CBCS SCHEME

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17AU73

Seventh Semester B.E./B.Tech. Degree Examination, Dec.2024/Jan.2025
Finite Element Modeling and Analysis

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. What is Finite Element Method (FEM)? Explain the steps involved in FEM. **(10 Marks)**

b. Derive an expression for total potential energy of an elastic body subjected to body force, traction force and point force. **(10 Marks)**

OR

2 a. For the spring system shown in Fig. Q2 (a) using the principle of minimum potential energy, determine the nodal displacements. Take $F_1 = 75\,N$ and $F_2 = 100\,N$. **(10 Marks)**

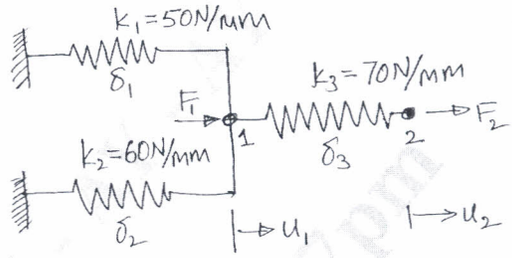


Fig. Q2 (a)

b. By R-R method, for a bar of cross sectional area A elastic modulus E, subjected to uniaxial loading P, show that at a distance 'x' from fixed end is $u = \left(\frac{P}{AE}\right)x$ and hence determine the end deflection and the stress to which the bar is subjected to. (Refer Fig. Q2 (b)) **(10 Marks)**

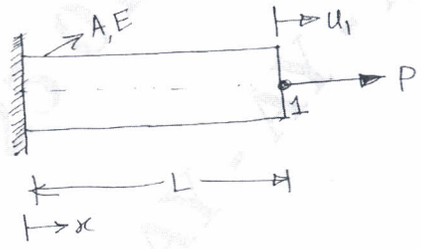


Fig. Q2 (b)

Module-2

3 a. Write properties of stiffness matrix K, Show node numbering and its effect on the half bandwidth. **(10 Marks)**

b. Determine the displacement in the system shown in Fig Q3(b) and hence determine the displacement at the point of application of load by Galerkin method.

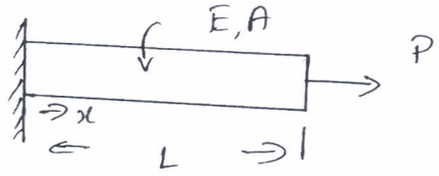


Fig Q3(b) **(10 Marks)**

OR

4 a. Explain the steps involved in FEM. **(08 Marks)**

b. What are the factors considered for discritization process? Explain any one factor. **(08 Marks)**

c. What are the properties of shape functions? **(04 Marks)**

Module-3

5 a. Fig.Q5(a) shows a one – dimensional bar subjected to an axial loading taking it as a single bar element, determine :

i) Nodal displacement

ii) Stress in each element

iii) Reaction at the support.

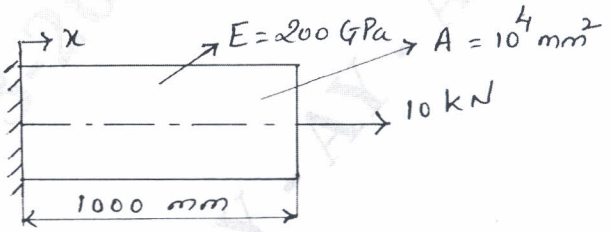


Fig.Q5(a) **(10 Marks)**

b. Using penalty method of handling boundary condition determine the nodal displacement, stress in each element and support reaction in the bar shown in Fig.Q5(b) due to applied force P = 100 kN. Take E_{steel} = 200 GPa and E_{cu} = 100 GPa.

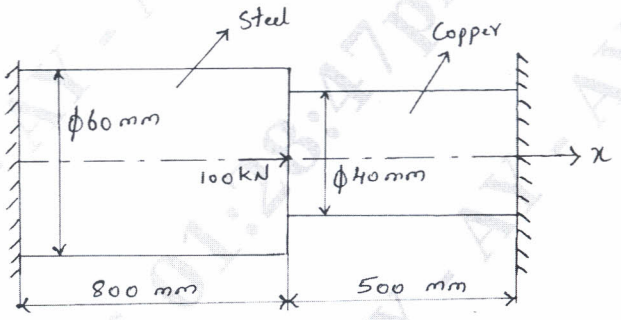


Fig.Q5(b) **(10 Marks)**

OR

6 a. Derive as expression for stiffness matrix for a 2 D truss element. **(10 Marks)**

b. For the two bar truss shown in Fig.Q6(b), determine the nodal displacement, stresses in each element and reaction at the support. Take E = 2×10^5 N/mm^2, A_c = 200 mm^2.

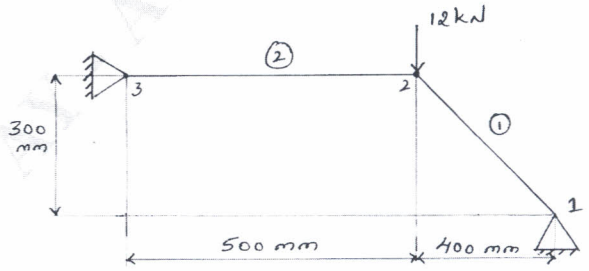


Fig.Q6(b) **(10 Marks)**

Module-4

7 a. Briefly explain isoparametric, sub and superparametric elements. **(08 Marks)**

b. What are the properties of shape functions? **(06 Marks)**

c. Explain about "Lagrange interpolation function". **(06 Marks)**

OR

8 a. Derive the shape function for two noded bar element (one dimensional) using Lagrangian polynomial. **(10 Marks)**

b. Derive the shape function for rectangular element (2-dimensional) using Lagrangian interpolation. **(10 Marks)**

Module-5

9 a. Derive hermite shape function ROF beam element. **(10 Marks)**

b. Fig Q9(b) shows a simply supported beam subjected to a uniformly distributed load. Obtain the maximum, deflection. Take Young's modulus E = 200 GPa and moment of inertia $I = 2 \times 10^6 mm^4$.

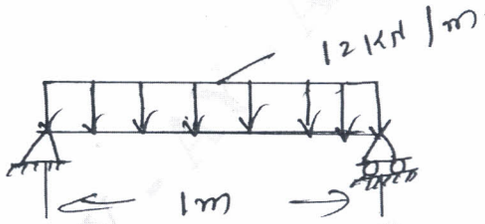
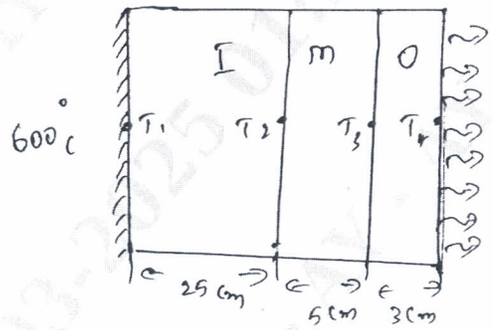


Fig Q9(b) **(10 Marks)**

OR

10 a. Derive the expression for differential equation for an 1-D Heat conduction. **(08 Marks)**

b. An induction durance wall is made up of three layers, inside, middle and outer layer with thermal conductivity K_1, K_2 and K_3 respectively of shown in Fig Q10(b). Determine the Nodal temperature.



$K_1 = 8.5 W/mK$
$K_2 = 0.25\ W/mK$
$K_3 = 0.08 W/mK$
$h = 45 W/m^2/K$
$T_\infty = 30°C$

Fig Q10(b) **(12 Marks)**

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