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CBCS SCHEME

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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.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

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)**

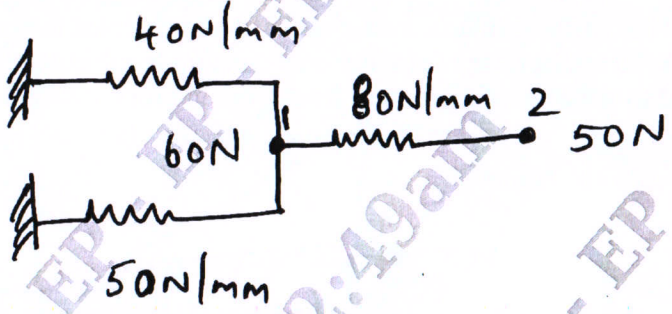


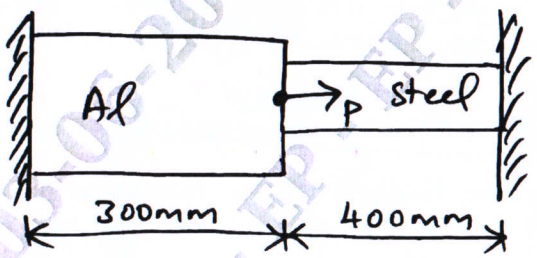
Fig. Q2 (a)

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)**



$E_{al} = 70 \times 10^9\ N/m^2$ $E_{st} = 200 \times 10^9\ N/m^2$

$A_{al} = 2400mm^2$ $A_{st} = 600mm^2$

$P = 200\ kN$

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)**

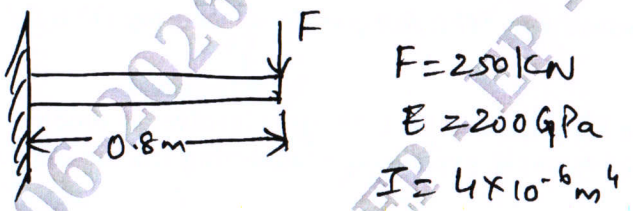


Fig. Q5 (b)

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 $E = 2\times10^5$ N/mm^2 and $G = 7\times10^4$ N/mm^2. **(10 Marks)**

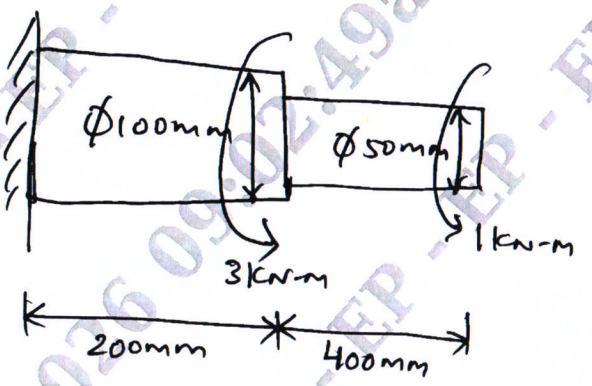


Fig. Q6 (b)

Module-4

7 a. With usual notations, derive the differential equation for 1-D heat conduction body. **(10 Marks)**

b. Determine the temperature distribution is 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)**

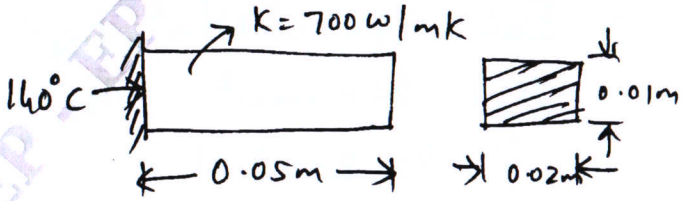


Fig. Q7 (b)

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 $V_x = 2$ m/sec.

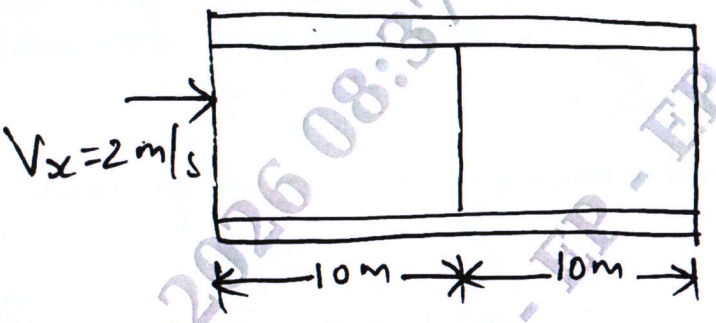


Fig. Q8 **(20 Marks)**

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)**

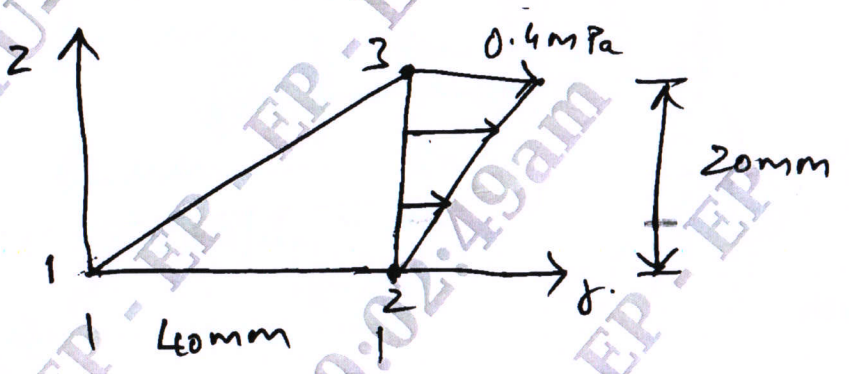


Fig. Q9 (b)

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 GPa and $\delta = 7860$ kg/m^3. **(10 Marks)**

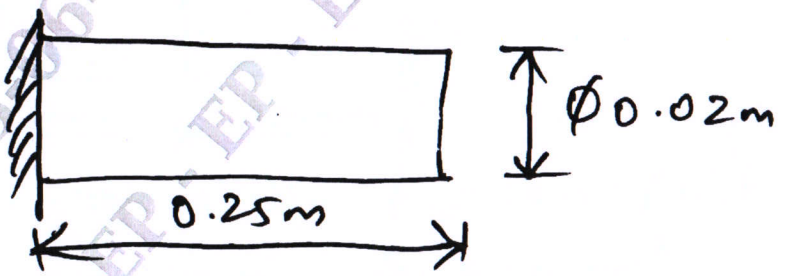


Fig. Q10 (b)

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