CBCS SCHEME

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18ME61

Sixth Semester B.E. Degree Examination, Feb./Mar. 2022
Finite Element Method

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 basic steps involved in FEM. **(10 Marks)**
b. State the principle of minimum potential energy. **(02 Marks)**
c. Explain with sketches, plane strain and plane stress. **(08 Marks)**

OR

2 a. Explain simplex, complex and multiplex elements. **(06 Marks)**
b. Use Rayleigh-Ritz method to find the stress and displacement at loading point of a bar shown in Fig.Q2(b). Take E = 70 GPa, A = 100 mm^2.

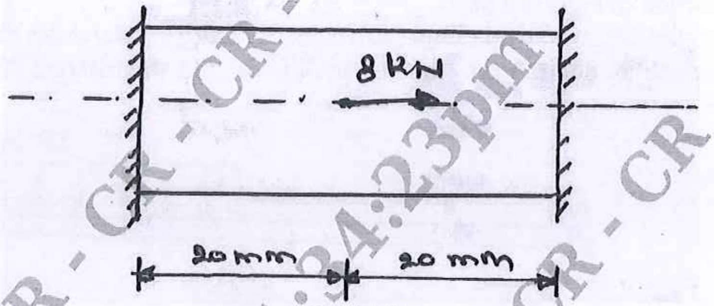

Fig.Q2(b) **(12 Marks)**

c. List the advantages of the finite element method. **(02 Marks)**

Module-2

3 a. Derive shape function for a two noded bar element. **(08 Marks)**
b. Derive the strain-displacement matrix [B] for a CST element. **(12 Marks)**

OR

4 a. Determine the nodal displacements and the stresses in each element in the bar shown in Fig.Q4(a). Take E_{Al} = 70 GPa, E_{Steel} = 210 GPa, P = 12 kN.

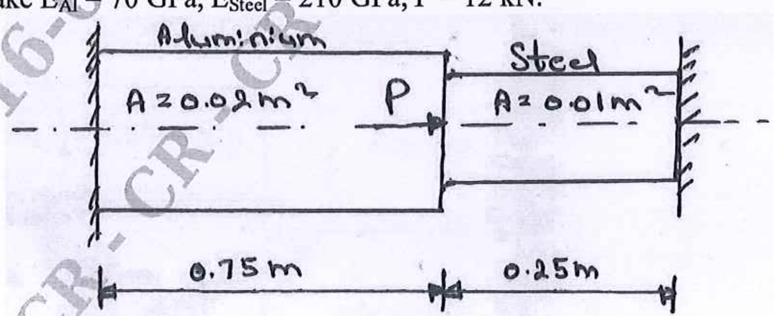

Fig.Q4(a) **(10 Marks)**

b. For the two bar truss shown in Fig.Q4(b). Determine the nodal displacement, stress in each element. Take $A = 200\ mm^2$, $E = 2 \times 10^5\ N/mm^2$.

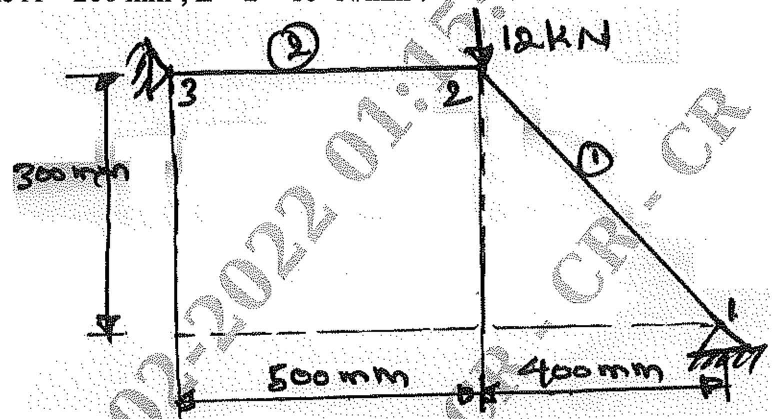

Fig.Q4(b) **(10 Marks)**

Module-3

5 a. Derive Hermite shape function of a beam element and show the variation of the shape function over the element. **(10 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, $I = 4 \times 10^6\ mm^4$.

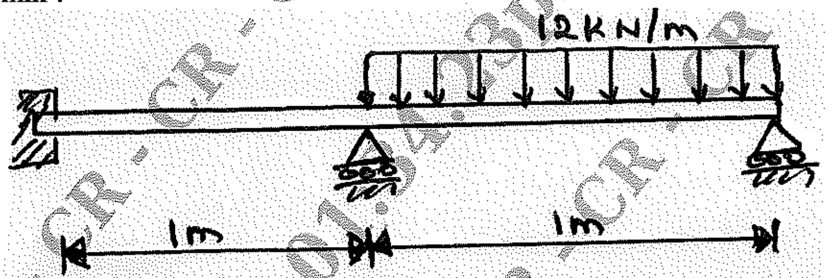

Fig.Q5(b) **(10 Marks)**

OR

6 a. Derive the stiffness matrix for beam elements. **(10 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 torque of 3 kN-m at its change in cross section. Determine the angle of twist and shear stresses in the bar. Take $E = 2 \times 10^5\ N/mm^2$ and $G = 7 \times 10^4\ N/mm^2$.

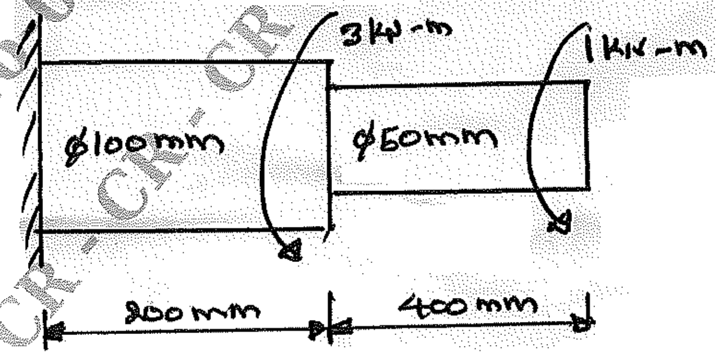

Fig.Q6(b) **(10 Marks)**

Module-4

7 a. Discuss the derivation of one dimensional heat transfer in thin fin. **(08 Marks)**

b. A composite wall consists of three materials as shown in Fig.Q7(b). The outer temperature is $T_0 = 20°C$. Convection heat transfer takes place on the inner surface of the wall with $T_\infty = 800°C$ and $h = 25\ W/m^2°C$. Determine the temperature distribution in the wall. Take $K_1 = 20\ W/m°C$, $K_2 = 30\ W/m°C$, $K_3 = 50\ W/m°C$.

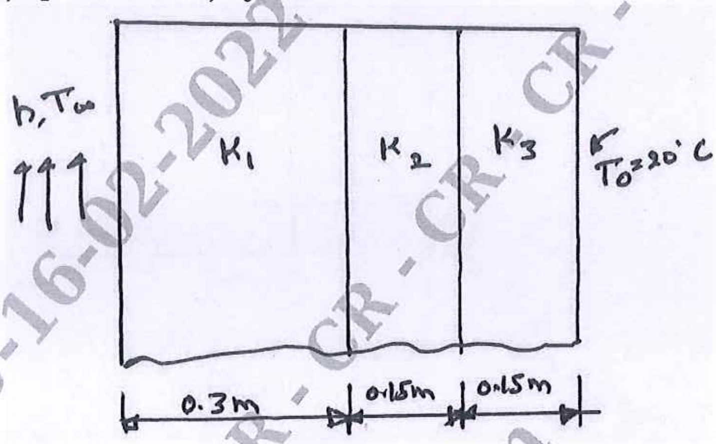

Fig.Q7(b) **(12 Marks)**

OR

8 a. Calculate the temperature distribution in a one dimensional fin with the physical properties given in Fig.Q8(a). There is a uniform generation of heat inside the wall of $\overline{Q} = 400\ W/m^3$. Take $K = 300\ W/m°C$.

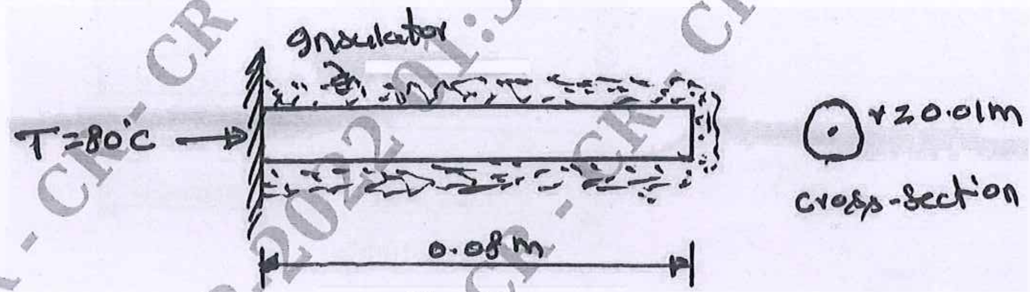

Fig.Q8(a) **(10 Marks)**

b. For the smooth pipe shown in Fig.Q8(b), with uniform cross-section of 1 m^2, determine the flow velocities at the center and right end, knowing the velocity at the left is $V_x = 2$ m/sec.

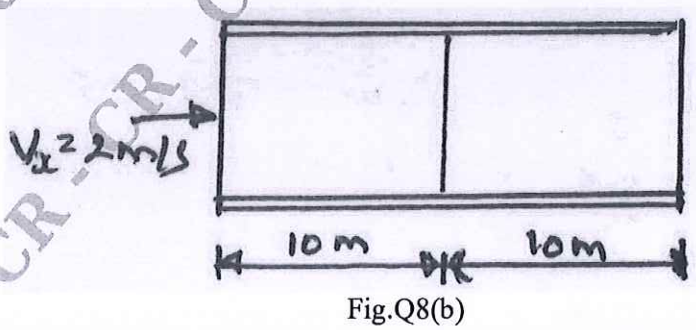

Fig.Q8(b) **(10 Marks)**

Module-5

9 a. Derive the stiffness matrix of axisymmetric bodies with triangular elements. **(12 Marks)**

b. For the element of an axisymmetric body rotating with a 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 the specific density is 7850 kg/m^3.

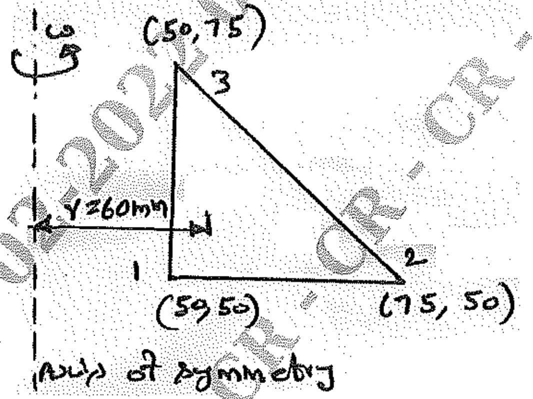

Fig.Q9(b) **(08 Marks)**

OR

10 a. Derive the consistent mass matrix of one dimensional bar element. **(06 Marks)**

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

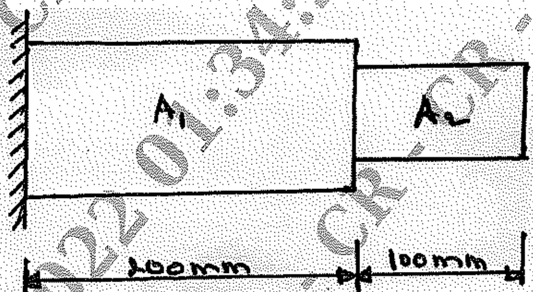

Fig.Q10(b) **(14 Marks)**

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