

CBCS SCHEME

17AU73

Seventh Semester B.E. Degree Examination, Jan./Feb.2021 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 $F_1 = 75 \text{ N}$ and $F_2 = 100 \text{ N}$. (10 Marks)

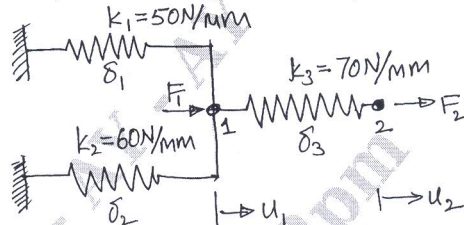


Fig. Q2 (a)

- 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)

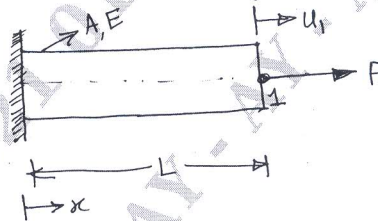


Fig. Q2 (b)

Module-2

- 3 a. Write an interpolation polynomial for linear quadratic and cubic element (for 1d, 2d and 3d). (07 Marks)
- b. Derive shape function in Cartesian / Global co-ordinates for one-dimensional bar element having two nodes. (07 Marks)
- c. Define shape function and discuss relevant mathematical equations. (06 Marks)

OR

- 4 a. What are interpolation functions? Explain 2D pascal triangle. (07 Marks)
- b. List the properties of stiffness matrix. (07 Marks)
- c. Write about the different types of elements used in FEM. (06 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg. 42+8 = 50, will be treated as malpractice.

Module-3

- 5 a. For the axially loaded bar shown in Fig.Q5 (a), determine
 (i) Nodal displacement, (ii) Element stresses (iii) Support reactions.
 Take $E_{\text{steel}} = 200 \text{ GPa}$; $E_{\text{cu}} = 100 \text{ GPa}$

(10 Marks)

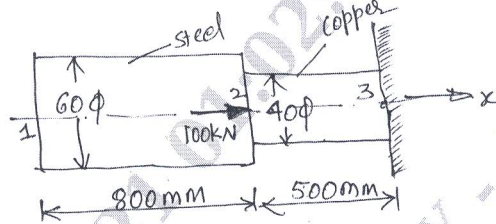


Fig. Q5 (a)

Given $A_1 = 2400 \text{ mm}^2$, $E_1 = 70 \times 10^9 \text{ N/m}^2$, $A_2 = 600 \text{ mm}^2$, $E_2 = 200 \times 10^9 \text{ N/m}^2$

- b. Consider the bar shown in Fig. Q5 (b). An axial load $P = 200 \times 10^3 \text{ N}$ is applied as shown. Using Penalty approach for handling boundary conditions, do the following
 (i) Determine the nodal displacements.
 (ii) Determine the stress in each material.

(10 Marks)

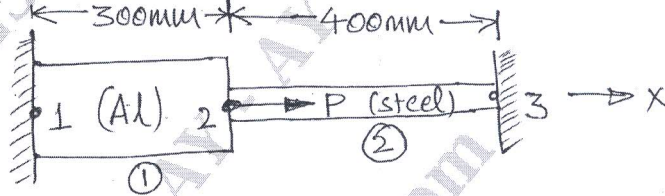


Fig. Q5 (b)

OR

- 6 For the two bar truss shown in Fig. Q6, determine the nodal displacement, stresses in each element and reaction at the support.
 $E = 2 \times 10^5 \text{ N/mm}^2$, $A_e = 200 \text{ mm}^2$

(20 Marks)

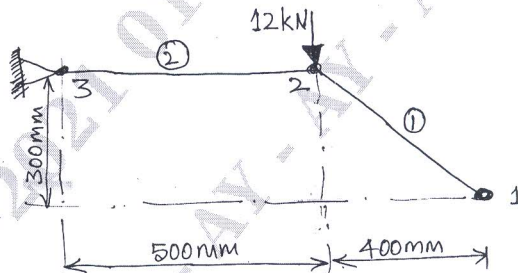


Fig. Q6

Module-4

- 7 a. Briefly explain isoparametric, sub and superparametric elements.
 b. What are the properties of shape functions?
 c. Explain about "Lagrange interpolation function".

(08 Marks)

(06 Marks)

(06 Marks)

OR

- 8 a. Derive the shape function for two noded bar element (one dimensional) using Lagrangian polynomial.
 b. Derive the shape function for rectangular element (2-dimensional) using Lagrangian interpolation.

(10 Marks)

(10 Marks)

Module-5

- 9 a. Derive the element conductivity matrix for one dimensional heat flow element. (10 Marks)
 b. Find the temperature distribution in the 1D fin shown in Fig. Q9 (b). Take two elements for FE idealization. (10 Marks)

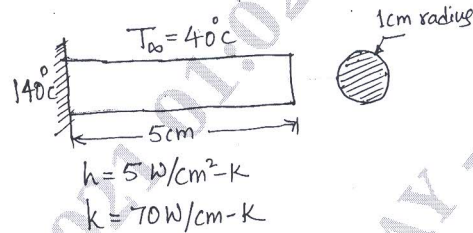


Fig. Q9 (b)

OR

- 10 a. Fig. Q10 (a), shows a simply supported beam subjected to a uniformly distributed load. Obtain the maximum deflection. Take Young's modulus $E = 200 \text{ GPa}$ and Moment of Inertia $I = 2 \times 10^6 \text{ mm}^4$. (10 Marks)

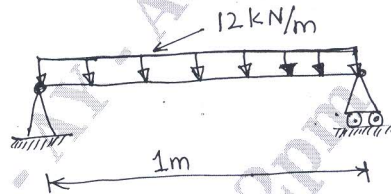


Fig. Q10 (a)

- b. A uniform cross sectional beam is fixed at one end supported by a roller at the other end. A concentrated 20 kN is applied at the mid length of the beam as shown in Fig. Q10 (b). Determine the deflection under load. Take $E = 210 \text{ GPa}$ and $I = 2500 \text{ mm}^4$ (10 Marks)

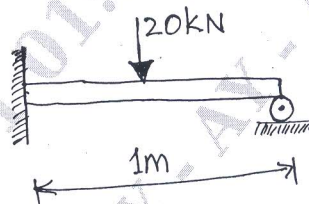


Fig. Q10 (b)

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