USN | | | | | | | | | | | **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.

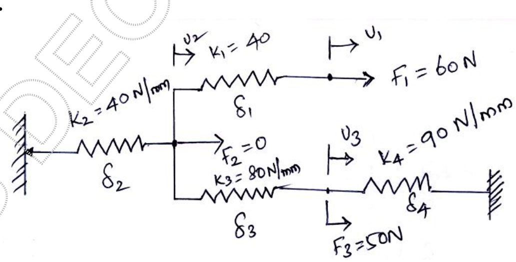

Fig. Q2 (a) **(10 Marks)**

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)

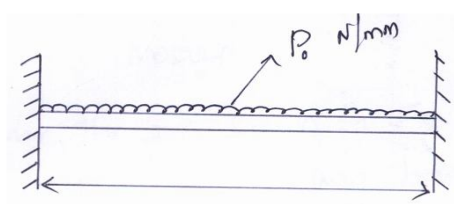

Fig. Q2 (b) **(10 Marks)**

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.

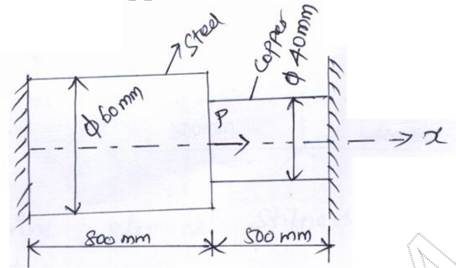

Fig. Q5 (a) **(10 Marks)**

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 $P = 76.6\times10^{-6}$ 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.

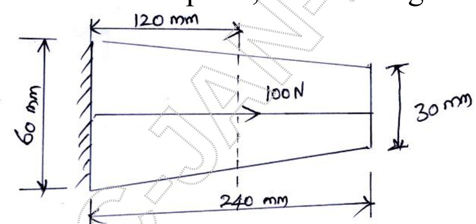

Fig. Q5 (b) **(10 Marks)**

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 $E = 2\times10^5$ N/mm^2. A_C = 200 mm^2. **(10 Marks)**

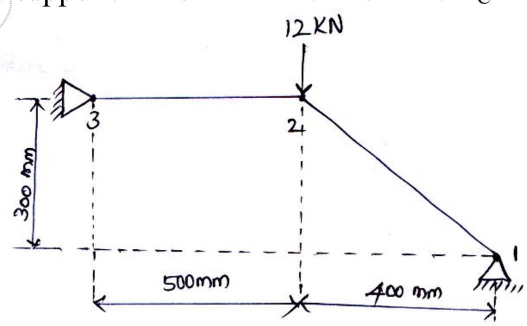

Fig. Q6 (a)

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 ϵ_x, ϵ_y and γ_{xy} Nodal displacement

$$\{q\} = \{2 \quad 1 \quad 1 \quad -4 \quad -3 \quad 7\}\times10^{-2}\,\text{mm}$$

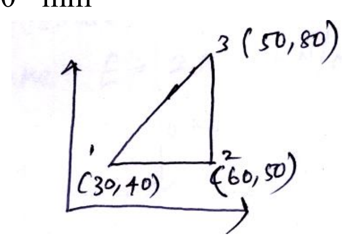

Fig. Q7 (a) **(10 Marks)**

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 $E = 2\times10^8$ KN/m^2 and $I = 4\times10^{-6}$ m^4.

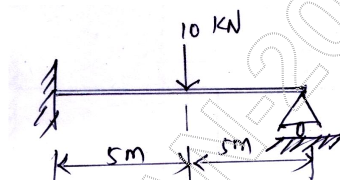

Fig. Q9 (a) **(10 Marks)**

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.

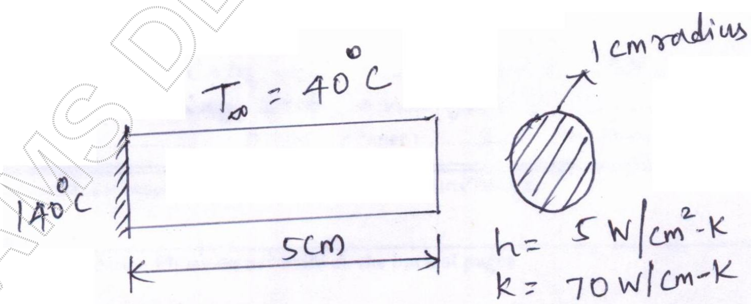

Fig. Q10 (a) **(10 Marks)**

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.

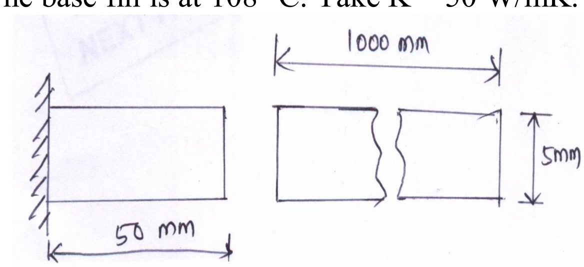

Fig. Q10 (b) **(10 Marks)**

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