Code No: 126VE **R15**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech III Year II Semester Examinations, December - 2018
FINITE ELEMENT METHODS
(Common to ME, AE, MSNT)

Time: 3 hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART - A

(25 Marks)

1.a) Define the principle of minimum potential energy. [2]
b) What is the strain displacement relation for plane stress condition? Represent them graphically. [3]
c) A cantilever beam is subjected to a uniformly distributed load throughout its length. What are its essential and natural boundary conditions? [2]
d) Derive the transformation matrix for a truss element oriented at an arbitrary angle with the bar element. [3]
e) List the assumption made in approximating a solid as axisymmetric. [2]
f) Derive the shape functions for four noded quadrilateral element using natural coordinate system and check the properties of the shape functions. [3]
g) List the essential and natural boundary conditions in the Heat Transfer Analysis? [2]
h) A rectangular fin of length 60 mm is modeled as a single one dimensional linear element. The temperatures at the end points of the fine are 120 ^{0}C and 90 ^{0}C. Determine the temperature at 40 mm from the peak temperature point [3]
i) What are the degrees of freedom for tetrahedron element in structural mechanics? [2]
j) What is the Consistent Mass matrix and Lumped Mass matrix for a truss element? [3]

PART - B

(50 Marks)

2.a) Obtain the shape functions for a two noded axial element using local coordinate system, global coordinate system and natural coordinate system.
b) Derive the stiffness matrix for a one dimensional two noded axial element. Enumerate the properties of the stiffness matrix. [5+5]

OR

3. A two step bar subjected to loading conditions is shown in figure 1. The areas of the cross section of the two members are 200 mm^2 and 400 mm^2. Determine the displacements at nodal points, the stresses in elements and the reactions at the supports. [10]

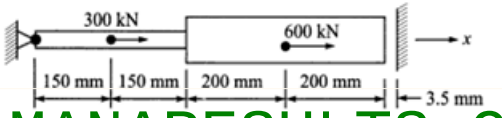

Figure 1

4. For the plane bar-truss structure shown in Figure 2, determine the horizontal and vertical displacements at node number 1. Given E, Young's Modulus = 210 GPa and A, area of each truss = 400 mm^2. Also find the stresses in each element. [10]

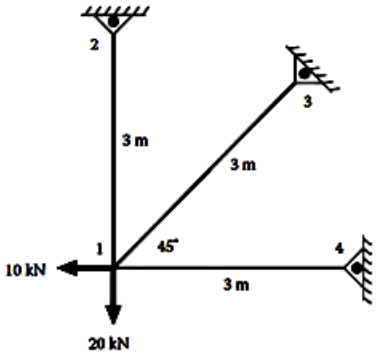

Figure 2

OR

5. Calculate the maximum deflection and slope by using finite element method for the simply supported beam of length L, Young's modulus E and the moment of Inertia I, subjected to a Moment load M at the centre. How would the load vector change if the moment were applied at one-third the span rather than at the centre? [10]

6. The coordinates of the vertex of a triangular element are A (12, 20), B (4, 10) and C (25, 4). Determine stiffness matrix assuming plane stress condition with thickness 10 mm and Young's modulus 200 GPa. The edge AB is fixed and a Point load of 10kN is applied at point C in the vertical downward direction. Determine the deformation at a point P (11, 14). All the dimensions are in mm only. [10]

OR

7. For the axisymmetric loading shown in figure 3, develop the nodal force vector using triangular elements. [10]

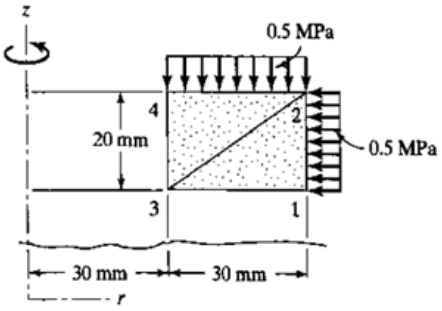

Figure 3

8. A composite wall consists of layers of aluminium, copper and steel. The steel external surface is 350 ^{0}C, and the external surface of the aluminium is exposed to an ambient of 25 ^{0}C with a heat transfer coefficient of 5 W/m^2 ^{0}C. Calculate the heat loss and the interfacial temperature using a three-element model using the data given in the table. [10]

Details of the composite wall

Material	Thermal conductivity (W/m °C)	Thickness (cm)
Aluminium	200	5
Copper	400	15
Steel	50	20

OR

9.a) Explain the Galerkin method as applied to steady state heat transfer.

b) The coordinates of vertices of a triangular element are given by A (50, 50), B (70, 60) and C (60, 80). All the dimensions are in mm only. The temperatures at these vertices A, B and C are 100 ^{0}C, 200 ^{0}C and 300 ^{0}C respectively. Determine the temperature at the point P (55, 55). [5+5]

10. Consider the axial vibrations of a steel bar shown in the Figure 4.
a) Develop global stiffness and mass matrices,
b) Determine the natural frequencies and mode shapes [5+5]
Assume E = 300 GPa, Density = 7250 kg / mm^3

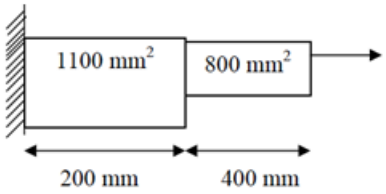

Figure 4

OR

11.a) A cube of 50 mm side is modeled as a single hexahedral element. Derive the Jacobian matrix at the body centre of this hexahedral element.

b) Enumerate the various factors in the selection of proper element type in Finite Element Software. [5+5]

---ooOoo---