CBCS SCHEME

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15ME61

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

Time: 3 hrs. Max. Marks: 80

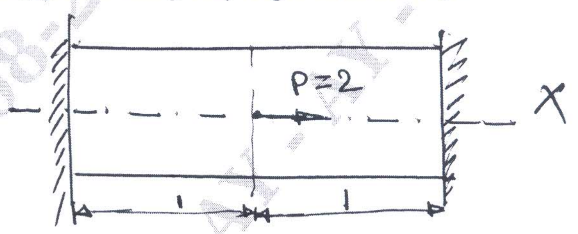
Note: Answer any FIVE full questions.

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.

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 $K_1 = 40$ N/m, $K_2 = 60$ N/m, $K_3 = 80$ N/m, $F_1 = 60$ N, $F_2 = 50$ N.

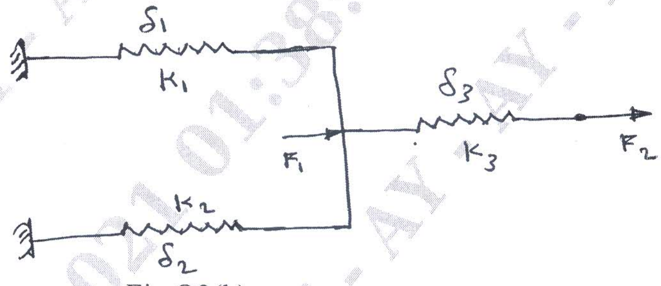
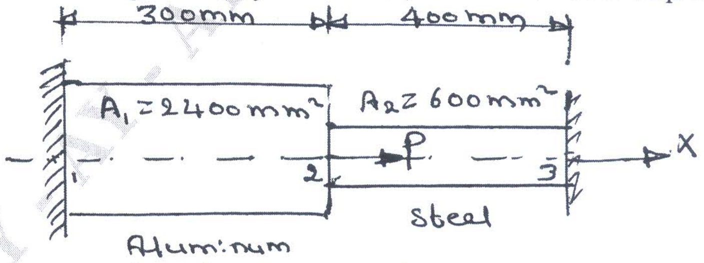


Fig.Q2(b) **(08 Marks)**

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 $P = 200 \times 10^3$ N is applied as shown, using the penalty approach for handling boundary conditions, determine nodal displacements.



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

Fig.Q3(a) **(10 Marks)**

b. Derive shape functions for CST element. **(06 Marks)**

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 GPa, area of each bar = 1000 mm^2

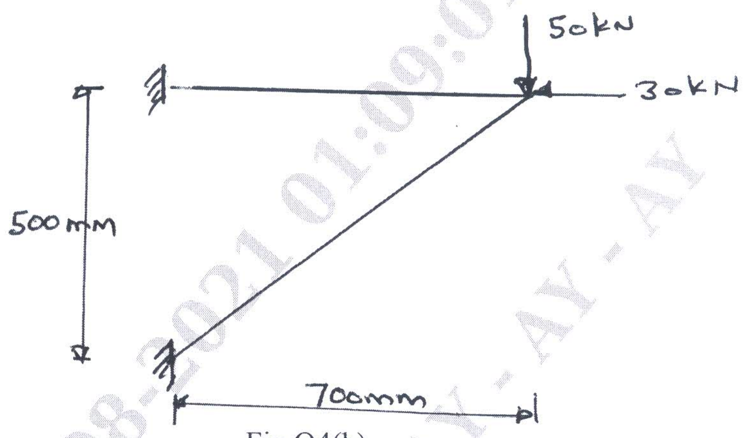


Fig.Q4(b) **(10 Marks)**

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 GPa, $I = 4 \times 10^6$ mm^4.

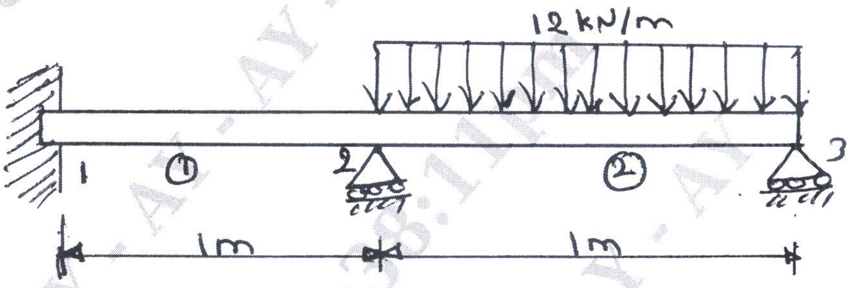


Fig.Q5(b) **(10 Marks)**

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

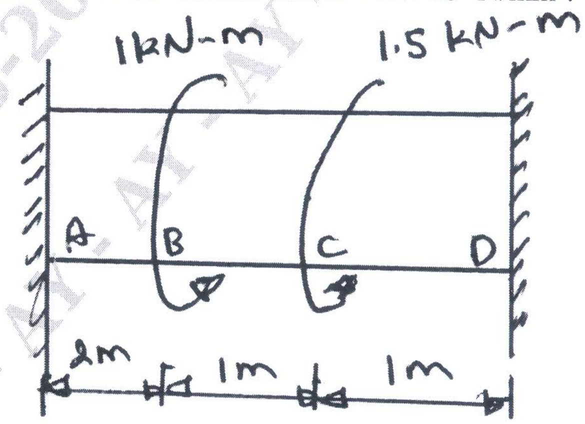
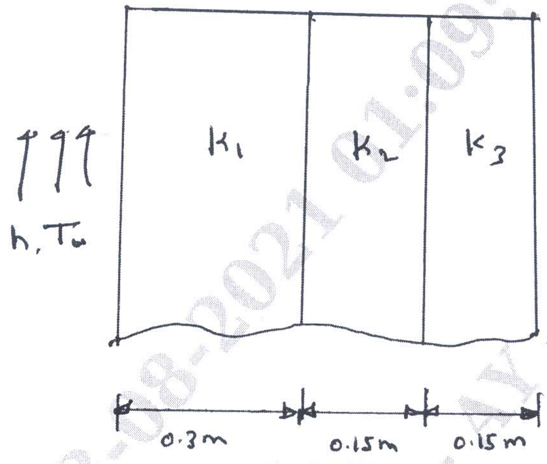


Fig.Q6(b) **(10 Marks)**

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 $T_0 = 20°C$. Convection head transfer takes place on the inner surface of the wall with $T_\infty = 800°C$ and $h = 25\ W/m^2$. Determine temperature distribution in the wall.



$T_0 = 20°C$
$K_1 = 20\ W/m°C$
$K_2 = 30\ W/m°C$
$K_3 = 50\ W/m°C$
$h = 25\ W/m^2°C$
$T_\infty = 800°C$

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 $V_x = 2$ m/sec.

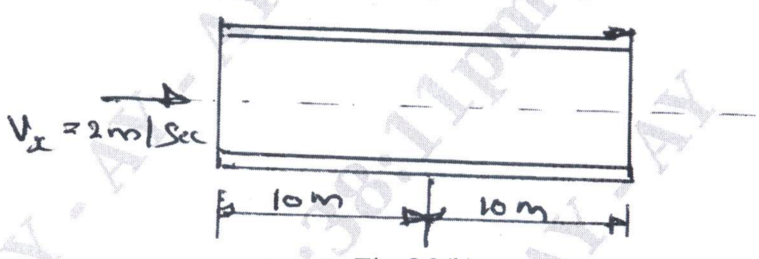


Fig.Q8(b) **(10 Marks)**

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 GPa, $\gamma = 0.3$.

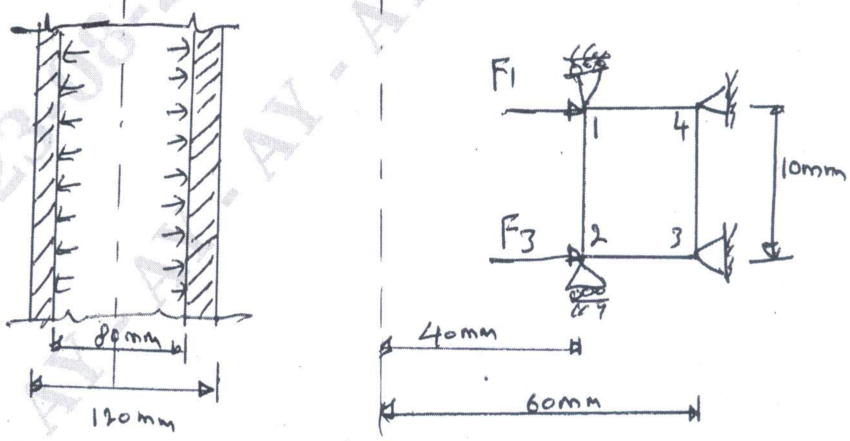


Fig.Q9 **(16 Marks)**

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

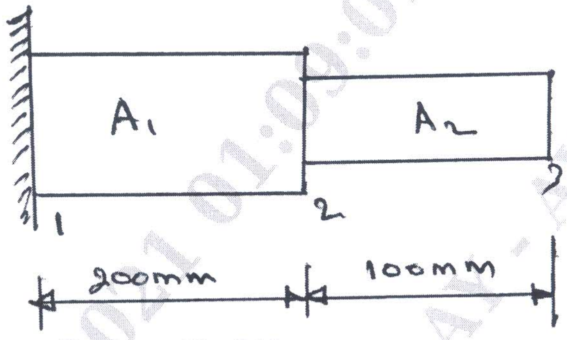


Fig.Q10

(16 Marks)

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