GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER–VIII (NEW) - EXAMINATION – SUMMER 2017
Subject Code: 2181911   **Date: 04/05/2017**
**Subject Name: Finite Elements Method(Department Elective II)**
**Time: 10:30 AM to 01:00 PM**   **Total Marks: 70**
Instructions:
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** List and describe the general steps of the Finite Element Method.   **07**
        (b) What is meshing convergence? Define the **h, p, r** and **hp** refinement.   **07**

Q.2 **(a)** Formulate the isoparametric formulation shape function for 1D bar element.   **07**
        (b) For the spring assemblage with arbitrarily numbered nodes shown in following   **07**
        Figure 1, obtain (a) the global stiffness matrix, (b) the displacements of nodes 3
        and 4 and (c) the reaction forces at nodes 1 and 2. A force of 5000 lb is applied
        at node 4 in the x direction. The spring constants are given in the figure. Nodes
        1 and 2 are fixed.
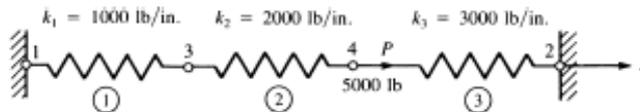
Figure 1
OR

        (b) Determine the displacements of nodes and elemental stresses for the bar as   **07**
        shown in Figure 2. Take: $A_1 = A_2 = 300$ mm^2, $A_3 = 400$ mm^2, $l_1 = l_2 = 150$ mm,
        $l_3 = 200$ mm, $P_1 = P_2 = 10$ kN and E = 200 GPa.
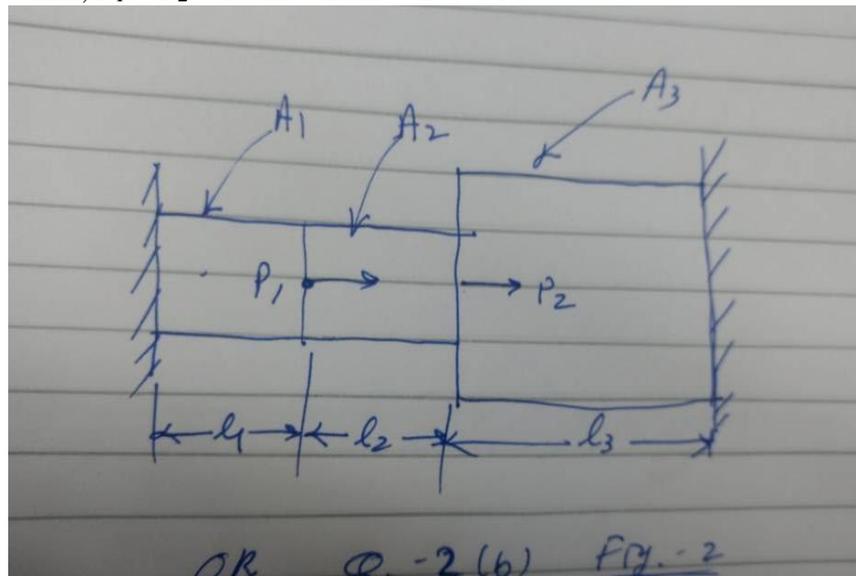
Figure 2

Q.3 **(a)** Consider the bar shown in Figure 3. Determine the nodal displacement using   **07**
        penalty approach. Take: $A_1 = 200$ mm^2, $A_2 = 300$ mm^2, $l_1 = l_2 = 350$ mm, $E_1 =$
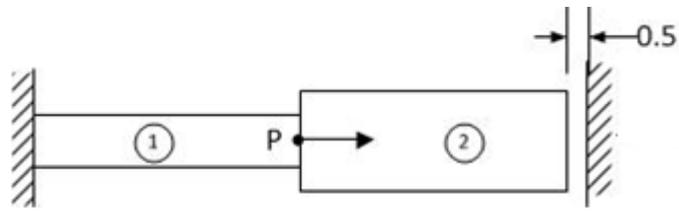   80 GPa, $E_2 = 200$ GPa, P = 60 kN.

Figure 3

(b) For the plane truss composed of the three elements shown in Figure 4 subjected **07** to a downward force of 10,000 lb applied at node 1, determine the x and y displacements at node 1. Let $E = 30 \times 10^6$ psi and $A = 2$ in.^{2} for all elements. The lengths of the elements are shown in the Figure 4.
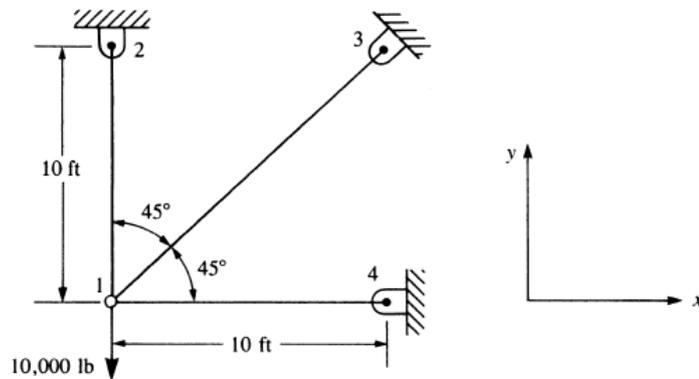

Figure 4

OR

Q.3 (a) Formulate the additional load vector due to thermal effect in 1D bar element. **07**

(b) A two-step bar as shown in Figure 5 is subjected to thermal loading conditions. **07** An axial load $P = 200 \times 10^3$ N applied $20°$ C to the end. The temperature of the bar is raised by $50°$ C. Consider $E_1 = 70 \times 10^3$ N/mm^2, $E_2 = 200 \times 10^3$ N/mm^2, $A_1 = 700$mm^2, $A_2 = 1000$mm^2, $\alpha_1 = 23 \times 10^{-6}$ per $°$C and $\alpha_2 = 11.7 \times 10^{-6}$ per $°$C. Determine the Element stiffness matrix, Global stiffness matrix and force vector.
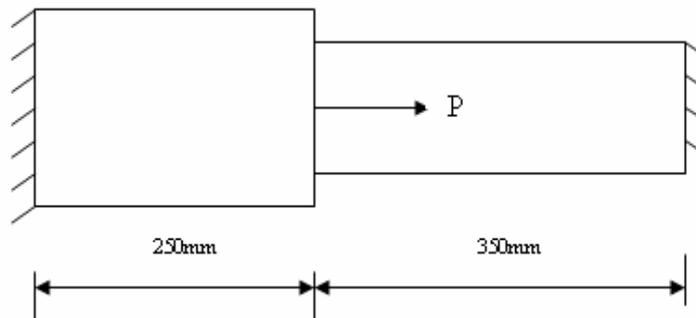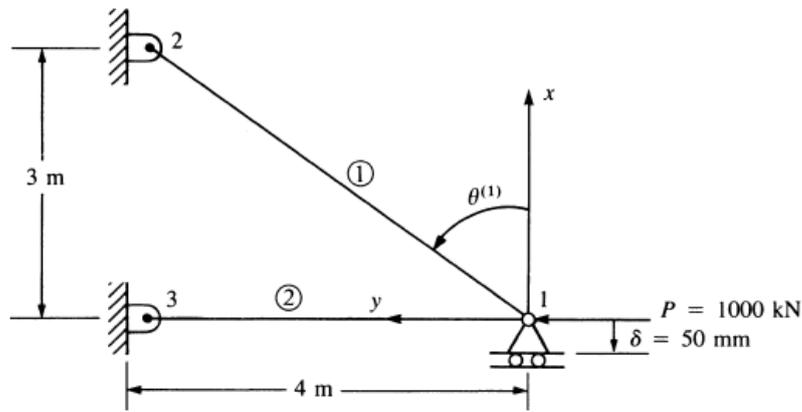

Figure 5

Q.4 (a) For the two-bar truss shown in Figure 6, determine the displacement in the y **07** direction of node 1 and the axial force in each element. A force of $P = 1000$ kN is applied at node 1 in the positive y direction while node 1 settles an amount $\delta = 50$ mm in the negative x direction. Let $E = 210$ GPa and $A = 6.00 \times 10^{-4}$ m^2 for each element. The lengths of the elements are shown in the figure.

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Figure 6

(b) Derive the element stiffness matrix and stress equation for plane truss.　　07

OR

Q.4 (a) Draw the axisymmetric element and explain use of axisymmetric element.　　07

(b) Determine the displacement and rotation under the force and moment located at the center of the beam shown in Figure 7. The beam has been discretized into the two elements shown in Figure 7. The beam is fixed at each end. A downward force of 10 kN and an applied moment of 20 kN-m act at the center of the beam. Let E = 210 GPa and $I = 4 \times 10^{-4}$ m^4 throughout the beam length.　　07
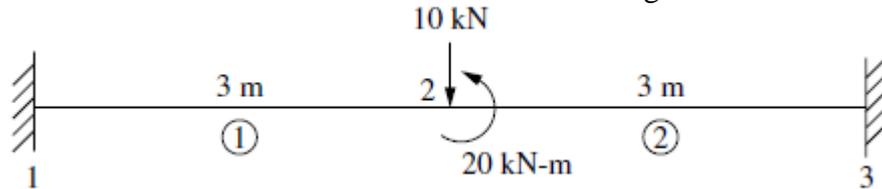
Figure 7

Q.5 (a) Determine (a) the fluid head distribution along the length of the coarse gravelly medium shown in Figure 8 (b) the velocity in the upper part, and (c) the volumetric flow rate in the upper part. The fluid head at the top is 10 in. and that at the bottom is 1 in. Let the permeability coefficient be Kxx = 0.5 in./s. Assume a cross-sectional area of A = 1 in^2. For the finite element discretization use three elements, each 10 in. long.　　07
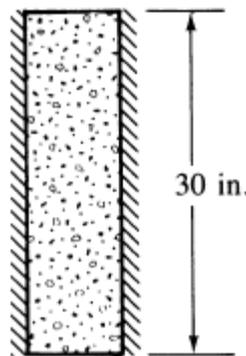
Figure 8

(b) List out the software used to solve FEM problems and discuss the applications of FEM.　　07

OR

Q.5 (a) List out the types of method to dynamics problems and write the consistent and lumped mass matrices for 1D element.　　07

(b) Discuss the defects of CST element.　　07

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