CBCS SCHEME

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18ME61

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 $F_1 = 75$ N and $F_2 = 100$ N. **(12 Marks)**

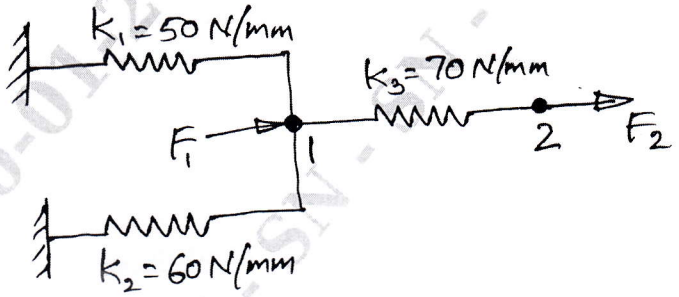


Fig.Q.1(b)

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 GPa, A = 100 mm^2. Assume the displacement model to be a second order polynomial. **(14 Marks)**

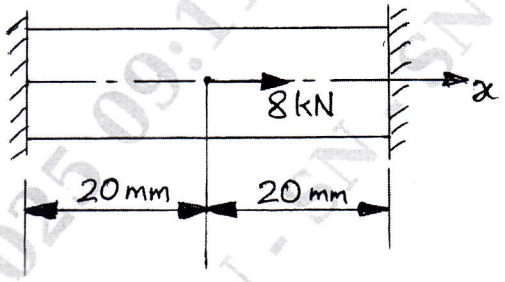


Fig.Q.2(b)

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 GPa and A = 10^4 mm^2. **(12 Marks)**

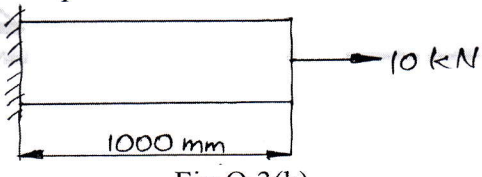


Fig.Q.3(b)

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)**

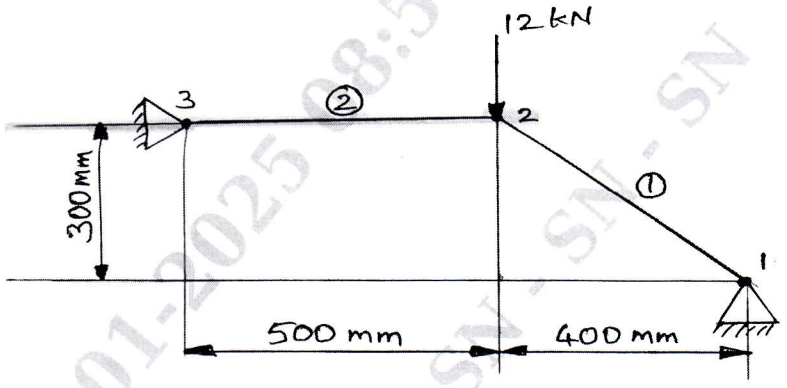


Fig.Q.4(b)

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 $E = 2 \times 10^5$ N/mm^2 and $I = 4 \times 10^{-6}$ m^4. **(10 Marks)**

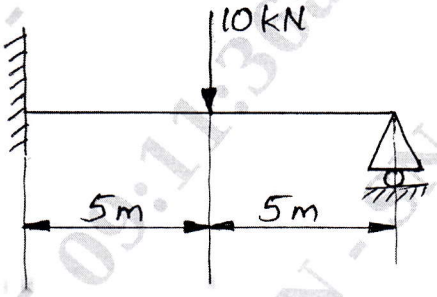


Fig.Q.5(b)

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 GPa. Also determine the angle of twist at the center. **(14 Marks)**

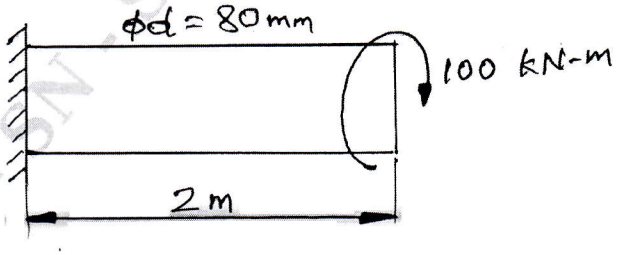


Fig.Q.6(b)

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).

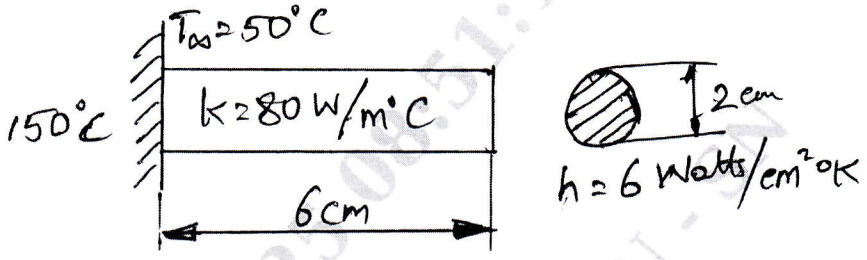


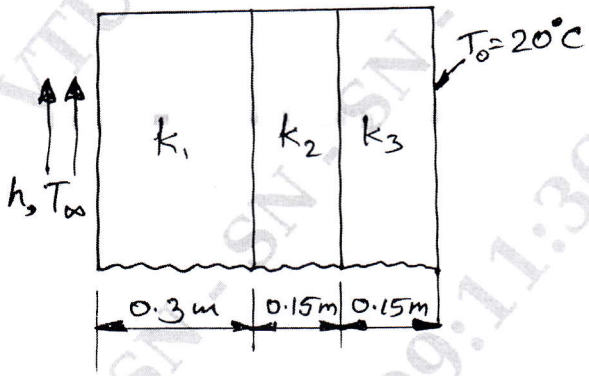
Fig.Q.7(b)

(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)**



$K_1 = 20$ W/m°C
$K_2 = 30$ W/m°C
$K_3 = 50$ W/m°C
$h = 25$ W/m²°C
$T_\infty = 800$°C

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)**

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