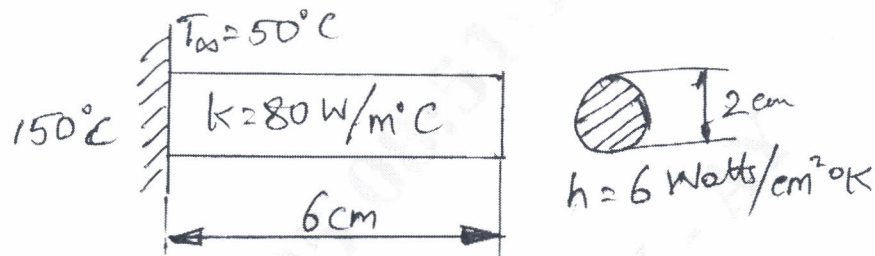


Fig.Q.7(b)

(14 Marks)

OR

- 8 a. Derive element conductivity matrix, element convection matrix and element heat flux vector for a two noded one dimensional fin. (08 Marks)
 b. Solve for temperature distribution in the composite wall shown in the Fig.Q.8(b). Use penalty approach of handling boundary conditions. (12 Marks)

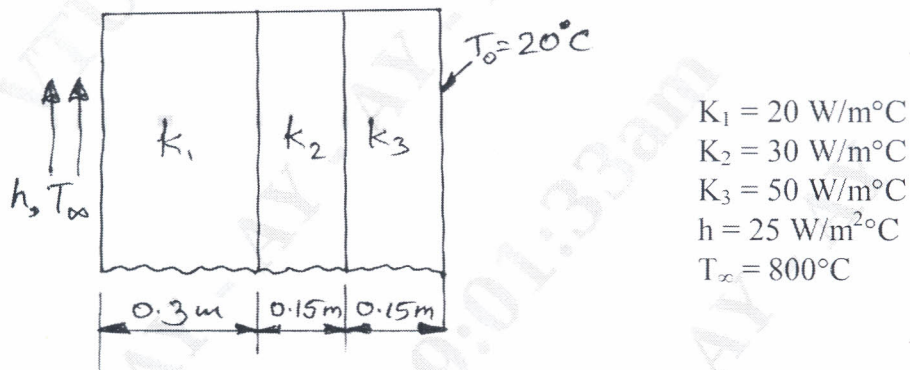


Fig.Q.8(b)

Module-5

- 9 a. Derive the stiffness matrix for an axisymmetric element using potential energy approach. (10 Marks)
 b. Derive lumped mass matrix and consistent mass matrix for a bar element. (10 Marks)

OR

- 10 a. Calculate the eigen values and eigen vectors for the matrix $[A] = \begin{bmatrix} 8 & 1 \\ 1 & 2 \end{bmatrix}$. (10 Marks)
 b. Derive the shape function for an axisymmetric triangular element. (10 Marks)
