Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject code: 1721501 Date: 02-12-2014

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)** Derive the load vector for a 3-noded bar element having length l_e, loaded with uniformly distributed load along the length. **07**

(b) For the spring assemblage shown in fig. 1, obtain the displacements of nodes 2 & 3 and the reaction forces at nodes 1 & 4. Take P = 5 kN. **07**

Q.2 **(a)** Determine the shape functions for the Constant Strain Triangle. **07**

(b) For the plane truss shown in fig. 2, determine the displacements at node 1 and stresses in each element. Let E = 2×10^5 N/mm^2 and A = 500 mm^2 for all elements. **07**

OR

(b) Determine nodal displacements and reactions for the beam shown in fig. 3. The beam is assumed to have constant EI. **07**

Q.3 **(a)** Determine shape functions for a 2-noded beam element using polynomial functions (generalized coordinates). **07**

(b) Determine the displacement and rotation under the force and moment located at the center of the beam shown in fig. 4. Also, find vertical displacements at 0.5m and 1.5m from node-1. The beam is assumed to have constant EI. **07**

OR

Q.3 **(a)** Derive element stiffness matrix for a 2-noded beam element. Show sample calculation for k_{22}. **07**

(b) The fin shown in fig. 5 is insulated on the perimeter. The left end has a constant temperature of 100^o C. A positive heat flux of q = 5000W/m^2 acts on the right end. Let K_{xx} = 6W/(m ^{o}C) and cross-sectional area A = 0.1m^2. Determine the temperatures at 0.1m, 0.2m, 0.3, and 0.4. Assume that the heat leaving the left end is same as the heat coming in to the fin at the right end. **07**

Q.4 **(a)** Explain in brief steps of analysis of structures using finite element method. **07**

(b) Evaluate the element stiffness matrix and element stresses for the element shown in fig. 6. The coordinates are in mm. Assume plane stress conditions. Let E = 2×10^5 MPa, ε = 0.25, and thickness t = 10 mm. Assume the element nodal displacements u_1 = 0.0, v_1 = 1 mm, u_2 = 0.5mm, v_2 = 0.0, u_3 = 0.0, and v_3 = 1 mm. **07**

OR

Q.4 **(a)** Draw neat sketch and define plane stress and plane strain problems. Also, show the constitutive law for plane stress and plane strain problems. **07**

(b) For the smooth pipe of variable cross section shown in fig. 7, determine the potential at the junctions, the velocity and volumetric flow rate in part-1 of pipe. The potential at the left end is 10 m^2/s and that at the right end is 1 m^2/s. **07**

Q.5 **(a)** Derive the consistent mass matrix for dynamic analysis of one dimensional bar element having modulus of elasticity E, mass m, density and cross sectional area A. **07**

(b) For the plate configuration shown in fig. 8, determine the deflection at the point of load application using a one-element model. Let t = 10 mm, E = 70000 MPa and ε = 0.25. Assume plane stress conditions. **07**

OR

Q.5 **(a)** What is pre processor and post processor? Enlist various desirable features of pre processor and post processor. **07**

(b) For the one dimensional bar fixed at one end and free at other end with length 2L, modulus of elasticity E, mass density , and cross-sectional area A, determine the first two natural frequencies using 2-noded 2-elemets and lumped mass matrix. **07**

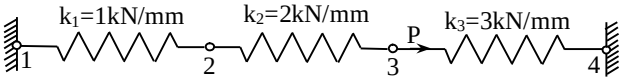

Fig. 1 Q-1(b)

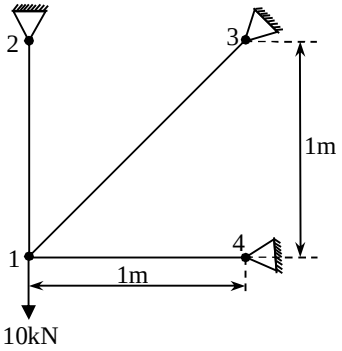

Fig. 2 Q-2(b)

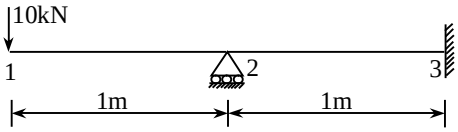

Fig. 3 Q-2(b) OR

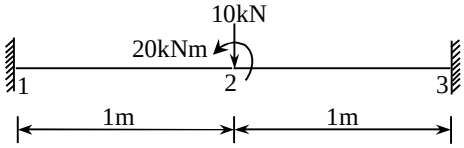

Fig. 4 Q-3(b)

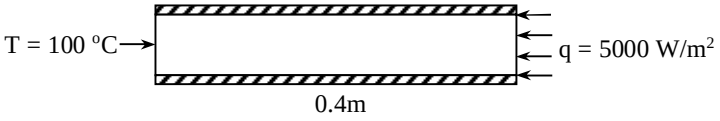

Fig. 5 Q-3(b) OR

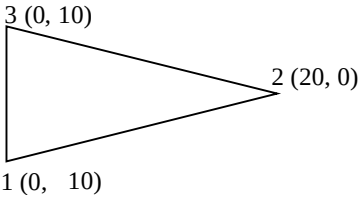

Fig. □Q-4(b)

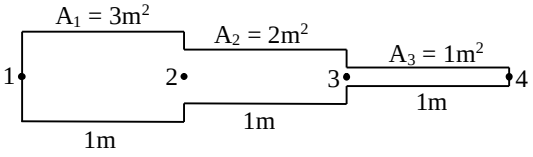

Fig. 7 Q-4(b) OR

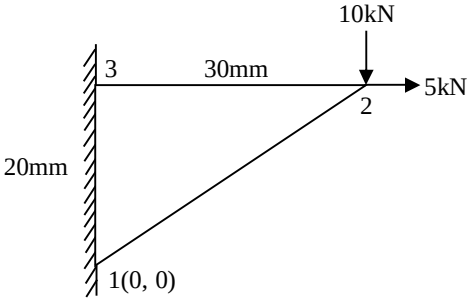

Fig. □Q-5(b)

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