Hall Ticket No | | | | | | | | | | | Question Paper Code: AAE009

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Four Year B.Tech V Semester End Examinations (Regular) - November, 2018

Regulation: IARE – R16

FINITE ELEMENT METHODS

Time: 3 Hours **(AE)** **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) Discuss the finite element methodology to solve the structural problems. **[7M]**

   (b) Consider a bar as shown in Figure 1. An axial load of 200 kN is applied at a point p. Take $A_1 = 2400\ mm^2$, $E_1 = 70 \text{ x } 10^9\ N/m^2$, $A_2 = 600\ mm^2$, $E_2 = 200 \text{ x } 10^9\ N/m^2$. Calculate the following: (i) Nodal displacement at point P (ii) Stresses in each material. **[7M]**

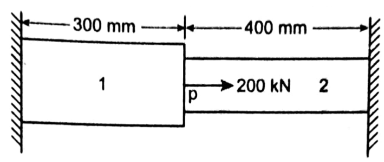

Figure 1

2. (a) Derive the stiffness matrix k' for Quadratic shape functions **[7M]**

   (b) A two-step bar subjected to loading condition as shown in Figure 2 is fixed at one end and the free end is at a distance of 3.5mm from the support. Determine stresses in the element. Take E=200X10^9 N/mm^2. **[7M]**

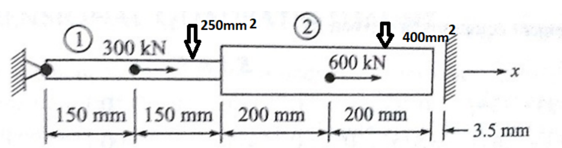

Figure 2

UNIT – II

3. (a) Derive the transformation Matrix 'L' for a plane truss element. **[7M]**

   (b) For the truss in Figure 3 . a horizontal load of P = 4000 lb is applied in the x direction at node 2.Write down the element stiffness matrix [k]. **[7M]**

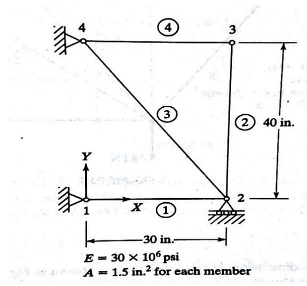

Figure 3

4. (a) Derive shape function and stiffness matrix for 2D truss element. **[7M]**
   (b) For the cantilever beam subjected to the uniform load w as shown in Figure 4, determine the vertical displacement and rotation at the free end. Assume the beam to have constant EI throughout its length. **[7M]**

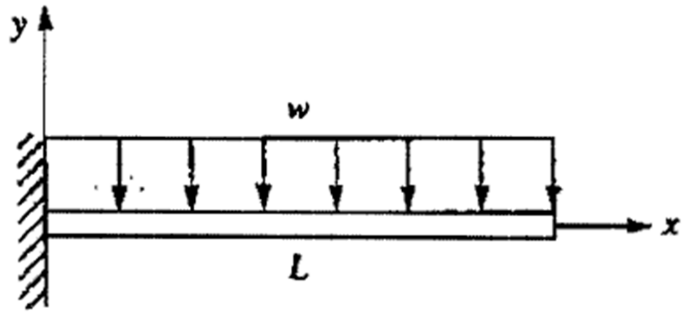

Figure 4

UNIT – III

5. (a) Derive the stiffness matrix for beam element using potential energy approach. **[7M]**
   (b) For a thin plate subjected to in-plane loading a shown in Figure 5 determine the Global Stiffness matrix. The plate thickness t=1cm, E = 20 X 10^6 N/cm^2 and moment of inertia I=2500cm^4. Consider it as a two elemental beam problem. **[7M]**

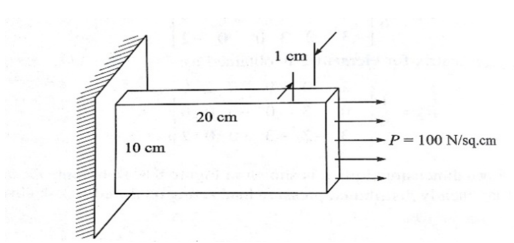

Figure 5

6. (a) For the triangular element shown in Figure 6. Obtain the strain-displacement relationship matrix [B] and determine the strains $\varepsilon_x, \varepsilon_y$ and γ_{xy}. **[7M]**

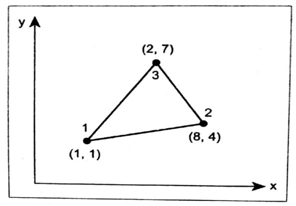

Figure 6

(b) The nodal coordinates for an axisymmetric triangular element are given Table 1. Evaluate [B] matrix for that element. **[7M]**

Table 1

$r_1 = 10$ mm	$z_1 = 10$ mm
$r_2 = 30$ mm	$z_2 = 10$ mm
$r_3 = 30$ mm	$z_3 = 40$ mm

UNIT – IV

7. (a) Derive the shape function and stiffness matrix for 1D heat conduction element. **[7M]**

(b) Compute element matrices and vectors for the element shown in Figure 7, when the edge kj experiences convection heat loss. **[7M]**

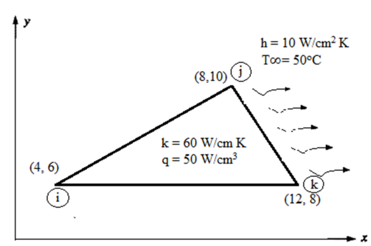

Figure 7

8. (a) Calculate the temperature distribution in a one dimension fin with physical properties given in Figure 8. The fin is rectangular in shape and is 120 mm long. 40 mm wide and 10 mm thick. Assume that convection heat loss occurs from the end of the fin. Use two elements. Take k = 0.3 W/mm^oC; h = 1 x 10^{-3}W/$mm^{20}c$, $T\infty = 20^o$C. Assume unit area. **[7M]**

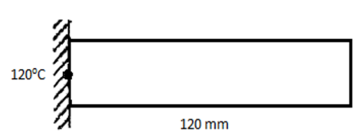

Figure 8

(b) Find the temperature distribution in a square region with uniform heat generation as shown in Figure 9. Assume that there is no temperature variation in the z-direction. Take k= 30W/cm^0c, h=10 watts/cm^{20}k, l = 10cm, $T\infty = 50^o$C, Q= 100 W/cm^3. Consider it a two elemental problem. **[7M]**

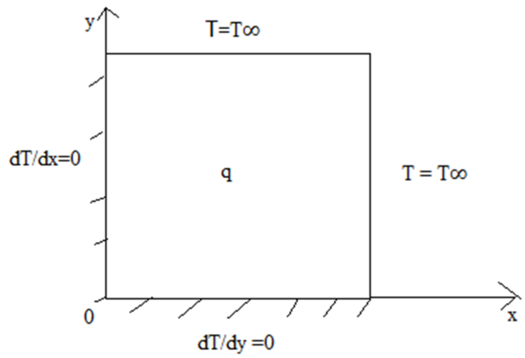

Figure 9

UNIT – V

9. (a) Consider a uniform cross-section bar as shown in Figure 10 of length L made up of material whose Young's modulus and density is given by E and ρ. Estimate the natural frequencies of axial vibration of the bar using lumped mass matrix. Consider the bar as one element. **[7M]**

   (b) For the one dimensional bar shown in Figure 10, determine natural frequencies of longitudinal vibration using two elements of equal length. Take E = 2 x 10^5 N/mm^2, ρ = 0.8 x 10^{-4} N/mm^3, and L= 400 mm. **[7M]**

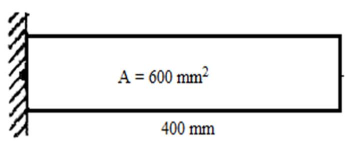

Figure 10

10. (a) Determine the natural frequencies of transverse vibration for a beam fixed at both ends. The beam may be modeled by two elements, each of length L, density ρ, modulus of elasticity E, cross sectional area A and moment of inertia I. Consider lumped mass approach. **[7M]**

    (b) Consider the simply supported beam shown in Figure 11. Let the length L = 1 m, E = 2 x 10^{11} N/m^2, area of cross section A = 30 cm^2, moment of inertia I = 100 mm^4, density ρ = 7800 kg/m^3. Determine the natural frequency using lumped mass matrix approach. **[7M]**

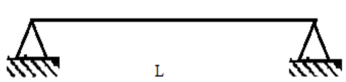

Figure 11

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