CBCS SCHEME

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18ME61

Sixth Semester B.E. Degree Examination, June/July 2023
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. Define FEM. List the advantages and disadvantages of FEM. **(10 Marks)**

b. List and explain steps in FEM. **(10 Marks)**

OR

2 a. Explain simplex, complex and multiplex elements. **(06 Marks)**

b. A cantilever beam of span 'L' is subjected to a point load at its free end as shown in Fig.Q2(b). Derive an equation for the deflection at free end by using RR method. Assume polynomial displacement function.

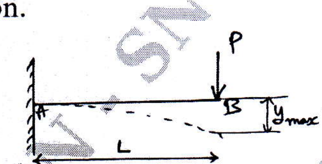

Fig.Q2(b) **(14 Marks)**

Module-2

3 a. Derive the element stiffness matrix of 1D bar element. **(08 Marks)**

b. Using penalty method of handling boundary condition, determine the nodal displacement, stress in each element and support reaction in the bar shown due to applied load in Fig.Q3(b). P = 100 kN.

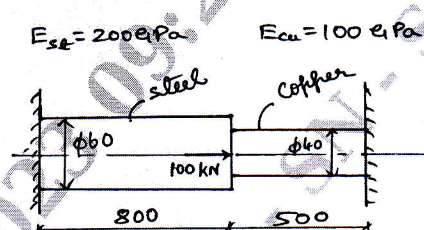

Fig.Q3(b) **(12 Marks)**

OR

4 a. List the assumptions made in Truss. **(04 Marks)**

b. A 4 bar truss element is shown in Fig.Q4(b). Determine the following:

i) Nodal displacement ii) Stress in each element iii) Reaction at supports.

Area of each truss element = 100 mm^2 ; E = 2×10^5 N/mm^2.

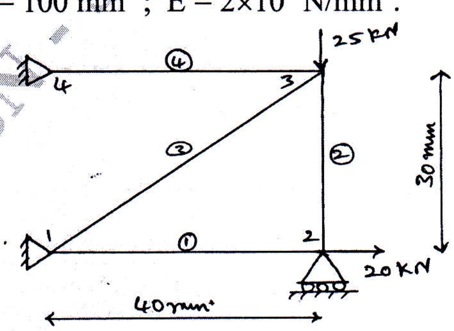

Fig.Q4(b) **(16 Marks)**

Module-3

5 a. Derive the Hermite shape function of a Beam element. **(08 Marks)**

b. For the beam shown in Fig.Q5(b), determine the displacement at node 2 and internal loads. Take E = 210 GPa, b = 0.2 m ; h = 0.4 m.

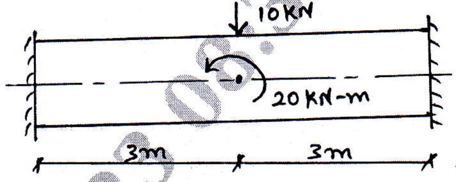

Fig.Q5(b) **(12 Marks)**

OR

6 a. Derive the stiffness matrix for the torsion of shafts. **(08 Marks)**

b. A solid stepped bar of circular cross section shown in Fig.Q6(b) is subjected to a torque of 1 kN-m at its free end and a torque of 3 kN-m at its change in c/s. Determine the angle of twist and shear stresses in the bar. Take E = 2×10^5 N/mm^2 and G = 7×10^4 N/mm^2.

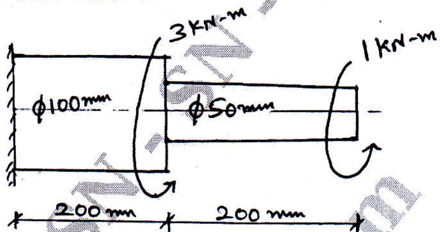

Fig.Q6(b) **(12 Marks)**

Module-4

7 a. Derive the governing differential equation for 1-D heat conduction. **(06 Marks)**

b. Determine the temperature distribution in the composite wall using 1D heat elements, use penalty approach of handling BC's. Refer Fig.Q7(b).

Given :

k_1 = 20 W/m °C
k_2 = 30 W/m °C
k_3 = 55 W/m °C
h = 30 W/m^2 C
T_∞ = 900°C
A = Unit area

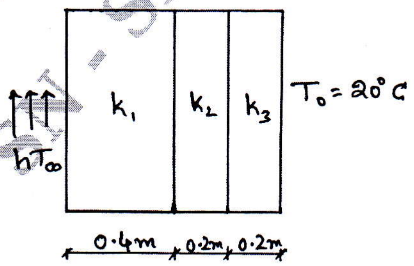

Fig.Q7(b) **(14 Marks)**

OR

8 a. Derive the element stiffness matrix of 1-D fluid flow element. **(06 Marks)**

b. For the smooth pipe of variable cross-section shown in Fig.Q8(b), determine the potential at the junction, the velocities in each section of pipe and the volumetric flow rate. The potential at left end is P_1 = 10 m^2/s and at right end is P_4 = 1 m^2/s. For the fluid flow through a smooth pipe k_x = 1.

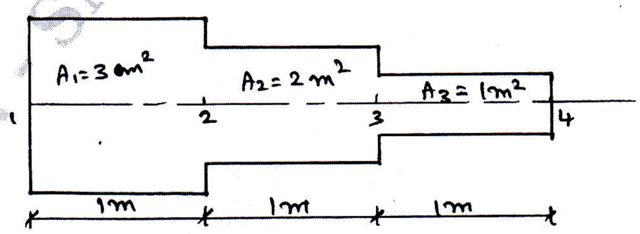

Fig.Q8(b) **(14 Marks)**

Module-5

9 a. Derive the element stiffness matrix of a triangular axisymmetric element using potential energy approach. **(06 Marks)**

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

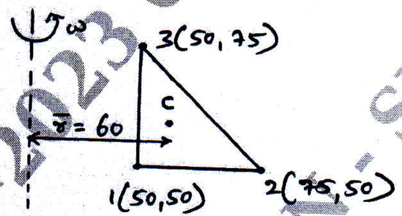

Fig.Q9(b) **(14 Marks)**

OR

10 a. Derive an expression of element mass matrices of
(i) 1-D bar element
(ii) Truss element **(10 Marks)**

b. Evaluate eigen value and eigen vector of longitudinal vibration of the constrained uniform circular bar shown in Fig.Q10(b). Take minimum two elements. Take E = 210 GPa and ρ = 7860 kg/m^3.

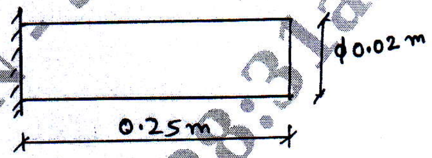

Fig.Q10(b) **(10 Marks)**

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