



CBCS SCHEME

21AU644

Sixth Semester B.E./B.Tech. Degree Examination, June / July 2026 Finite Element Methods

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Explain the basic steps involved in the Finite Element Method. (12 Marks)
- b. Explain the convergence criteria. (04 Marks)
- c. Explain the significance of node numbering and location of nodes. (04 Marks)

OR

- 2 a. Sketch and write the linear interpolations polynomials for 1D, 2D and 3D elements. (06 Marks)
- b. Explain with sketch the simplex and complex elements. (04 Marks)
- c. A bar of length L , cross sectional area A and modulus of elasticity E , is subjected to distributed load $q = cx$ where c is constant. Determine the expression for displacement of the bar at the end using RR method, as shown in figure Q. 2 (c).

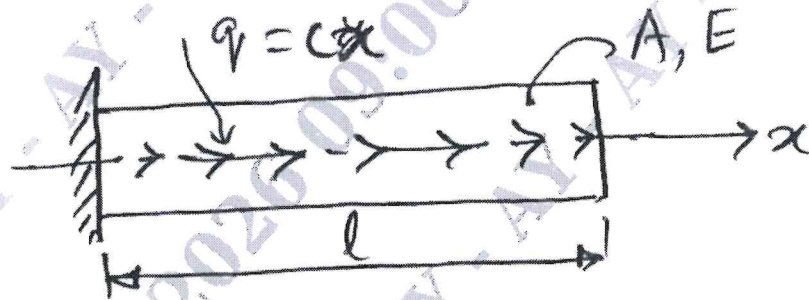


Fig. Q.2 (c)

(10 Marks)

Module-2

- 3 a. Define the shape function and derive the shape function for a bar element using natural coordinates. (10 Marks)
- b. List the properties of shape functions and derive the shape functions of 3 noded bar element using Lagrange's interpolation functions. (10 Marks)

OR

- 4 a. Explain the concept of ISO parametric and super parametric elements with neat sketch. (06 Marks)
- b. Evaluate $I = \int_{-1}^{+1} \left(3e^x + x^2 + \frac{1}{x+2} \right) dx$ using 1 pt and 2 pt formula. (04 Marks)
- c. Determine the nodal displacements of stepped bar using FEM, as shown in fig.Q. 4(c)

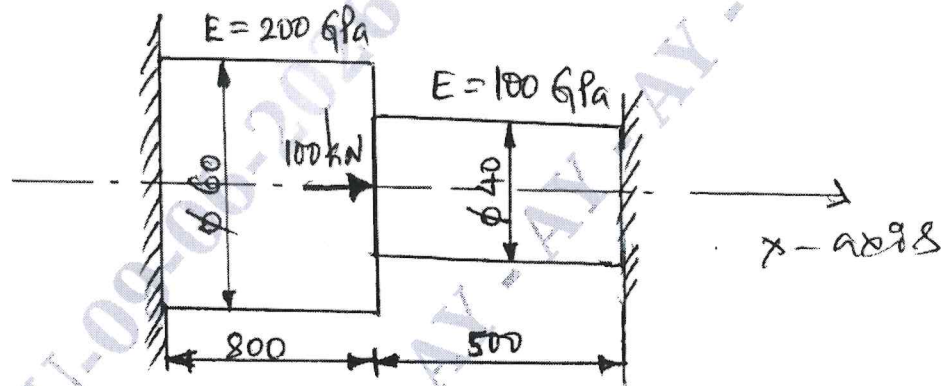


Fig. Q.4(c)

(10 Marks)

Module-3

- 5 a. Derive the Hermite shape functions for a beam element. (10 Marks)
- b. A cantilever beam subjected to a point load of 100 kN at its free end. Determine the deflection at its free end. $E = 200 \text{ GPa}$, $I = 4 \times 10^6 \text{ mm}^4$ and $L = 1000 \text{ mm} = 1 \text{ m}$. (10 Marks)

OR

- 6 a. Derive the load vector for the beam element carries a UDL 'q' and of length l, with usual notations. (08 Marks)
- b. A solid shaft of circular cross section as shown in figure Q 6 (b), subjected to a torque of 1 kN – m @ its free end and a torque of 3kN –m at its change of cross section. Determine the angle of twist and shear stress in the shaft. $E = 200 \text{ GPa}$, $G = 70 \text{ GPa}$.

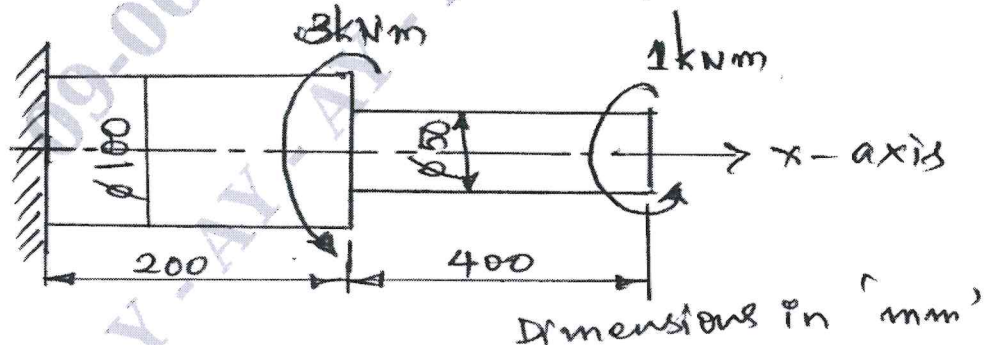


Fig. Q. 6 (b)

(12 Marks)

Module-4

- 7 a. Derive the conductivity matrix for a 1 D bar element using usual notations. (06 Marks)
- b. An induction furnace wall consists of 3 layers as shown in figure Q. 7 (b). Determine the nodal temperature at each point and sketch the temperature gradient across the composite wall.

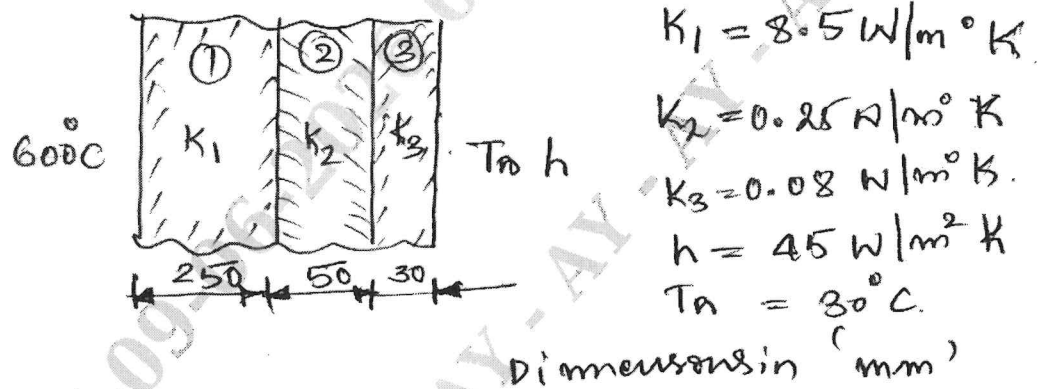


Fig. Q. 7 (b)

(14 Marks)

OR

- 8 a. Derive the convection matrix for a 1 D bar element considering lateral surface only with usual notations. (06 Marks)
- b. A composite wall consists of two materials as shown in figure Q 8 (b). The outer temperature is 20°C and $T_\infty = -5^\circ\text{C}$, $h = 25 \text{ W/m}^2\text{C}$. Determine the temperature distribution.

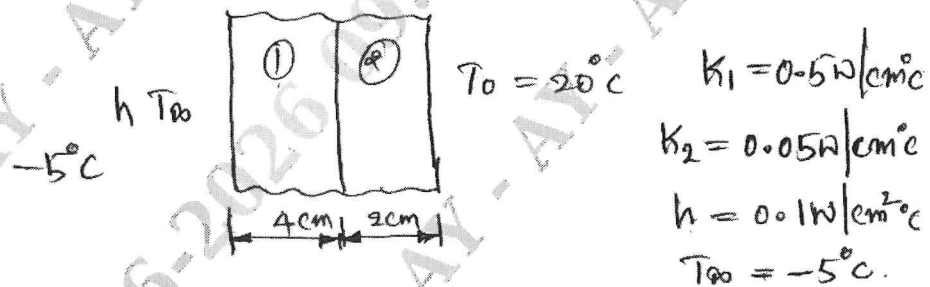


Fig. Q. 8 (b)

(14 Marks)