CBCS SCHEME

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21ME53

Fifth Semester B.E./B.Tech. Degree Examination, Dec.2024/Jan.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 steps involved in finite element method to solve engineering problems. **(10 Marks)**

b. With an example, explain node numbering scheme and node location system. **(10 Marks)**

OR

2 a. Explain simplex, complex and multiplex elements with examples. **(10 Marks)**

b. Determine the displacement at the nodes for spring mass system shown in Fig Q2(b), using principle of minimum potential energy. Take $F_1 = 60$ N, $F_2 = 50$ N. **(10 Marks)**

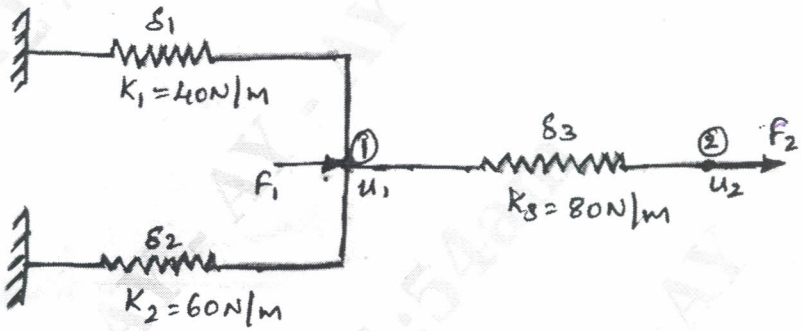


Fig Q2(b)

Module-2

3 a. Derive the elemental stiffness matrix for 1D bar element. **(10 Marks)**

b. For the two bar truss shown in Fig Q3(b), determine the nodal displacement and stress in element 1, Take, $E = 2 \times 10^5$ N/mm^2, $A = 200$ mm^2.

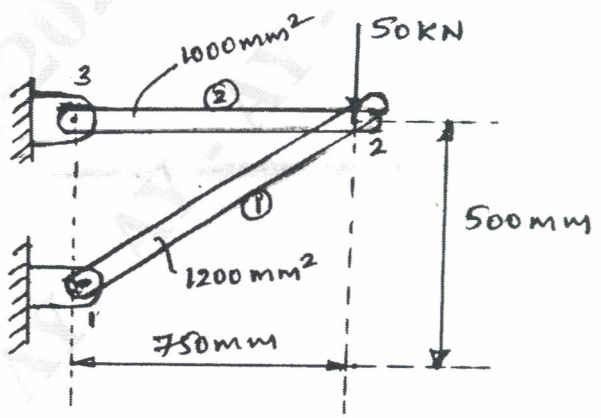
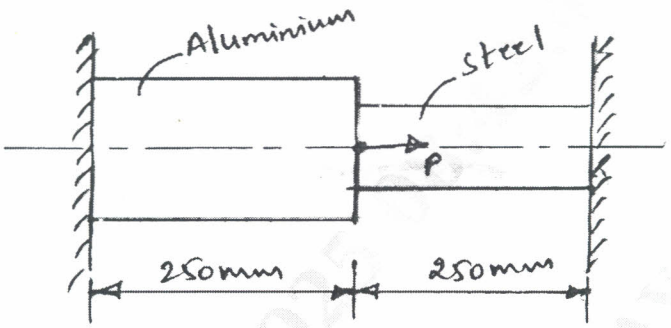


Fig Q3(b) **(10 Marks)**

OR

4 Determine the stresses in members of structure given below in Fig Q4, using penalty approach of handling boundary conditions.



Given/Take

$P = 4000$ N
$A_1 = 1600$ mm^2
$A_2 = 800$ mm^2
$E_{Al} = 80$ GPa
$E_{steel} = 210$ GPa

Fig Q4

(20 Marks)

Module-3

5 a. Derive Hermite shape function for beam element. **(10 Marks)**

b. Fig Q5(b), shows a simply supported beam subjected to a uniformly distributed load. Obtain the maximum deflection. Take E = 200 GPa, I = 2×10^6 mm^4.

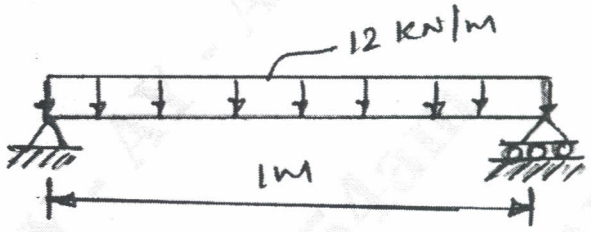


Fig Q5(b) **(10 Marks)**

OR

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

b. A bar of circular cross section having a diameter of 50 mm is firmly fixed at its ends and subjected to a torque at B and C as shown in Fig Q6(b). Determine maximum angle of twist and shear stress. Take G = 7×10^4 N/mm^2 and E = 2×10^5 N/mm^2.

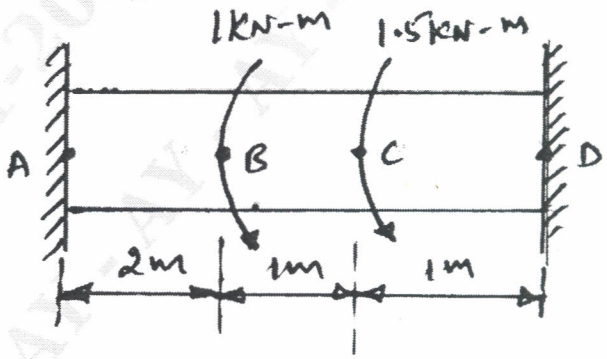


Fig Q6(b) **(10 Marks)**

Module-4

7 Determine the temperature distribution in the composite wall using 1D heat element, use penalty approach of handing boundary condition.
Take : $K_1 = 25$ W/m°C, $K_2 = 35$ W/m°C, $K_3 = 55$ W/m°C, $h = 30$ W/m^2 °C, $T_\infty = 900$°C, $A = 1m^2$.

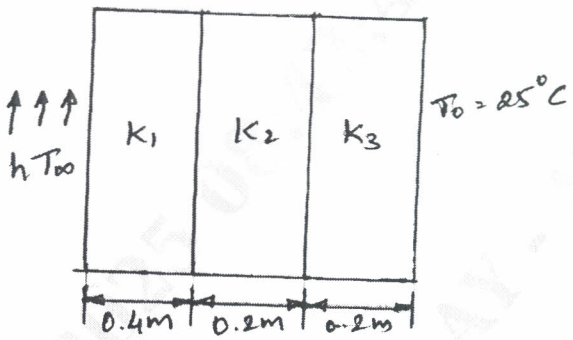


Fig Q7 **(20 Marks)**

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/s.

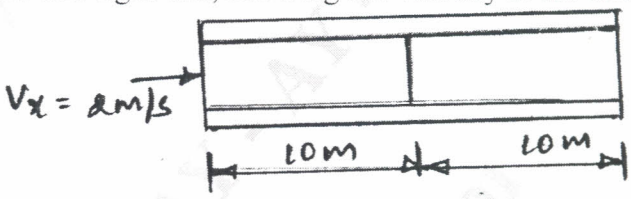


Fig Q8 **(20 Marks)**

Module-5

9 a. Derive stiffness matrix of axi-symmetric bodies with triangular elements. **(10 Marks)**

b. For the element of an axisymmetric body rotating with a constant angular velocity W = 1000 rev/min as show in Fig Q9(b). Determine the body force vector. Include the weight of the material, where the specific density is 7850 Kg/m^3.

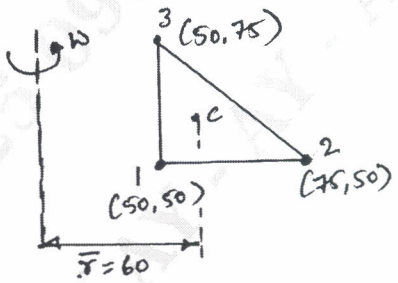


Fig Q9(b) **(10 Marks)**

OR

10 a. Derive an equation for lumped mass matrix for 1D bar element. **(10 Marks)**

b. Determine the natural frequency of vibration of the cantilever beam shown in Fig Q10(b). Take E = 200 GPa, $\rho = 7840$ Kg/m^3, $I = 2000$ mm^4, $A = 240$ mm^2. **(10 Marks)**

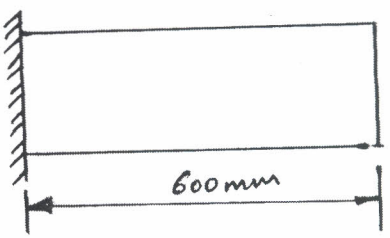


Fig Q10(b)