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21ME53

Fifth Semester B.E./B.Tech. Degree Examination, June/July 2025
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. Explain the basic steps involved in Finite Element Method. **(10 Marks)**

b. What are the advantages and disadvantages of Finite Element Method? **(10 Marks)**

OR

2 a. Explain plane stress and plane strain conditions. **(10 Marks)**

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

Module-2

3 a. Derive shape functions for 1D quadratic bar elements in natural coordinates. **(10 Marks)**

b. Derive shape functions for constant strain triangle in natural coordinates. **(10 Marks)**

OR

4 For the stepped bar shown in Fig.Q.4. Determine the nodal displacement and stressed at each node. **(20 Marks)**

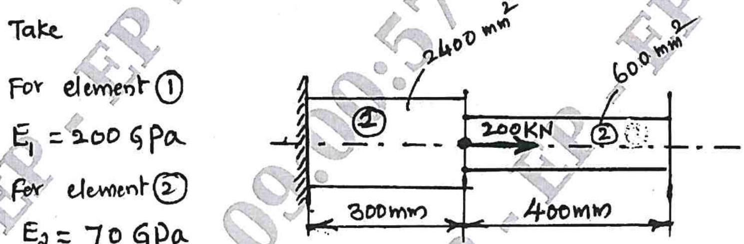

Fig.Q.4

Module-3

5 a. Derive H_1 and H_2 Hermite shape functions for beam elements. **(10 Marks)**

b. A cantilever beam subjected to point load of 250 kN as shown in Fig.Q.5(b). Determine the deflection at free end. Take E = 200 GPa, $I = 4 \times 10^6$ mm^4. **(10 Marks)**

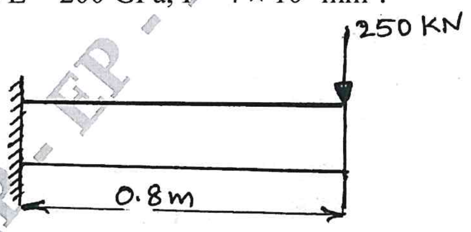

Fig.Q.5(b)

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.

OR

6 a. Derive stiffness matrix equation for torsion of shaft. **(10 Marks)**

b. For the circular stepped shaft shown in Fig.Q.6(b). Determine stresses and angle of twist. Take : E = 200 GPa , G = 70 GPa **(10 Marks)**

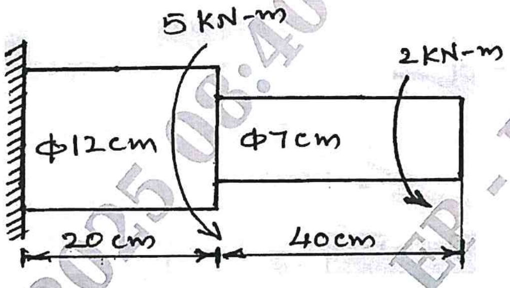

Fig.Q.6(b)

Module-4

7 a. Derive stiffness matrix or conductivity matrix for 1-D bar element. **(08 Marks)**

b. Determine the temperature distribution in the rectangular fin as shown in Fig.Q.7(b). Assume steady state and only conduction process. Take heat generated inside the fin as 400 W/m^2. **(12 Marks)**

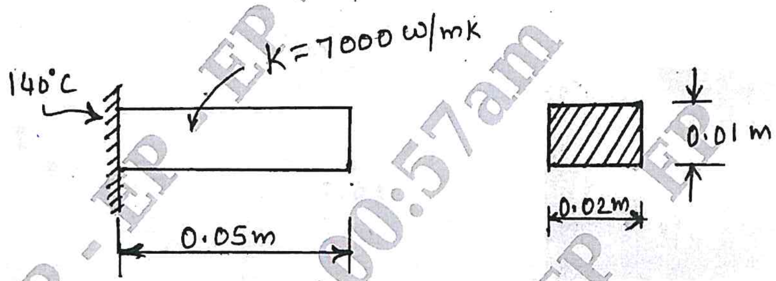

Fig.Q.7(b)

OR

8 For smooth pipe of variable cross section shown in Fig.Q.8. Determine the potential at the junctions, velocities in each section of pipe and volumetric flow rate. Potential at left end P_1 = 10 m^2/s, right end P_u = 1 m^2/s. Fluid flow through the pipe K_x = 1. **(20 Marks)**

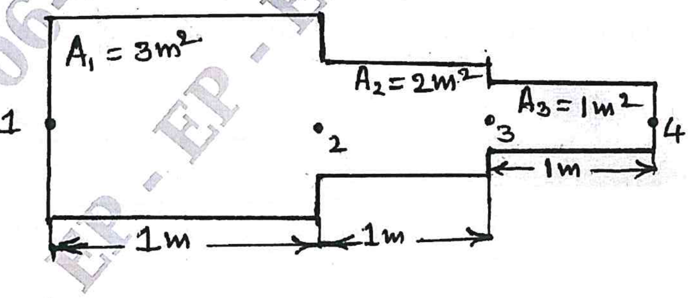

Fig.Q.8

Module-5

9 a. Derive stiffness matrix of axisymmetric bodies with triangular elements. **(12 Marks)**

b. For the element of an axisymmetric body rotating with a constant angular velocity w = 1000 rev/min as shown in Fig.Q.9(b). Determine the body force vector, include the weight of the material, where the specific density is 7850 kg/m^3. **(08 Marks)**

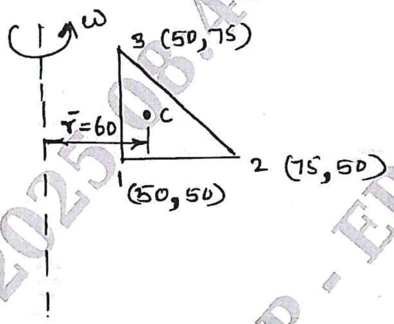

Fig.Q.9(b)

OR

10 a. Derive the consistent mass matrix for 1-D bar element. **(10 Marks)**

b. Evaluate eigen values of longitudinal vibration of the constrained uniform circular bar shown in Fig.Q.10(b). Take minimum two elements and E = 210 GPa and ρ = 7860 kg/m^3. **(10 Marks)**

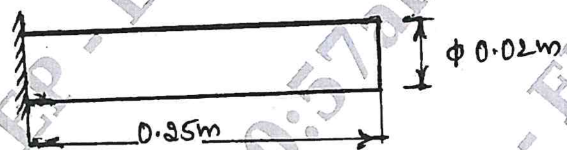

Fig.Q.10(b)

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