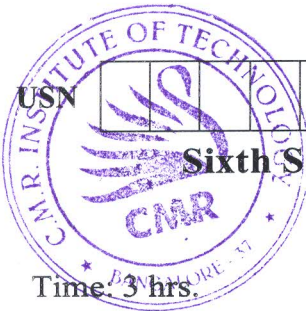


CBCS SCHEME



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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.

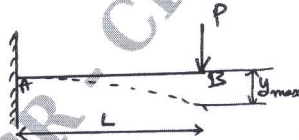


Fig.Q2(b)

(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). $P = 100 \text{ kN}$.

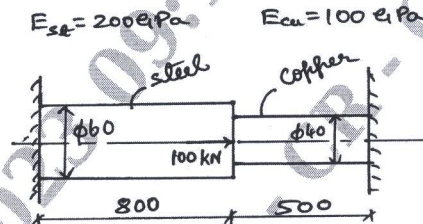


Fig.Q3(b)

(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 ; $E = 2 \times 10^5 \text{ N/mm}^2$.

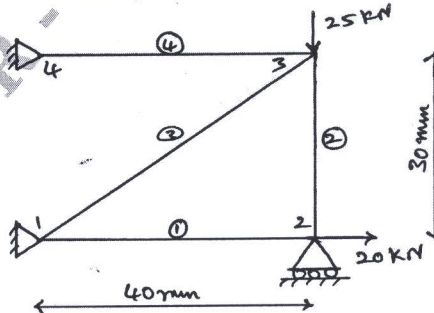


Fig.Q4(b)

(16 Marks)

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-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 $E = 210 \text{ GPa}$, $b = 0.2 \text{ m}$; $h = 0.4 \text{ m}$.

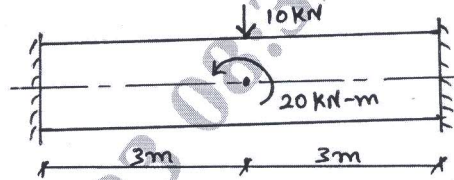


Fig.Q5(b)

(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 $E = 2 \times 10^5 \text{ N/mm}^2$ and $G = 7 \times 10^4 \text{ N/mm}^2$.

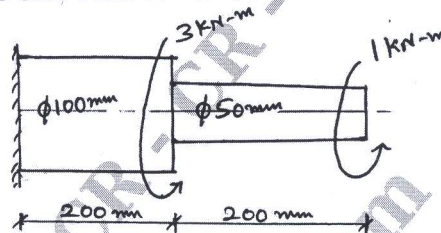


Fig.Q6(b)

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(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 :

- $k_1 = 20 \text{ W/m } ^\circ\text{C}$
- $k_2 = 30 \text{ W/m } ^\circ\text{C}$
- $k_3 = 55 \text{ W/m } ^\circ\text{C}$
- $h = 30 \text{ W/m}^2 \text{ } ^\circ\text{C}$
- $T_\infty = 900^\circ\text{C}$
- $A = \text{Unit area}$

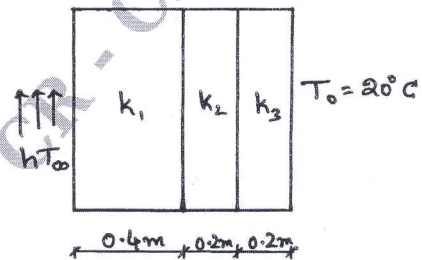


Fig.Q7(b)

(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 $P_1 = 10 \text{ m}^2/\text{s}$ and at right end is $P_4 = 1 \text{ m}^2/\text{s}$. For the fluid flow through a smooth pipe $k_x = 1$.

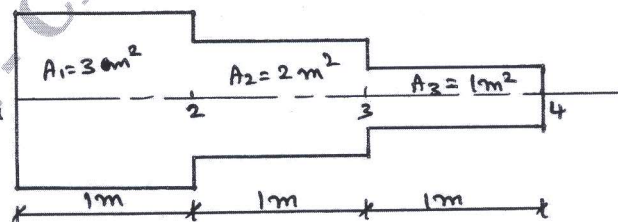
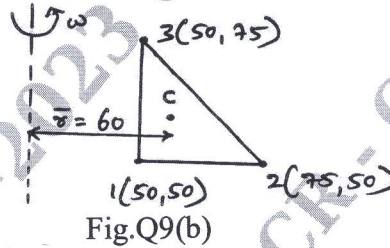


Fig.Q8(b)

(14 Marks)

Module-5

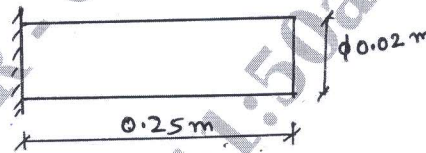
- 9 a. Derive the element stiffness matrix of a triangular axisymmetric element using potential energy approach. (06 Marks)
- b. For the element of an axisymmetric body rotating with constant angular velocity $\omega = 1000$ rev/min as shown in Fig.Q9(b). Determine the body force vector. Include the weight of the material, where specific density is 7850 kg/m^3 .



(14 Marks)

OR

- 10 a. Derive an expression of element mass matrices of
 (i) 1-D bar element
 (ii) Truss element
- 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 $E = 210 \text{ GPa}$ and $\rho = 7860 \text{ kg/m}^3$.



(10 Marks)
