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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 $F_1 = 75$ N and $F_2 = 100$ N. **(10 Marks)**

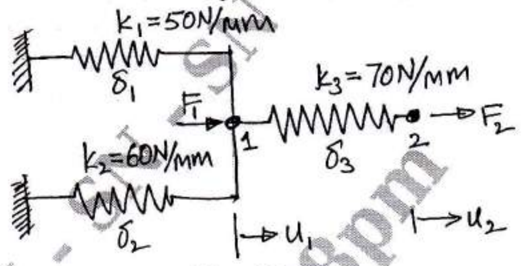

Fig. Q2 (a)

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)**

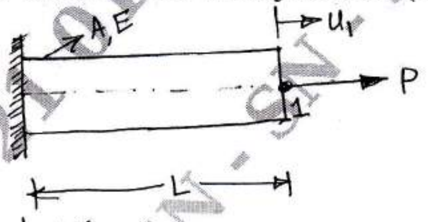

Fig. Q2 (b)

Module-2

3 a. Write 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)**

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 $E_{steel} = 200\,GPa$; $E_{cu} = 100\,GPa$ **(10 Marks)**

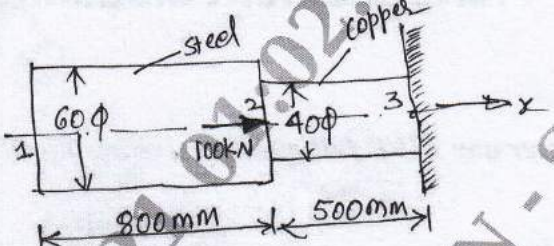

Fig. Q5 (a)

Given $A_1 = 2400\,mm^2$, $E_1 = 70\times10^9\,N/m^2$, $A_2 = 600\,mm^2$, $E_2 = 200\times10^9\,N/m^2$

b. Consider the bar shown in Fig. Q5 (b). An axial load $P = 200\times10^3\,N$ 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)**

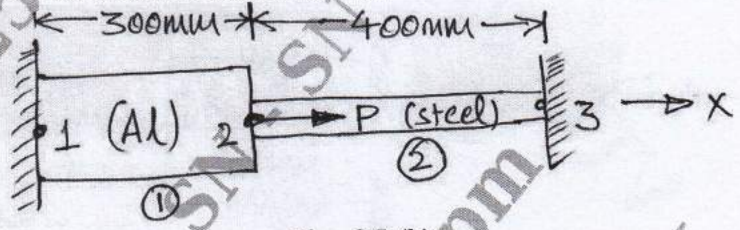

Fig. Q5 (b)

OR

6 For the two bar truss shown in Fig. Q6, determine the nodal displacement, stresses in each element and reaction at the support. **(20 Marks)**
$E = 2\times10^5\,N/mm^2$, $A_e = 200\,mm^2$

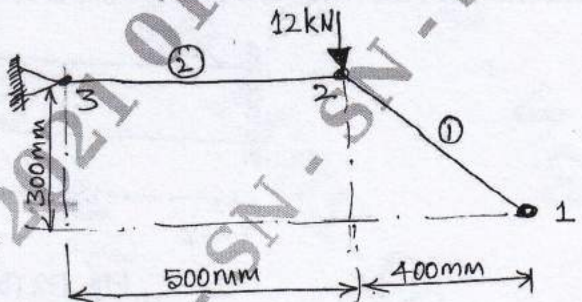

Fig. Q6

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 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)**

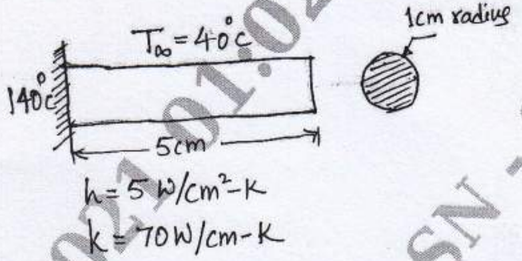

Fig. Q9 (b)

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 $E = 200$ GPa and Moment of Inertia $I = 2 \times 10^6 \text{ mm}^4$. **(10 Marks)**

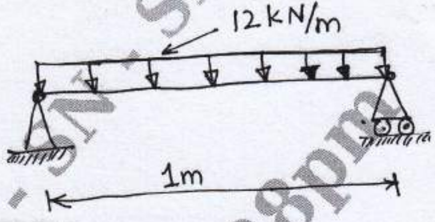

Fig. Q10 (a)

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 $E = 210$ GPa and $I = 2500 \text{ mm}^4$ **(10 Marks)**

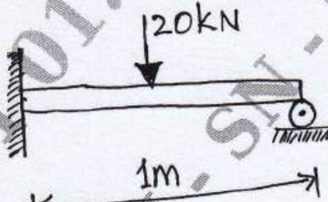

Fig. Q10 (b)

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