Hall Ticket No | | | | | | | | | | | Question Paper Code: AME014

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

B.Tech III Semester End Examinations (Regular) - May, 2019

Regulation: IARE – R16

FINITE ELEMENT MODELING

Time: 3 Hours **(ME)** **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) What is the need of finite element analysis for solving the engineering problems? Explain its significance in solving different solid mechanics problems. **[7M]**

   (b) A stepped bar is subjected to an axial load of 300 KN as shown in Figure 1. Find the nodal displacements, element stresses and strains and reactions. Take E = 2 X 10^5 N/mm^2. The cross sectional areas are 100 mm^2 and 150mm^2. **[7M]**

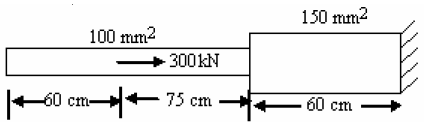

Figure 1

2. (a) Enumerate the following **[7M]**
   i.Shape function
   ii.Quadratic shape function

   (b) For the three stepped bar shown in Figure 2, determine the following. **[7M]**
   i. Global stiffness matrix
   ii. Displacements at Nodes 2 and 3

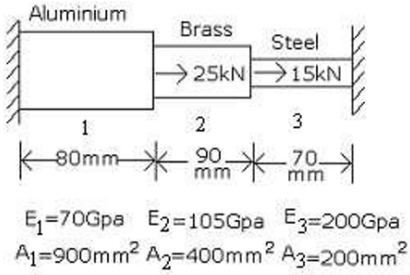

Figure 2

UNIT – II

3. (a) Explain the process to determine the stiffness matrix of a 2-noded plane truss element **[7M]**

   (b) For the truss shown in Figure 3, solve the horizontal and vertical displacements at node 1. Let A = 6 x 10^{-4} m^2, E = 70 GPa and L = 2.5 m. **[7M]**

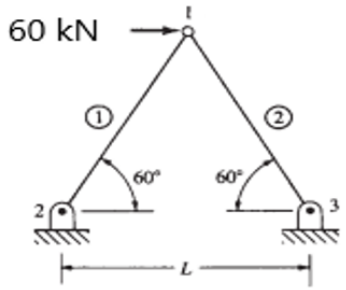

Figure 3

4. (a) Enumerate the procedure to determine the Hermite shape functions of a 2-noded beam element. **[7M]**

   (b) A cantilever beam of span 2 m is simply supported at middle and free end. It is subjected to a uniformly distributed load of 10 kN/m. Find the slopes at middle and free end of the beam assuming E = 200 GPa and I = 100 x 10^{-6} m^4. **[7M]**

UNIT – III

5. (a) What is the strain displacement matrix and explain the process to determine for a CST element. **[7M]**

   (b) The coordinates of the nodes of CST element are 1 (2, 3), 2 (4, 1) and 3 (4, 5) in millimetres. Compute its stiffness matrix assuming plane stress conditions. Take E = 100 GPa and ϑ = 0.25, t = 10mm. **[7M]**

6. (a) Write the expression of traction force for four node quadrilateral element. **[7M]**

   (b) The co-ordinates of a 4-noded isoparametric quadrilateral element in millimeters are 1 (10, 10), 2 (20, 10), 3(20, 20) and 4 (12,16). Find the Jacobian matrix of this element. **[7M]**

UNIT – IV

7. (a) Specify the applications of heat transfer problems. What are different types of boundary conditions for 1D heat conduction problems? **[7M]**

   (b) Determine the nodal temperature in a composite wall, the wall is maintained at 100 ^0c at the left face and convection mode of heat transfer occurs between the right face and existing fluid. Take k_1 = 0.06w/cm deg c and k_2 = 0.2w/cm deg c. convection co efficient of heat transfer between walls and fluid h=0.1w/cm^2 C and T_∞ =25^{0}C. Consider unit area=1 cm^2 perpendicular to the direction of heat flow. **[7M]**

8. (a) Explain 2-D finite element formulation in heat transfer analysis with a suitable example. **[7M]**

   (b) A furnace wall is made up of three layers, inside layer with thermal conductivity 8.5W/mK, the middle layer with conductivity 0.25 W/mK, the outer layer with conductivity 0.08W/mk .The respective thickness of inner, middle and outer layer are 25cm, 5cm and 3cm respectively. The inside temperature of the wall is 600^0C and outside of the wall is exposed to atmospheric air at 30^0C with heat transfer coefficient of 45W/m^2K. Determine the nodal temperatures. **[7M]**

UNIT – V

9. (a) Distinguish between consistent and lumped mass matrices. Derive the consistent mass matrix of a 2-noded axial bar element and write corresponding lumped mass matrix. **[7M]**

   (b) Find the natural frequencies of a cantilever beam of length 1 m. Assume E = 200 GPa, ρ = 7800 kg/m^3. Area moment of inertia I of the cross section of the beam through neutral axis is 4 x 10^6 mm^4 and area of cross-section is 100 mm^2. Take one element and use lumped mass matrix. **[7M]**

10. (a) Discuss the methodology to solve the Eigen value problem for the estimation of natural frequencies of a stepped bar. **[7M]**

    (b) Evaluate the lowest Eigenvalue and the corresponding Eigenmode for the beam shown in Figure 4 below. **[7M]**

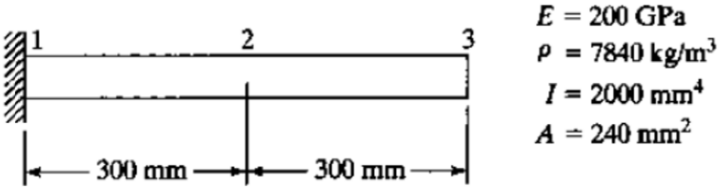

Figure 4

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