Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-II Remedial Examination December 2010

Subject code: 720901 **Subject Name: Finite Element Method**

Date: 18 /12 /2010 **Time: 02.30 pm – 05.00 pm**

Total Marks: 60

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Write the capabilities of Finite Element Methods. **04**

(b) Write the general steps to be followed in Finite Element Analysis. **04**

(c) Comment on the use of element type and number of elements in the solution using FEM. **04**

Q.2 **(a)** Sketch the FEA model showing the boundary conditions and type of element for the following: **06**

i) Fly wheel ii) A plate with a central hole subjected to in-plane load.

(b) Determine the displacements of nodes of the spring system shown in figure 1 using minimum potential energy method. **06**

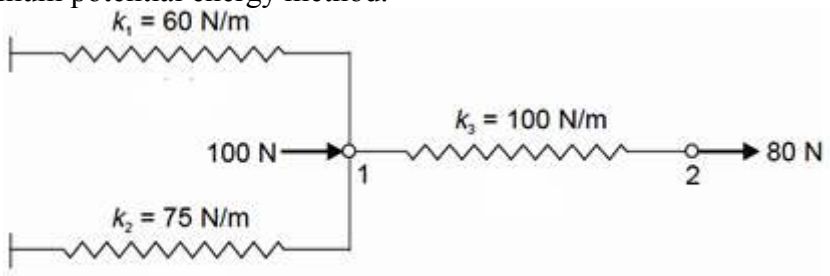

Figure 1

OR

(b) Determine the displacements of nodes of the spring system shown in figure 1 using direct stiffness method. **06**

Q.3 **(a)** For the axially loaded bar as shown in figure 2, determine the nodal displacements and element stresses. For steel, E = 20×10^6 N/cm^2 **06**

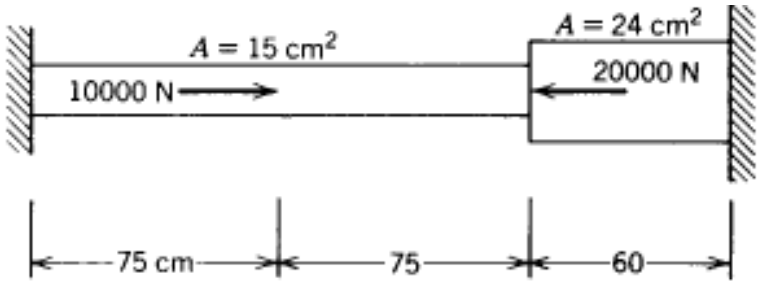

Figure 2

(b) For the beam shown in figure 3, determine the displacements and the slopes at the nodes. **06**

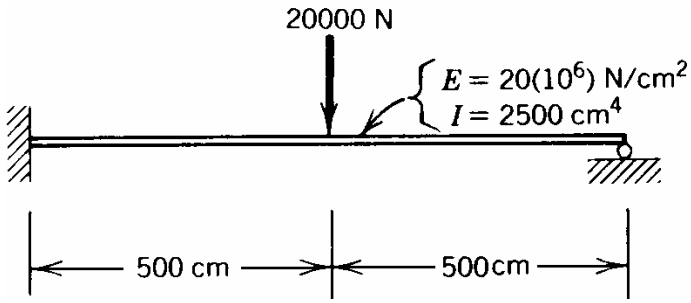

Figure 3

OR

Q.3 (a) For the axially loaded bar undergoing a temperature rise of 10° C as shown in figure 4, determine the nodal displacements and element stresses using penalty approach. Take, E = 20×10^6 N/cm^2 and $\alpha = 12 \times 10^{-6}$ /°C. **06**

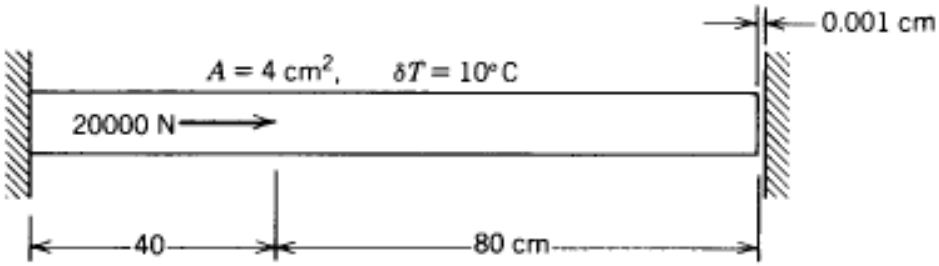

Figure 4

(b) The structure in figure 5 is axially loaded with P = 400 kN and is also subjected to an increase in temperature of 50°C. Determine the nodal displacements and elemental stresses. **06**

$A_1 = 2400$ mm^2 $\quad$ $A_2 = 1200$ mm^2

$E_1 = 0.7 \times 10^5$ N/mm^2 $\quad$ $E_2 = 2 \times 10^5$ N/mm^2

$\alpha_1 = 22 \times 10^{-6}$ /°C $\quad$ $\alpha_2 = 12 \times 10^{-6}$ /°C

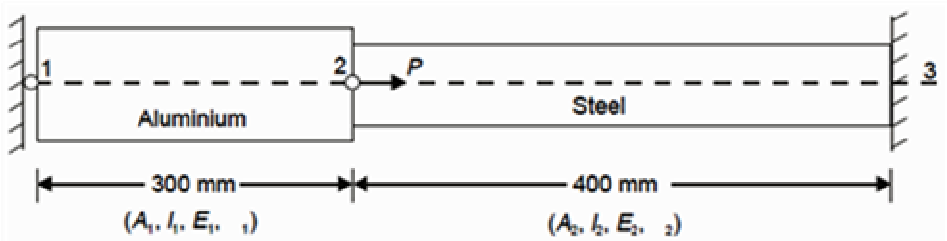

Figure 5

Q.4 (a) Find the displacements at nodes, stresses in members, and reactions at supports for the truss shown in figure 6. Take, E = 20×10^6 N/cm^2 **06**

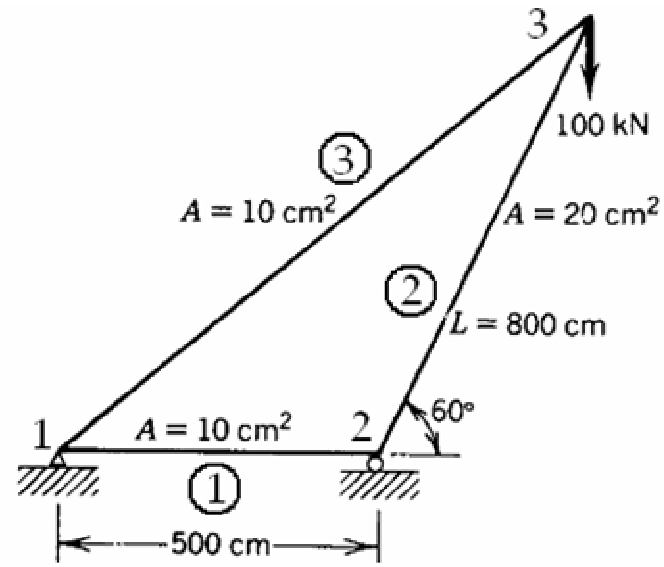

Figure 6

(b) Derive the shape functions in terms of natural coordinate system for a five noded bar element using Lagrange polynomial. **06**

OR

Q.4 (a) Find the displacements at nodes, stresses in members, and reactions at supports for the truss shown in figure 6. All elements are subjected to a uniform temperature rise of 30° C. **08**

Take, E = 20×10^6 N/cm^2 and $\alpha = 12 \times 10^{-6}$ /°C.

(b) Derive the shape functions in terms of natural coordinate system for a four noded quadrilateral element. **04**

Q.5 **(a)** A metallic fin, with thermal conductivity K=3 W/cm °C, 1 cm thick, 4 cm wide and 8 cm long extends from a plane wall whose temperature is maintained at 80° C. Determine the temperature distribution and amount of heat transferred from the fin to the air at 20° C with h = 0.1 W/cm^2 °C. Assume that convection heat loss occurs from the end of the fin. **06**

Model the fin as two elements of equal length.

(b) The wall of an industrial oven consists of two layers of different materials. The inside layer is composed of 10 cm of insulating material with a thermal conductivity of 0.08 W/m K. The exterior layer consists of 10 cm thick wall with a thermal conductivity of 0.8 W/m K. The inside temperature of oven is 250° C. The outside air temperature is 30° C with a convection coefficient of 50 W/m^2 K. **06**

Determine a temperature distribution in the composite wall of the oven.

OR

Q.5 **(a)** A metallic fin, with thermal conductivity K=300 W/m° C, 0.5 cm thick and 10 cm long extends from a plane wall whose temperature is 200° C. Determine the temperature distribution and amount of heat transferred from the fin to the air at 20° C with h = 10 W/m^2 °C. Take the width of the fin to be 1 m. Assume that the tip of the fin is insulated. **06**

Model the fin as two elements of equal length.

(b) Determine the Cartesian coordinate of the point P (ξ=0.4, η=0.4) for the element shown in figure 7. On this point the load components in X and Y directions are 20 kN and 8 kN respectively. Determine its nodal equivalent forces. **06**

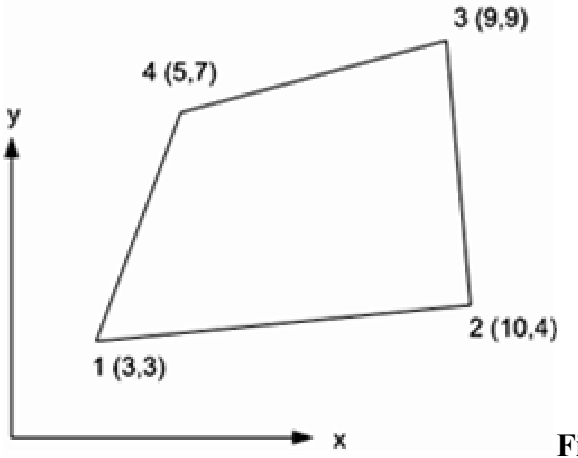

Figure 7

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