Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER–II • EXAMINATION – SUMMER 2015

Subject Code: 2720801 Date: 28/05/2015

Subject Name: FINITE ELEMENT METHODS

Time: 2:30 pm to 5:00 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 figure 1, determine the nodal displacements, the forces in each element, and the reactions using direct stiffness method. **07**

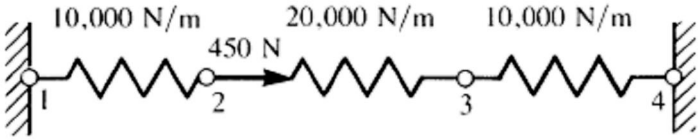


Figure 1

(b) (i). Discuss the properties of stiffness matrix. **02**

(ii). Using total potential energy approach, derive element stiffness matrix for the bar element. **05**

Q.2 **(a)** The nodal coordinates of triangular element are shown in figure 2. At the interior of point P, the x-coordinate is 3.3 and N_1 is 0.3. Determine N_2, N_3 and y coordinate at point P. Also determine the Jacobian for the (x, y) to (ξ, η) transformation for the element. **07**

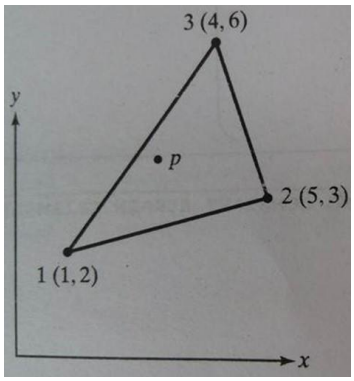
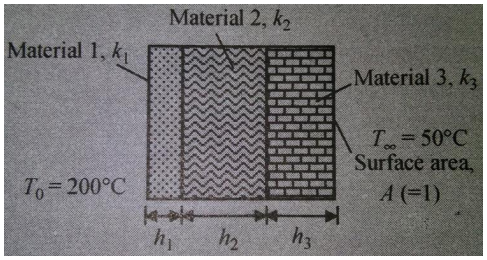


Figure 2

(b) Composite wall is consisting of three materials as shown in figure 3. The inside wall temperature is 200 ^{0}C and the outside air temperature is 50 ^{0}C with convection coefficient of 10 W / (m^{2}K). Determine the temperature distribution in the wall. **07**



k_1 = 70 W/ (mK)
k_2 = 40 W/ (mK)
k_3 = 20 W/ (mK)
h_1 = 2 cm
h_2 = 2.5 cm
h_3 = 4 cm
A = cross-sectional area = 1 m^2

Figure 3

OR

(b) For the bar as shown in figure 4, a load of 60 x 10^3 N is applied at point P. Do the following; **07**

(i). Determine the nodal displacement

(ii). Determine the stress in each element

(iii). Determine the reaction forces

(use minimum number of element to model the bar)

Take E = 20 x 10^3 N/mm^2

(Displacement at point Bô is 1.8 mm when wall does not exist)

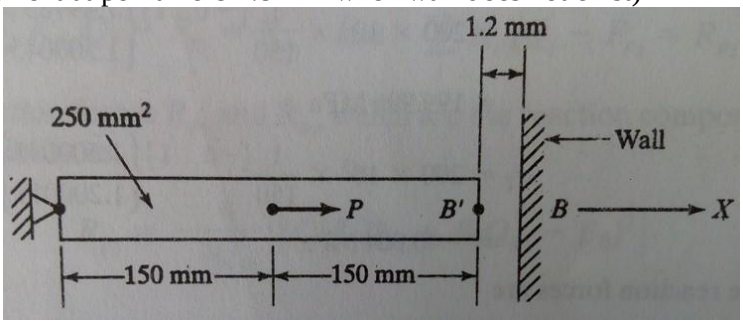


Figure 4

Q.3 **(a)** For the two bar truss shown in figure 5, determine the displacements of node 1 and stress in element 1-3. **07**

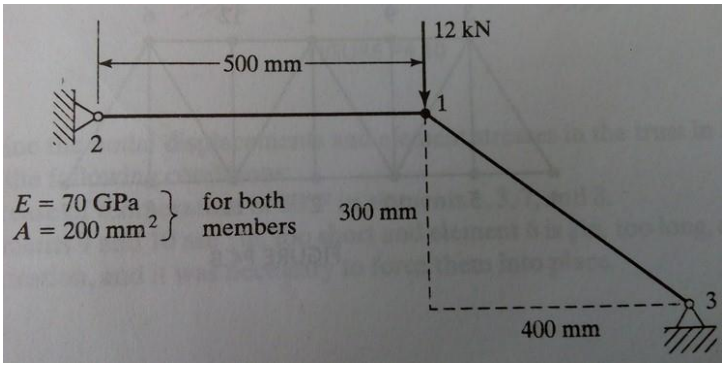


Figure 5

(b) Discuss shape functions for three-node quadratic element with the help of appropriate sketches. **07**

OR

Q.3 **(a)** Discuss Galerkinôs approach for derivation of element matrices using suitable example. **07**

(b) Discuss the shape function for 4-node quadrilateral element and define isoparametric formulation. **07**

Q.4 **(a)** For the beam and loading as shown in figure 6, determine; **07**

(i). slopes at 2 and 3

(ii). Vertical deflection at the mid-point of the distributed load

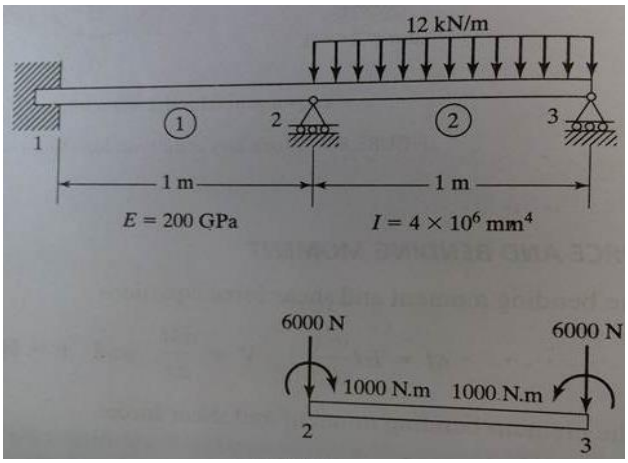


Figure 6

(b) An axial load P = 300 x 10^3 N is applied at 20^0C to the rod as shown in figure 7. Temperature is then raised to 60^0C. Determine; **07**

(i). Global stiffness matrix
(ii). Global load matrix
(iii). Determine nodal displacement
(iv). Determine element stresses

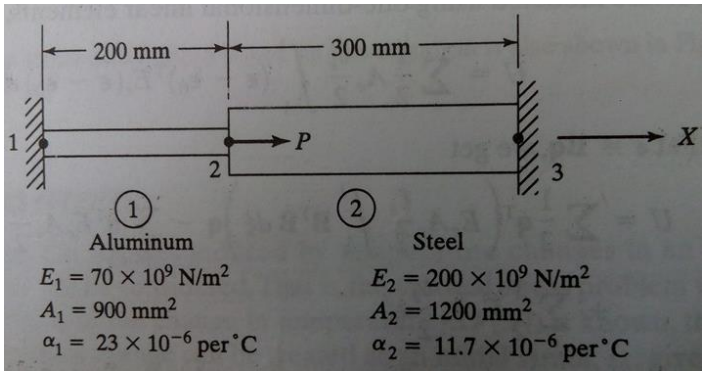


Figure 7

OR

Q.4 **(a)** Write short note on various types of elements used in FEM. **07**

(b) (i). Define shear locking. **02**

(ii). Discuss displacement field with reference to Kirchhoff plate theory. **05**

Q.5 **(a)** For the bar shown in figure 8 with length 2L, modulus of elasticity E, mass density ɟ, and cross-sectional area A, derive equation of the form (K- ∂M)U = 0 considering two finite elements and given boundary conditions. **07**
(K is global stiffness matrix, M is global mass matrix, U is global displacement matrix and ∂ is eigenvalue)

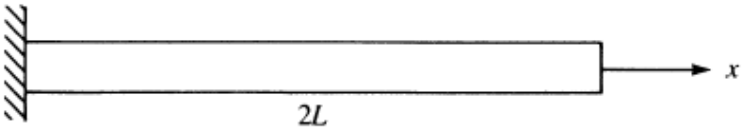


Figure 8

(b) Enlist various types of nonlinearity with reference to FEM and discuss geometrical non linearity giving suitable example. **07**

OR

Q.5 **(a)** Derive element mass matrix for the truss element. Enlist various methods for Eigenvalue evaluation. **07**

(b) ñUse of elimination approach for handling non-homogenous boundary condition leads to inaccuracy in solutionò Justify the statement with suitable discussion. **07**

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