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18AU71

Seventh Semester B.E. Degree Examination, Dec.2023/Jan.2024
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. Express the plane stress and plane strain relation with assumptions.   **(10 Marks)**
   b. Solve the following system of simultaneous equation by Gaussian elimination method :
$$x_1 - 2x_2 + 6x_3 = 0$$
$$2x_1 + 2x_2 + 3x_3 = 3$$
$$-x_1 + 3x_2 = 2$$
                                                                                   (10 Marks)

OR

2 a. For the spring shown in Fig. Q2 (a). Determine the nodal displacement using principle of minimum potential energy.

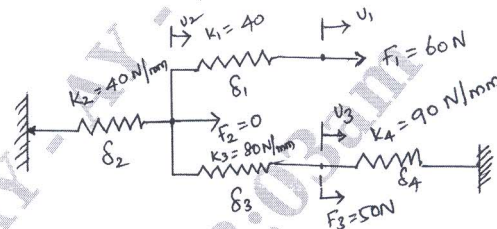Fig. Q2 (a)   **(10 Marks)**

   b. Using Rayleigh-Ritz method determine the maximum deflection of the beam fixed at both ends subjected to a uniformly distributed load P_0 over the entire length as shown in Fig. Q2 (b)
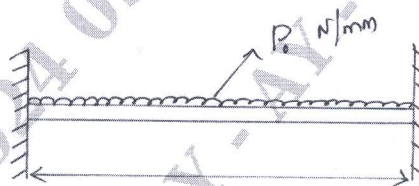

Fig. Q2 (b)   **(10 Marks)**

Module-2

3 a. Explain the steps involved in FEM and list the application of FEM.   **(10 Marks)**
   b. Use Galerian's method to obtain an approximate solution of differential equation,
$$\frac{d^2y}{dx^2} - 10x^2 = 5 \qquad 0 \le x \le 1$$
   with boundary condition $y(0) = y(1) = 0$ **(10 Marks)**

OR

4 a. Derive the shape function for 1D bar element in natural co-ordinate system.   **(10 Marks)**
   b. Explain the different types of Interpolation models in which brief about the polynomial form for 1D, 2D and 3D element.   **(10 Marks)**

Module-3

5 a. Consider the bar shown in Fig.Q5 (a), using Penality method of handling boundary condition. Determine the nodal displacement stress in each element. Due to applied force P = 100 kN. Take steel E = 200 GPa copper E_{CV} = 100 GPa.

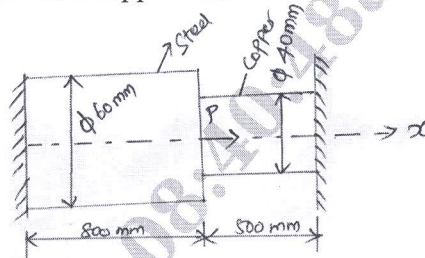Fig. Q5 (a)   (10 Marks)

b. Determine the nodal displacement, stress in each element at the fixed support for the thin plate of uniform thickness of 1 mm shown in Fig. Q5 (b). Take Young's modulus E = 200 GPa weight density of the plate P = 76.6×10^{-6} N/mm^3. In addition to this weight, it is subjected to a point load of 100 N at its point, model using the two bar element.

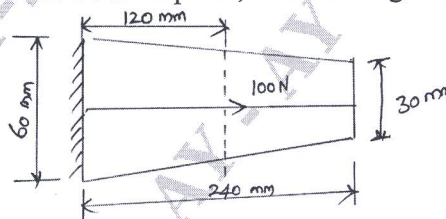Fig. Q5 (b)   (10 Marks)

OR

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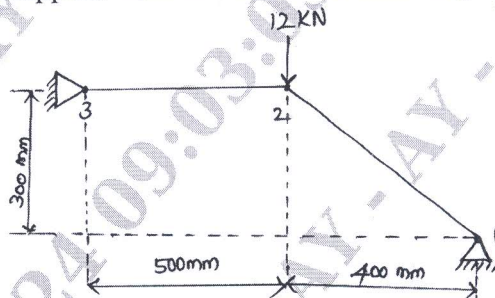

Fig. Q6 (a)

b. Derive element stiffness matrix for truss method.   (10 Marks)

Module-4

7 a. For the triangular element shown in Fig. Q7 (a). Obtain the strain-displacement matrix 'B' and determine the strains $\in_x$, $\in_y$ and γ_{xy} Nodal displacement

$\{q\} = \{2 \quad 1 \quad 1 \quad -4 \quad -3 \quad 7\} \times 10^{-2}$ mm

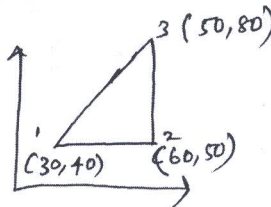Fig. Q7 (a)   (10 Marks)

b. Derive shape function for 2-D elements Quadrilateral / rectangular element.   (10 Marks)

OR

8 a. Explain the properties of shape function. **(04 Marks)**

   b. Explain the following with neat diagram,
      (i)   Iso-parametric element.
      (ii) Sub-parametric element.
      (iii) Super-parametric element. **(06 Marks)**

   c. Derive the Hermite shape function for beam element.
      Note : (Find the shape function 'H$_1$' and 'H$_2$' alone.) **(10 Marks)**

Module-5

9 a. For the beam element shown in Fig. Q9 (a) determine deflection under the given load. Take
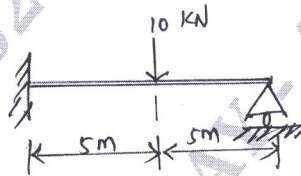 $E = 2 \times 10^8 \, KN/m^2$ and $I = 4 \times 10^{-6} \, m^4$.

Fig. Q9 (a) **(10 Marks)**

   b. Derive element stiffness matrix using Hermite Shape function. **(10 Marks)**

OR

10 a. Find the heat distribution in the '1D' Fin as shown in Fig. Q10 (a). Take two elements for
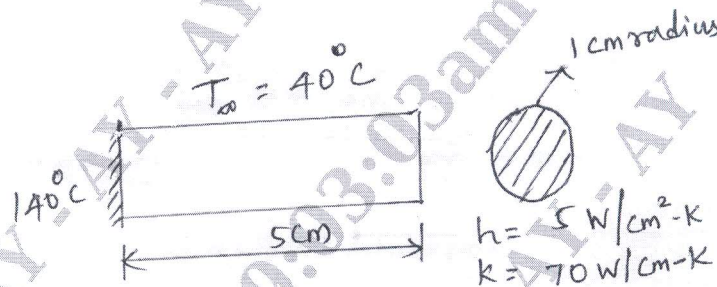   FE idealization.

Fig. Q10 (a) **(10 Marks)**

   b. Find the heat distribution in the fin shown in Fig. Q10 (b). Take two elements for FE
      idealization. The heat transfer co-efficient around the fin is 10 W/m^{2}K and ambient
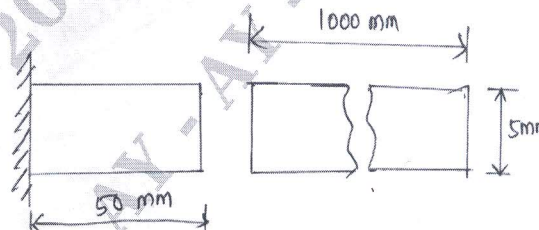   temperature is 28°C. The base fin is at 108°C. Take K = 50 W/mK.

Fig. Q10 (b) **(10 Marks)**

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