Seat No.: ________ Enrolment No.______________

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – II • EXAMINATION – SUMMER • 2014

Subject code: 1720901 **Date: 16-06-2014**

Subject Name: Finite Element Method

Time: 02:30 pm - 05:00 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)** For the spring assemblages shown in Figures 1, determine the nodal displacements, the forces in each element, and the reactions. **07**

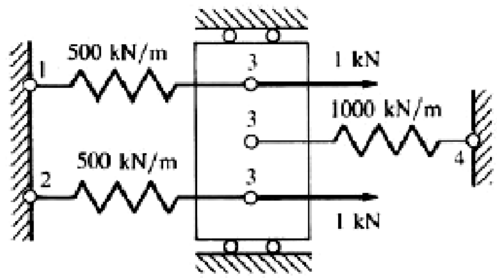

Figure 1

(b) Discuss the types of boundary conditions. Explain elimination approach for applications of boundary condition with the help of suitable example. **07**

Q.2 **(a)** For the two-bar truss shown in Figure 2, determine the displacement in the y direction of node 1 and the axial force in each element. A force (P) of 1000 kN is applied at node 1 in the positive y direction while node 1 settles an amount ŭ equal to 50 mm in negative x direction. Take modulus of elasticity (E) as 210 GPa and cross section area (A) as 0.0006 m^2 for each element. **07**

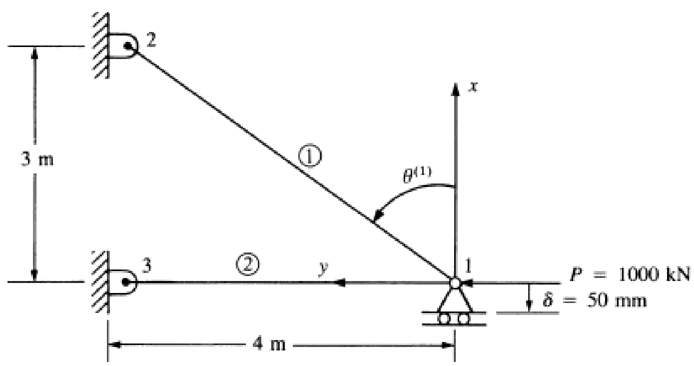

Figure 2

(b) For the structural system shown in Figure 3, determine displacements, stresses and support reactions using penalty approach. Assume point load P = 60,000 N and Youngôs modulus of material E = 20,000 N/mm^2 **07**

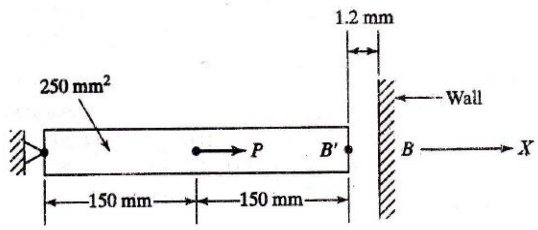

Figure 3

OR

(b) Briefly discuss the various types of elements used for discretization in finite element method **07**

Q.3 **(a)** A composite wall is consisting of three materials as shown in Figure 4. Outer temperature T_0 is 20 ^{0}C. Convection heat transfer takes place on inner surface of wall with ⍰ = 800 ^{0}C and h = 25 W/m^2 ^{0}C. Determine temperature distribution in wall. **07**

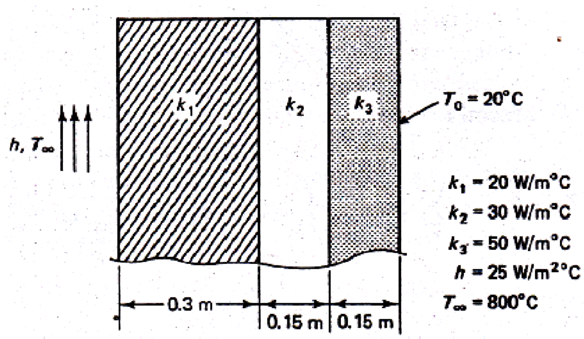

Figure 4

(b) For the beams shown in Figures 5, derive (1) Global stiffness matrix; (2) Global displacement vector (specifying boundary conditions); (3) Global load vector; (4) Write governing equation of beam. **07**

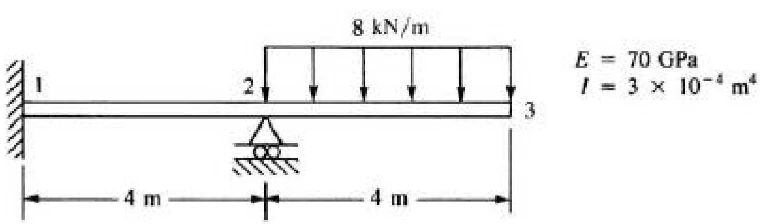

Figure 5

OR

Q.3 **(a)** Aluminium tapered bar of length 1000 mm is having cross-sectional area of 950 and 450 mm^2 at two ends. Bar is fixed at both the ends. Bar is subjected to an axial force of 100 kN (in positive x direction) at point P as shown in Figure 6 at temperature of 25 ^{0}C. Temperature is then raised to 55 ^{0}C. The coefficient of thermal expansion for Aluminium is 23 x 10^{-6} per ^{0}C. Modulus of elasticity of bar material is 70 x 10^3 N/mm^2. Model the bar with two elements and determine; **07**

(1). Nodal displacement (2) Stresses in each element

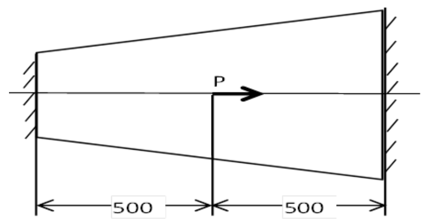

Figure 6

(b) For the beams shown in Figures 7, derive (1) Global stiffness matrix; (2) Global displacement vector (specifying boundary conditions); (3) Global load vector; (4) Write governing equation of beam. **07**

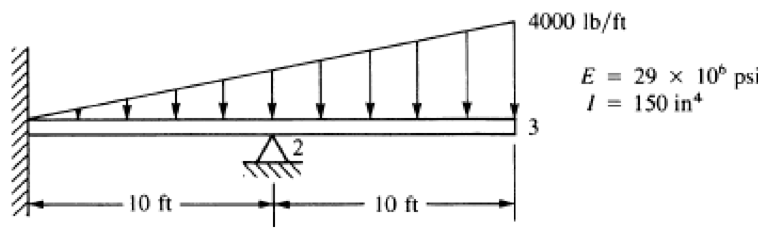

Figure 7

Q.4 **(a)** Derive the shape functions and Jacobian matrix for three noded triangular elements. **07**

(b) Consider element with quadratic shape function as shown in Figure 8. Evaluate natural coordinates and shape function for point P. Displacement at node 1, node 2 and node 3 is 0.2 mm, ï 0.1 mm and 0.05 mm respectively. Determine; (1) displacement at point P (2) determine in global terms where the displacement would be 0.1 mm and (3) determine shape functions at point where displacement is 0.1 mm. **07**

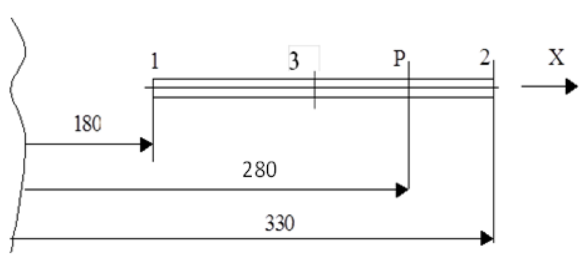

Figure 8

OR

Q.4 **(a)** For triangular element shown in Figure 9; (1) Evaluate shape functions N1, N2 and N3 at interior point P, (2) Evaluate Jacobian of transformation J **07**

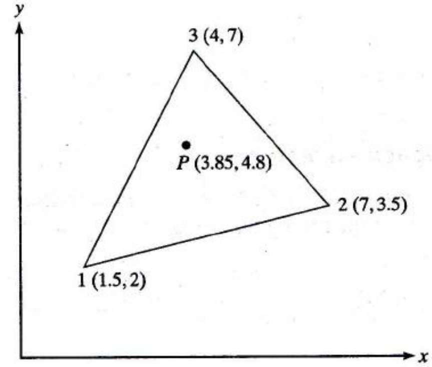

Figure 9

(b) Derive the shape functions and Jacobian matrix for four noded quadrilateral elements. **07**

Q.5 **(a)** Derive the general displacement function in matrix form for linear strain triangular element (LST) **07**

(b) (1). Discuss the properties of stiffness matrix. **05**

(2). Discuss the effect of node numbering on NBW (net band width) of stiffness matrix. **02**

OR

Q.5 **(a)** (1). With the help of illustrative example discuss plane stress and plane strain conditions. **04**

(2). Sketch the FEA model showing the boundary condition for orthogonal pipe with circular hole subjected to internal pressure. **03**

(b) Using potential energy approach derive equation KQ = F; **07**

Where, K = global stiffness matrix, Q = global displacement vector and F = global load vector

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