



CBCS SCHEME

21ME53

Fifth Semester B.E./B.Tech. Degree Examination, June/July 2026 Finite Element Analysis

Time: 3 hrs.

Max. Marks: 100

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

Module-1

- 1 a. Define FEA. Explain the basic steps involved in problem solving in FEA. (10 Marks)
- b. With an example, explain node numbering scheme and node location system. (10 Marks)

OR

- 2 a. Using minimum potential energy determine the nodal displacement of a spring system shown in Fig. Q2 (a). (10 Marks)

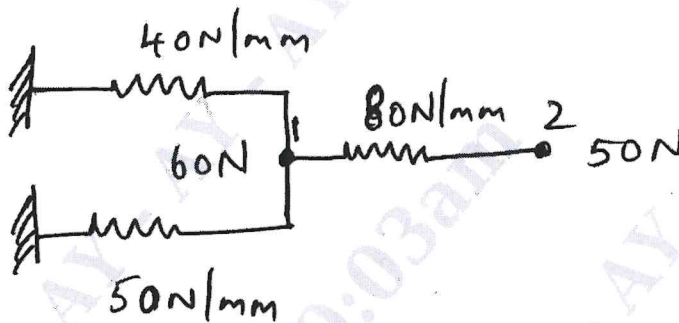
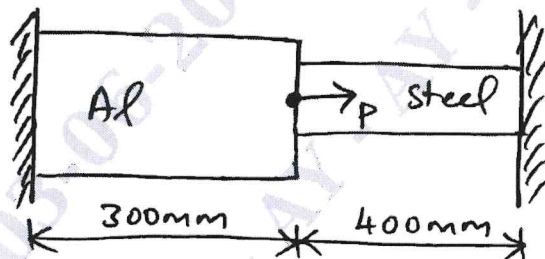


Fig. Q2 (a)

- b. Explain simplex, complex and multiplex elements. (10 Marks)

Module-2

- 3 a. Derive the elemental stiffness matrix for 1D bar element. (10 Marks)
- b. For the stepped bar shown in Fig. Q3 (b). Determine the nodal displacements, stress in each element. (10 Marks)



$$E_{Al} = 70 \times 10^9 \text{ N/m}^2 \quad E_{St} = 200 \times 10^9 \text{ N/m}^2$$

$$A_{Al} = 2400 \text{ mm}^2 \quad A_{St} = 600 \text{ mm}^2$$

$$P = 200 \text{ kN}$$

Fig. Q3 (b)

OR

- 4 a. Derive an expression for a shape function 4-noded tetrahedral element (TET4). (10 Marks)
 b. Derive an shape function for a cubic element in natural coordinates. (10 Marks)

Module-3

- 5 a. Derive Hermite shape function for a beam element. (10 Marks)
 b. Find the deflection at the free end and the support reaction of a cantilever beam shown in Fig. Q5 (b). (10 Marks)

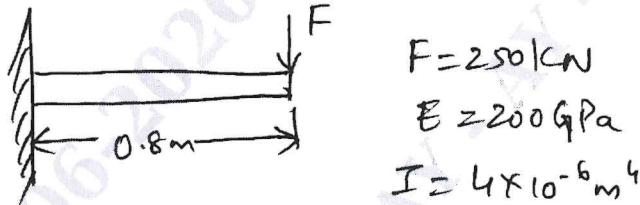


Fig. Q5 (b)

OR

- 6 a. Derive stiffness matrix for a circular shaft subjected to pure torsion. (10 Marks)
 b. A solid stepper bar of circular cross section is subjected to a torque of 1 kN-m at its free end and to a torque of 3 kN-m at its change in cross section as shown in Fig. Q6 (b). Determine the angle of twist and shear stresses in the bar. Take $E = 2 \times 10^5 \text{ N/mm}^2$ and $G = 7 \times 10^4 \text{ N/mm}^2$. (10 Marks)

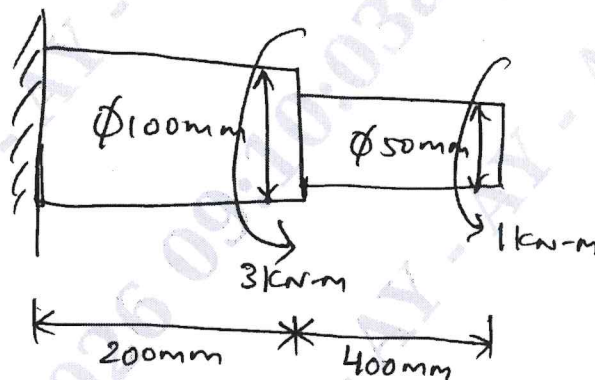


Fig. Q6 (b)

Module-4

- 7 a. With usual notations, derive the differential equation for 1-D heat conduction body. (10 Marks)
 b. Determine the temperature distribution in the rectangular fin as shown in Fig. Q7 (b). Assume steady state and only conduction process. Take heat generated inside the fin as 400 W/m^3 . (10 Marks)

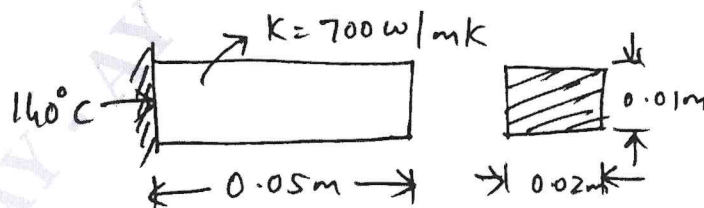


Fig. Q7 (b)

OR

- 8 For the smooth pipe shown in Fig. Q8 with uniform C/S of 1 m^2 , determine the flow velocities at the centre and right end, knowing the velocity at the left is $V_x = 2 \text{ m/sec}$.

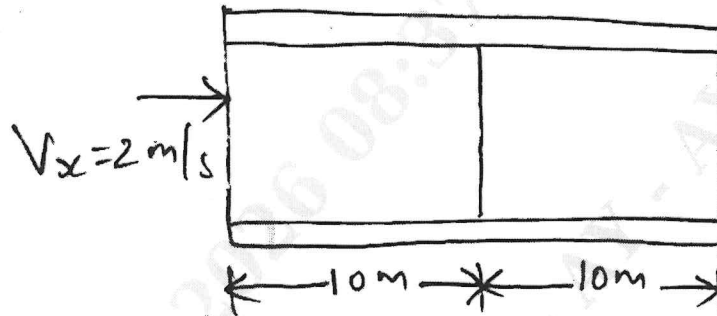


Fig. Q8

(20 Marks)

Module-5

- 9 a. Derive an expression for the body force vector of an axi-symmetric solid element. (10 Marks)
 b. Evaluate the nodal forces used to replace the linearly varying surface traction shown in Fig. Q9 (b). (10 Marks)

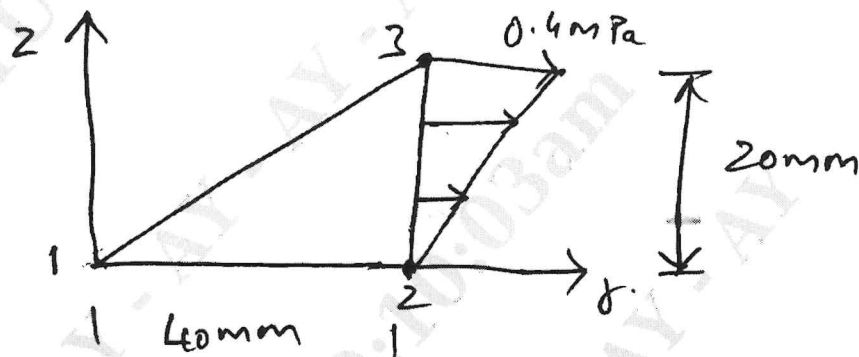


Fig. Q9 (b)

OR

- 10 a. Derive an equation for lumped matrix for 1D bar element. (10 Marks)
 b. Evaluate Eigen value of longitudinal vibration of the constrained uniform bar shown in Fig. Q10 (b). Take minimum two elements. Take $E = 210 \text{ GPa}$ and $\delta = 7860 \text{ kg/m}^3$. (10 Marks)

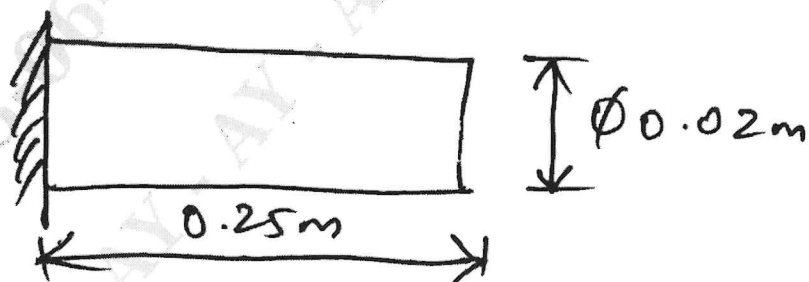


Fig. Q10 (b)
