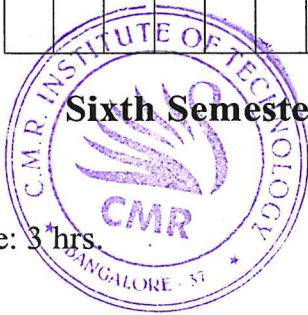


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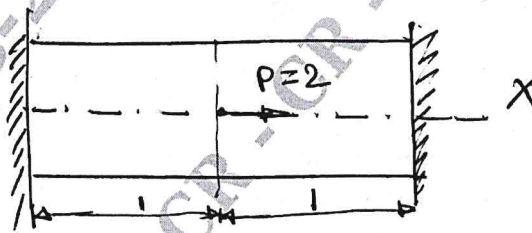
Sixth Semester B.E. Degree Examination, July/August 2021 Finite Element Analysis

Time: 3 hrs.

Max. Marks: 80

Note: Answer any FIVE full questions.

1.
 - a. Explain the basic steps in the finite element methods. (06 Marks)
 - b. State principle of minimum potential energy. (02 Marks)
 - c. Fig.Q1(c) shows a bar fixed at both ends subjected to an axial load as indicated. Determine the displacement at loading point using Rayleigh-Ritz method.



$E = 1, A = 1$
Fig.Q1(c)

(08 Marks)

2.
 - a. Explain the plane stress and plane strain problems with examples. (05 Marks)
 - b. Using principle of minimum potential energy determine the displacement at the nodes for a spring system shown in Fig.Q2(b). Take $K_1 = 40 \text{ N/m}$, $K_2 = 60 \text{ N/m}$, $K_3 = 80 \text{ N/m}$, $F_1 = 60 \text{ N}$, $F_2 = 50 \text{ N}$.

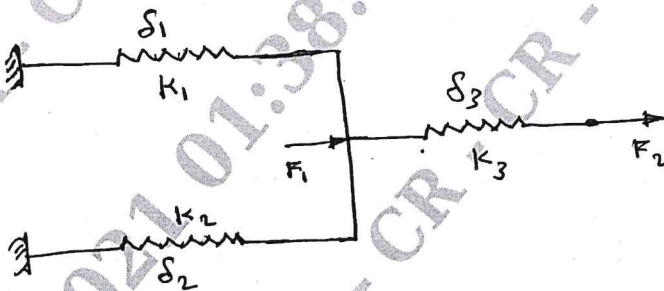
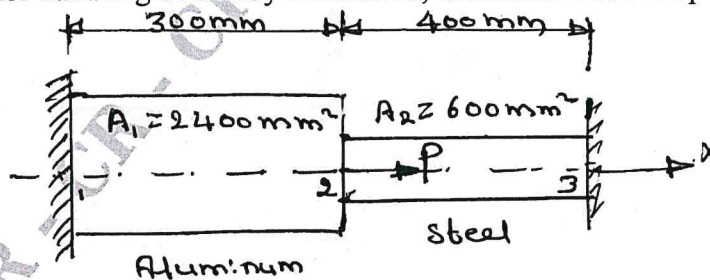


Fig.Q2(b)

(08 Marks)

- c. State and explain the convergence requirement for the finite element solution. (03 Marks)

3.
 - a. The bar shown in Fig.Q3(a), an axial load $P = 200 \times 10^3 \text{ N}$ is applied as shown, using the penalty approach for handling boundary conditions, determine nodal displacements.



$E_1 = 70 \times 10^9 \text{ N/m}^2, E_2 = 200 \times 10^9 \text{ N/m}^2$

Fig.Q3(a)

(10 Marks)

- b. Derive shape functions for CST element. (06 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.

- 4 a. Explain briefly the iso-parametric, sub parametric and super-parametric elements. (06 Marks)
 b. For the two bar truss shown in Fig.Q4(b), determine nodal displacements element. Take $E = 200 \text{ GPa}$, area of each bar = 1000 mm^2

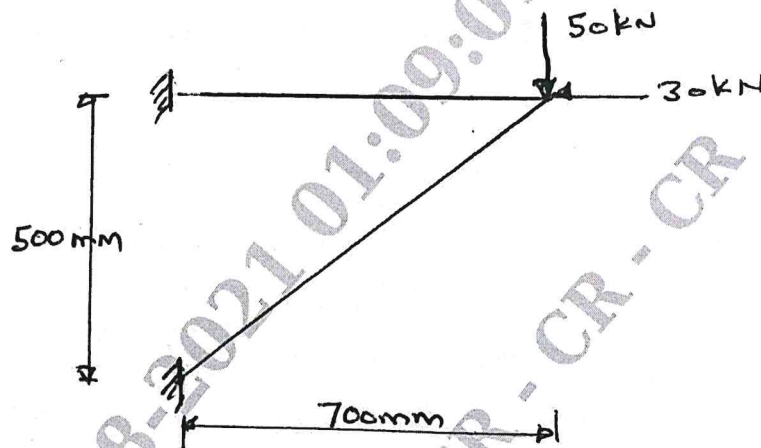


Fig.Q4(b)

(10 Marks)

- 5 a. Derive Hermit shape function for beam element. (06 Marks)
 b. For the beam and loading shown in Fig.Q5(b), determine the slopes at 2 and 3 and the vertical deflection at the midpoint of the distributed load. Take $E = 200 \text{ GPa}$, $I = 4 \times 10^6 \text{ mm}^4$.

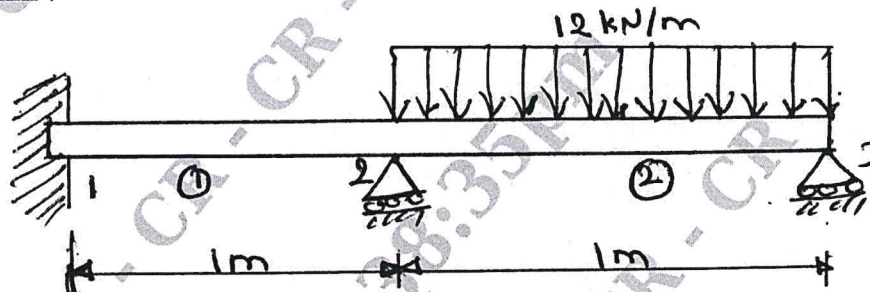


Fig.Q5(b)

(10 Marks)

- 6 a. Derive stiffness matrix for the beam element. (06 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 stresses. Take $G = 7 \times 10^4 \text{ N/mm}^2$ and $E = 2 \times 10^5 \text{ N/mm}^2$.

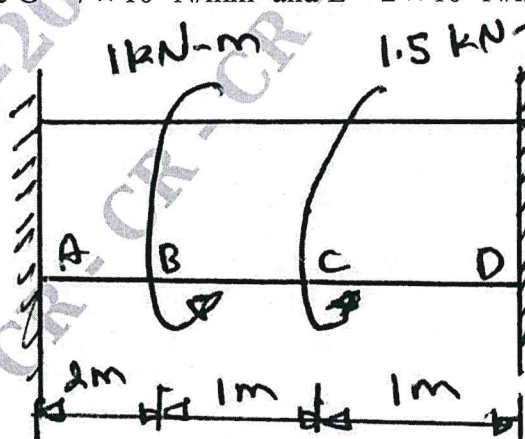


Fig.Q6(b)

(10 Marks)

- 7 a. Discuss the Galerkin approach for 1-D heat conduction problem. (06 Marks)
 b. A composite wall consists of three materials, as shown in Fig.Q7(b). The outer temperature is $T_0 = 20^\circ\text{C}$. Convection heat transfer takes place on the inner surface of the wall with $T_\infty = 800^\circ\text{C}$ and $h = 25 \text{ W/m}^2$. Determine temperature distribution in the wall.

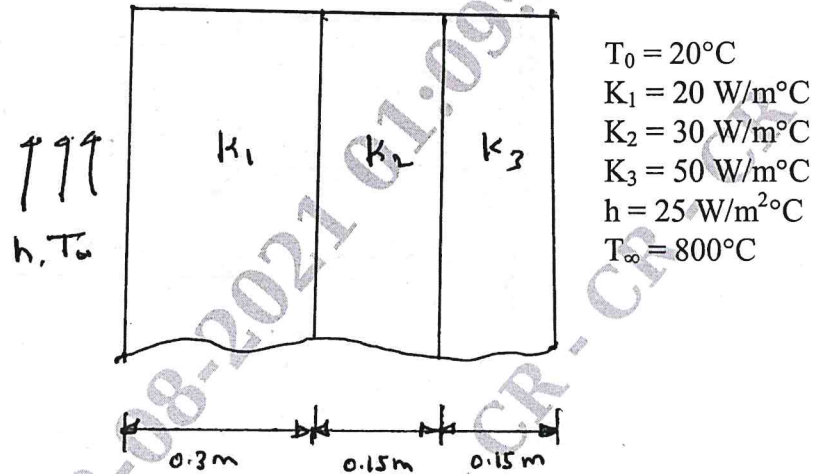


Fig.Q7(b)

(10 Marks)

- 8 a. Derive the stiffness matrix for one dimensional fluid element. (06 Marks)
 b. For the smooth pipe shown in Fig.Q8(b) with uniform cross section of 1 m^2 , determine the flow velocities at the centre and right end, knowing the velocity at the left is $V_x = 2 \text{ m/sec}$.

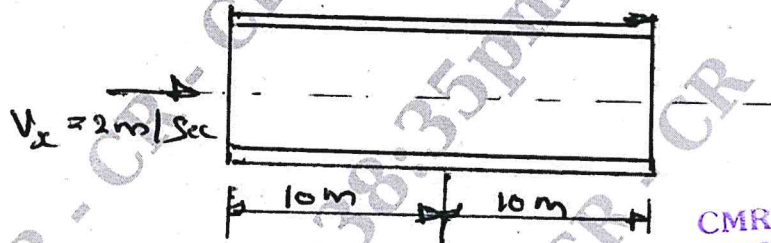


Fig.Q8(b)

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(10 Marks)

- 9 In Fig.Q9, a long cylinder of inside diameter 80 mm and outside diameter 120 mm snugly fits in a hole over its length. The cylinder is then subjected to an internal pressure 2 MPa. Using two elements on the 10 mm length, find the displacements at the inner radius. Take $E = 200 \text{ GPa}$, $\nu = 0.3$.

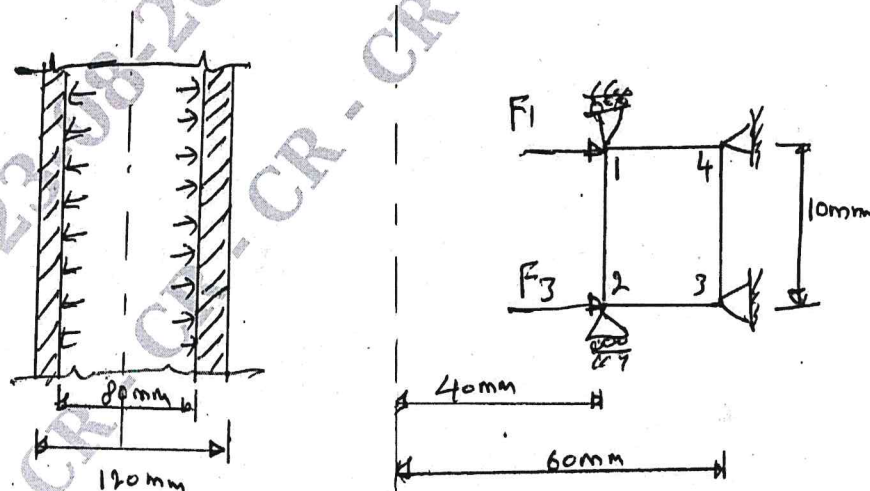


Fig.Q9

(16 Marks)

- 10 Evaluate eigen vectors and eigen values for the stepped bar shown in Fig.Q10. Take $E = 200 \text{ GPa}$ specific weight 7850 kg/m^3 . Draw mode shapes. Take $A_1 = 400 \text{ mm}^2$ and $A_2 = 200 \text{ mm}^2$.

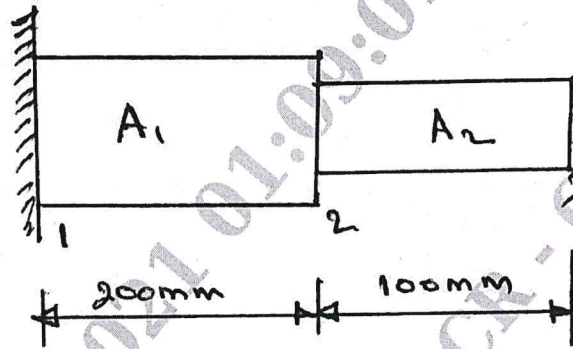


Fig.Q10

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(16 Marks)