I/E/TY

Reg. No:

Final Assessment Test – April 2025

VIT
Vellore Institute of Technology

Course: BMEE306L - Computer Aided Design and Finite Element Analysis

Class NBR(s): 3574 / 3575 / 3576 / 3577 / 6666

Slot: G2+TG2

Time: Three Hours

Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

PART – A (5 X 12 = 60 Marks)
Answer ALL Questions

1. A line has two endpoints with coordinates (2, 4) and (4, 8). A scaling factor of 2 and 3 about the point (2, 4) are to be applied in the X and Y directions, respectively. The line is to be rotated subsequently through 60° about the origin, in the counterclockwise direction. Determine the necessary transformation matrix and the new coordinates of the end points. [12]

2. (i) Provide the classification of Analytical and synthetic surface entities and explain any two types with examples. [6]

   (ii) Explain the importance of data exchange in CAD/CAM systems and name any two common standard data exchange formats. [6]

3. Solve the following differential equation along with the initial condition: [12]

$$\frac{du}{dx} + 3u = x, 0 \leq x \leq 1, \text{ and } u(0) = 1,$$

using the Galerkin's weighted residual method. Assume an initial approximation $u = a + bx + cx^2$.

4. Consider the two-bar truss shown in Figure 1. The loads acting at node A are given by $P_1 = 500$ N and $P_2 = 1000$ N. Assuming Elastic modulus, E = 200 GPa and Poisson's ratio, v = 0.3, [12]

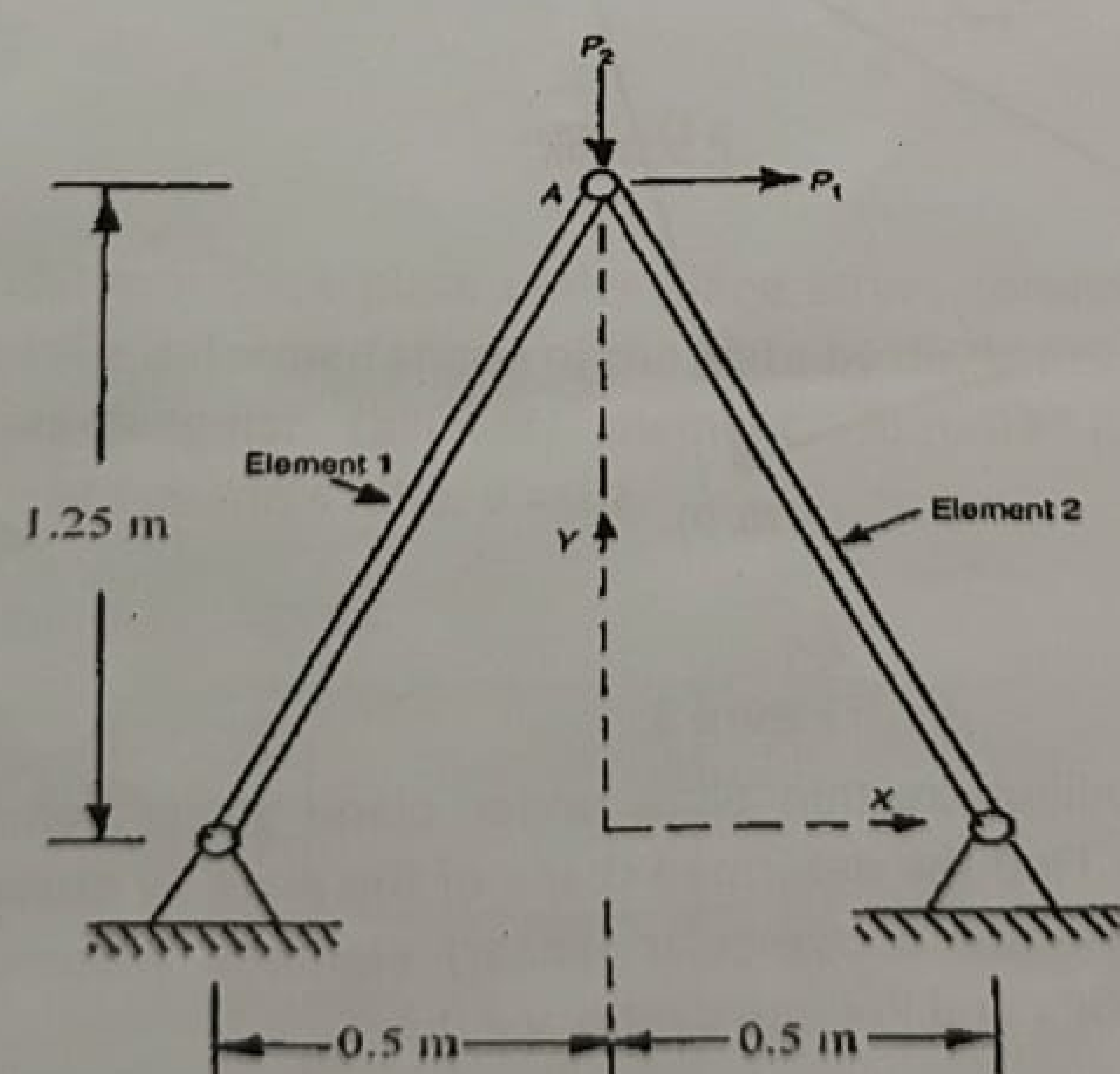

Figure 1

(i) Derive the assembled equilibrium equations of the truss.

(ii) Find the displacement of node A.

(iii) Find the stresses in elements 1 and 2.

Q 5. Determine the first natural frequency of the simply supported beam, shown in the figure 2, using a single linear element model. Assume Elastic modulus, E = 120 GPa, and density of the material, $\rho = 8.9\ kg/m^3$. **[12]**

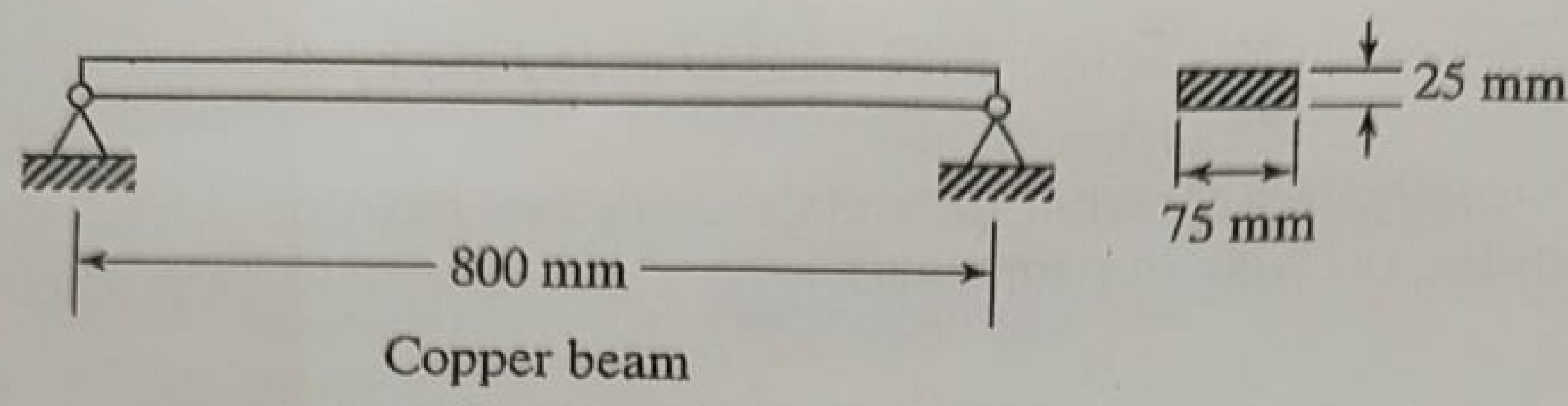

Figure 2

PART – B (2 X 20 = 40 Marks)

Answer <u>ALL</u> Questions

6. i) A cubic Bezier curve is defined by the control points as (20, 20), (60, 80), (120, 100) and (150, 30). Derive the parametric equation of the curve and calculate the midpoint coordinates. **[10]**

(ii) The end points of a Hermite cubic spline curve are $P_0(2, 3)$ and $P_1(6, 0)$. The tangent vector for end P_0 is given by line joining P_0 and point $P_2(-1, 1)$. The tangent vector for end P_1 is given by line joining $P_3(8, -1)$ and point P_1. Derive the parametric equation of the corresponding Hermite cubic curve. **[10]**

7.a) (i) Consider a linear triangular element *ijk* with its cartesian coordinates, as shown in the figure 3. The temperature values at the midpoints (P, Q, R) of the element edges (*ij*, *jk*, *ik*) are given in the figure. Determine the nodal temperatures using appropriate shape functions of the element. **[10]**

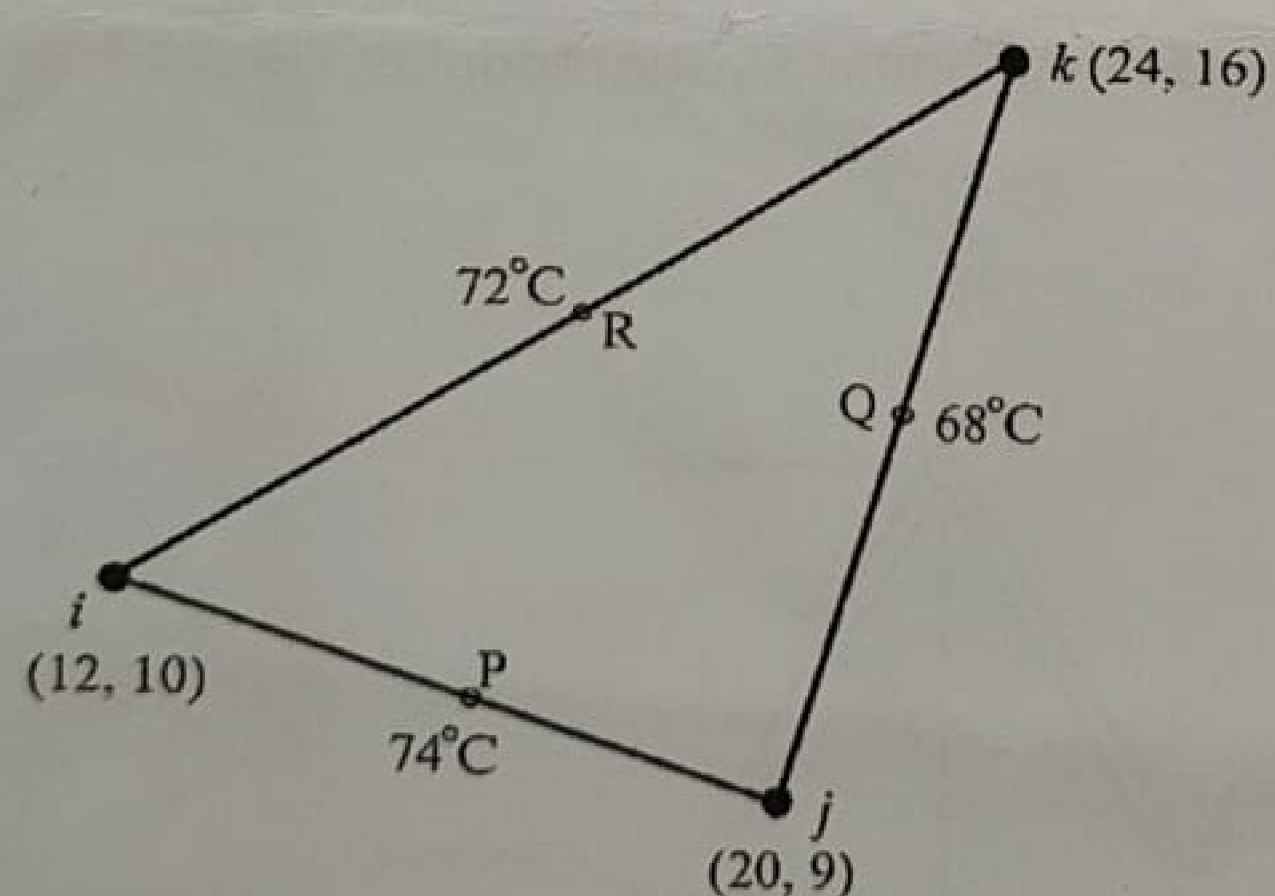

Figure 3

(ii) Consider a one-millimetre-thin plate under plane stress condition as shown in Figure 4. Find the deformed shape of the plate by discretizing it into a single three-noded triangular (linear) element. Assume Elastic modulus, E = 200 GPa and Poisson's ratio, $\nu = 0.3$. **[10]**

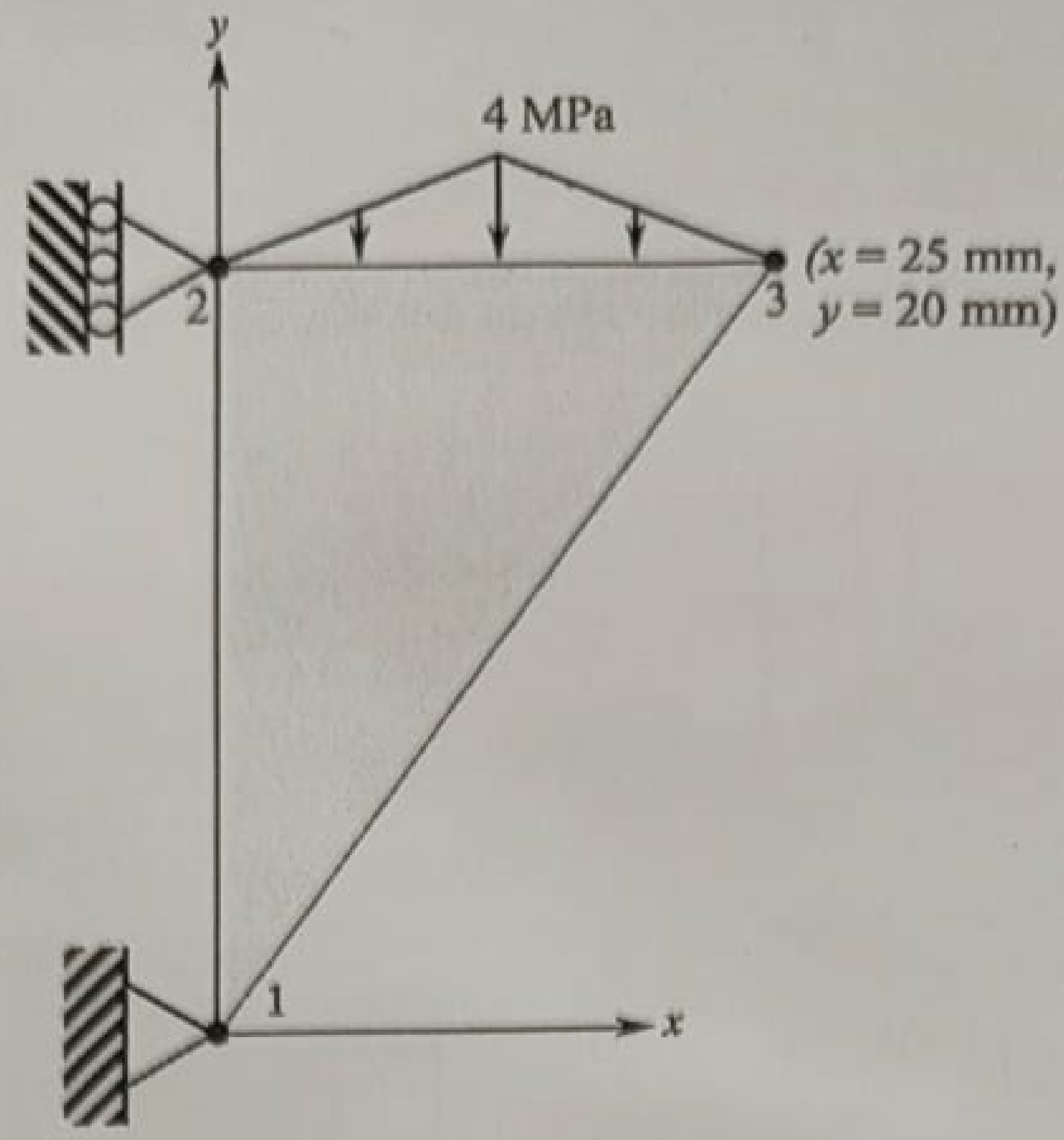

Figure 4

OR

7.b) i) Consider a four noded quadrilateral (trapezoid) element *ijkl* with its cartesian coordinates shown in the figure 5. The temperature values in the element are given at three nodes *i*, *j*, *k*, and at its centre point, P. Determine the temperature value at the node *l* using appropriate shape functions of the element. **[10]**

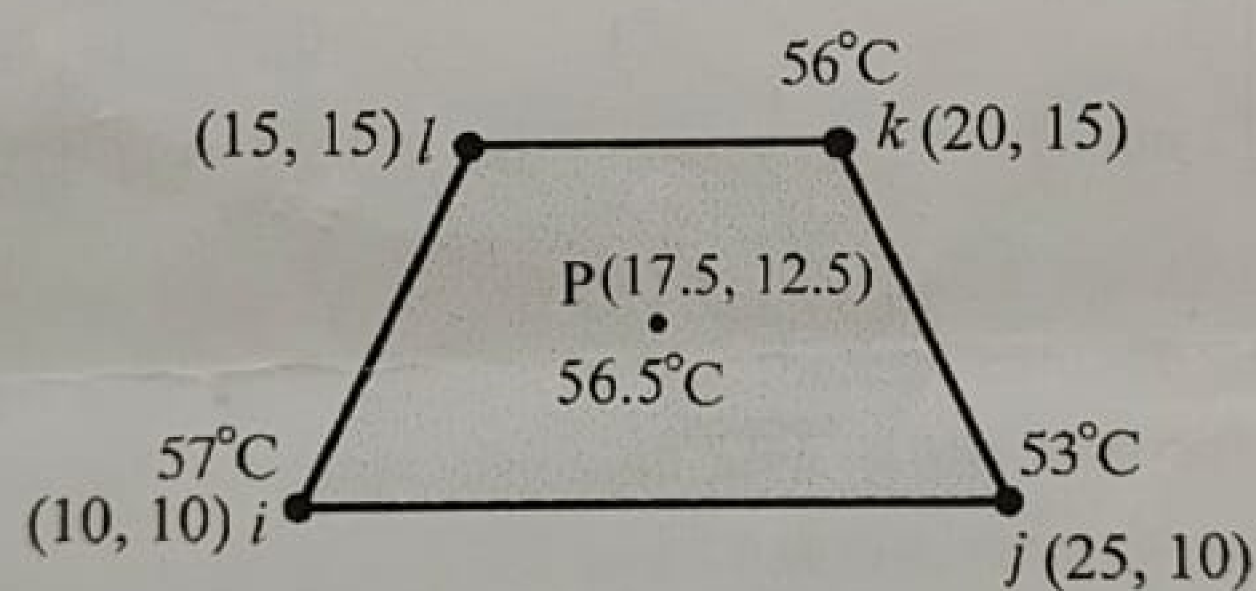

Figure 5

ii) Consider a 100 mm thick plate under plane strain condition as shown in Figure 6. Find the deformed shape of the plate by discretizing it into a single four-noded rectangular (bilinear) element. Assume Elastic modulus, E = 200 GPa and Poisson's ratio, ν = 0.3. **[10]**

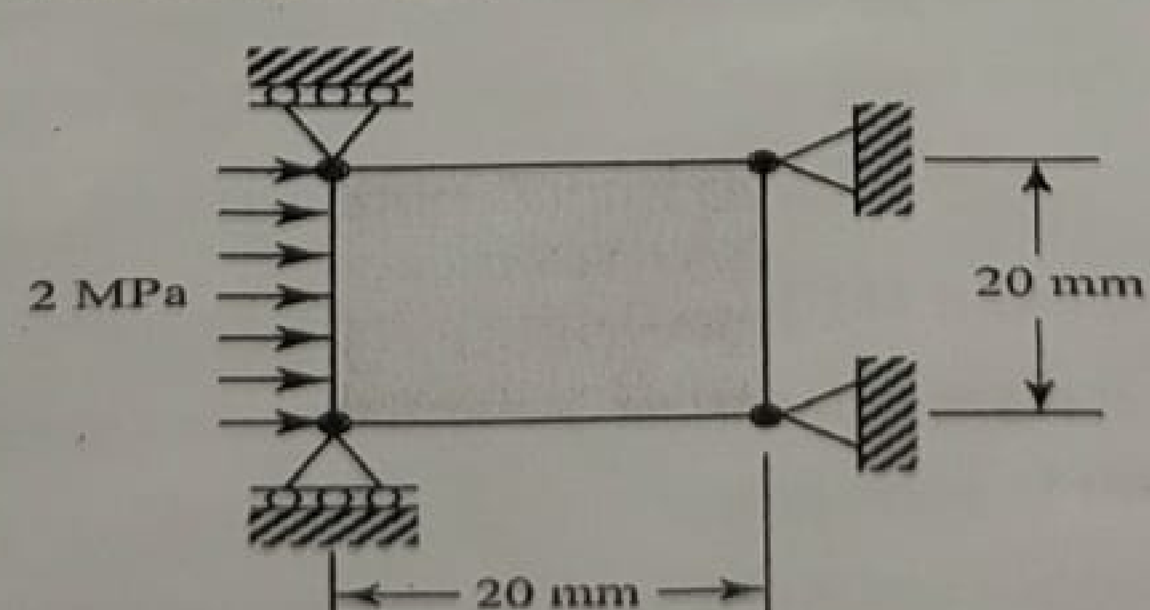

Figure 6

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