U.S.N

P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Seventh Semester, B.E. - Mechanical Engineering

Semester End Examination; Jan. / Feb. - 2021

Finite Element Methods in Engineering

Time: 3 hrs Max. Marks: 100

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT - I

1 a. Derive Stress-Strain relationship for plane stress condition. 7

b. List any advantages of finite element methods. 5

c. Using principle of minimum potential energy, determine nodal displacement for spring system shown Fig. 1(c). 8

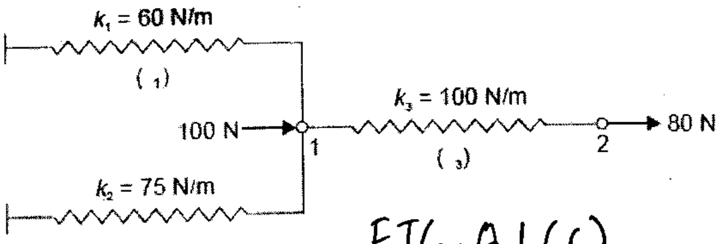

FIG. Q1(c)

2 a. With a neat sketch, explain strain-displacement relations for bar element. 8

b. Briefly explain steps involved in FEM. 12

UNIT - II

3 a. Define Iso parametric, sub parametric and super parametric elements with simple sketches. 8

b. Derive Jacobin (J), Displacement (B) and Strain (ε) matrices for three noded triangular element. 12

4 a. Briefly explain how Geometric Isotropy can be achieved using Pascal's triangle? 7

b. Explain Continuity, Compatability, and Completeness condition for Convergence. 6

c. Derive shape function for linear quadrilateral element by Lagrange method. 7

UNIT - III

5 a. Determine nodal displacements, elements stresses of the axially loaded bar shown in Fig.Q5 (a). Use elimination method to handle boundary conditions. 10

Take; E = 200 GPa and load P = 30 kN.

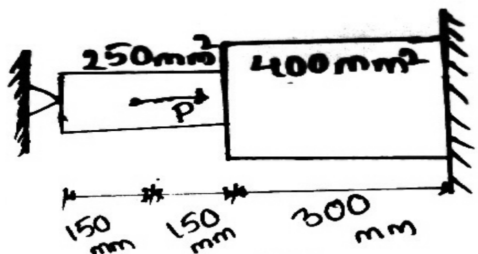

Fig. Q 5.a.

b. For bar shown in Fig Q.5(b) an axial load of 200 kN is applied using penalty approach to resolve boundary condition. Determine; 10

i) Nodal displacement

ii) Reactions of support

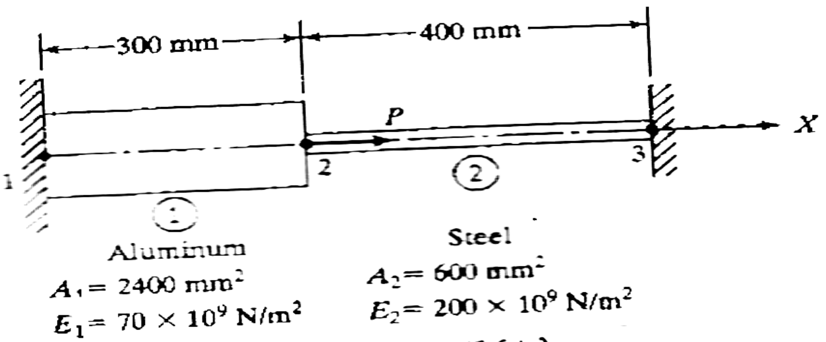

FIG Q5(b)

6 a. Derive expression for load vector for a bar element subjected to body force and traction. 10

b. The thin plate of uniform thickness 20 mm is as shown in Fig. 6(b). In addition to self-weight the plate subjected to a point load of 400 N at mid-point. The Young's modulus $E = 2 \times 10^5\ N/mm^2$ and unit weight $\rho = 0.8 \times 10^{-4}\ N/mm^2$. Analyze plate after modeling it with two elements and find stresses in each element and determine the reaction at support. 10

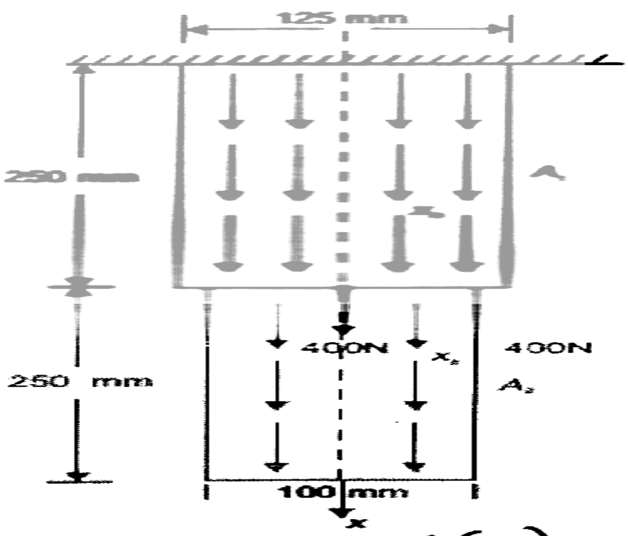

FIG 6(b)

UNIT - IV

7. For three bar truss shown in Fig. Q7, determine the nodal displacements, reactions at support E = 200 GPa. 20

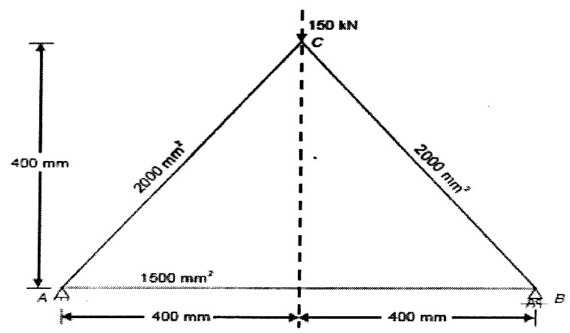

FIG. Q7

8. For the two bar truss elements shown in Fig. Q(8), determine displacement, stresses in each element axial force. P = 1000 kN is applied at node 1. While node 1 settles an amount $\delta = 50$ mm in negative direction. Take E = 210 GPa. A = 6×10^{-4} m^2 for each element. 20

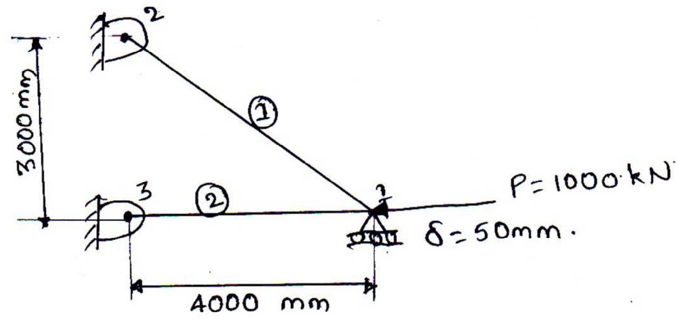

Fig. Q(8)

UNIT - V

9. A beam of length 10 m fixed at one end and supported by a roller at the other end carries a 20 kN concentrated load at the centre of the span by taking the modules of elasticity of material as 200 GPa and moment of inertia as 24×10^{-6} m^4. Determine;

   i) Deflection under load

   ii) Reactions at supports 20

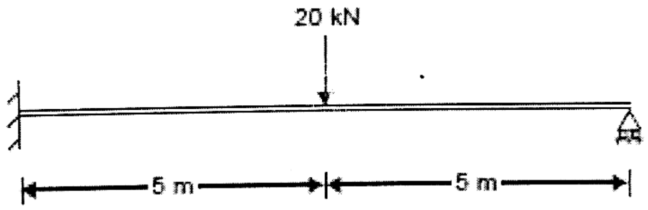

FIG Q9.

10. A composite wall consists of three materials as shown in Fig. Q(10). The outer temperature is T_0 = 20°C. Convection heat transfer takes place on the inner surface of the wall with T_∞ = 800°C and h = 25 W/m^2 °C. Determine the temperature distribution in the wall and heat transfer through the wall. 20

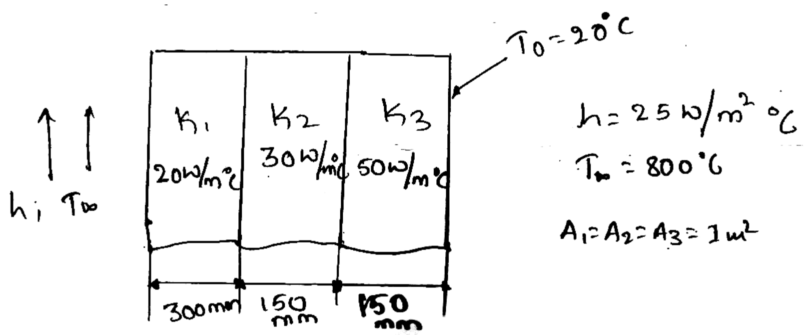

Fig Q.10

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