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; Dec. - 2019

Finite Element Method in Engineering

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Missing data, if any, may be suitably assumed.

UNIT - I

1 a.	List the engineering applications of Finite Element Method.	5
b.	Briefly explain the steps involved in Finite Element Method.	7
c.	Explain briefly with respect to discretization process; i) Size of Elements ii) Node numbering scheme	8
2 a.	Define Body force and Traction force and give any two examples for each.	4
b.	Explain the concept of plane stress and plane strain problems and write their stress strain relation.	8
c.	State the principle of minimum potential energy and derive the expression for total potential energy of a 3-D elastic body.	8

UNIT - II

3 a.	List and explain different coordinate systems used in Finite Element Method.	8
b.	Derive shape functions for a 3-noded triangular element in terms of Cartesian coordinate systems.	8
c.	The nodal co-ordinates of a 3-noded triangular element at nodes 1, 2 and 3 are (1, 1), (4, 1) and (1, 5) respectively. Evaluate the shape functions at point P whose coordinates are given by (2, 3).	4
4 a.	Derive shape functions for a 4-noded quadrilateral element using Lagrangian interpolation function.	10
b.	With necessary sketches, explain the concept of ISO, sub and super parametric elements.	10

UNIT - III

5 a.	Derive strain-displacement matrix-B and stress matrix for a 3-noded triangular element.	10
b.	Derive stiffness matrix for a 2-noded bar element.	10
6.	Fig. Q(6) shows a thin steel plate with Young's modulus E = 200 GPa and weight density $\rho = 76.6\times10^{-6}$ N/mm^3. In addition to its self weight the plate is subjected to a point load at its midpoint.	20

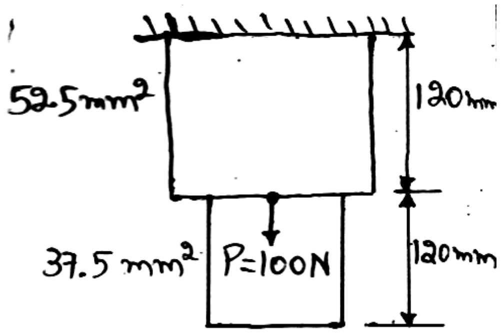

Fig. Q6

i) Write down the expressions for the element stiffness matrices and element body force vectors

ii) Assemble the structural stiffness matrix K and global load vector F

iii) Using the elimination approach, solve for the global displacement vector Q

iv) Evaluate the stresses in each element

v) Determine the reaction force at the support

UNIT - IV

7 a. Write the assumptions made during the Finite Element analysis of truss structures. 4

b. For the two bar truss structures shown in Fig. 7(b), determine the following:

i) Element stiffness matrices

ii) Support reactions at each support

iii) Stresses in each element or bar

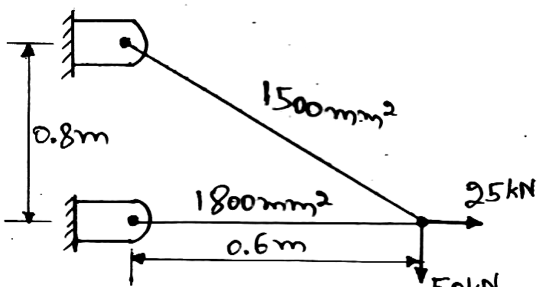

Fig. 7(b)

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8 a. Derive element stiffness matrix for a truss element. 8

b. Determine the unknown displacements for the structure shown in Fig. 8(b), E = 0.7×10^5 MPa and A = 200 mm^2.

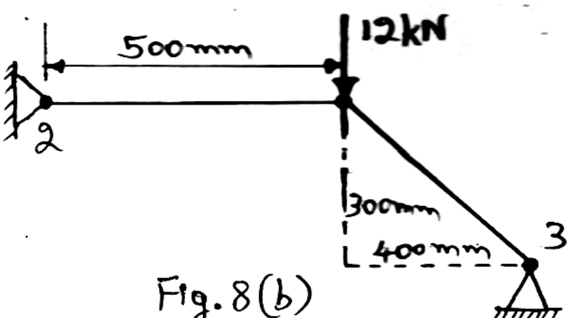

Fig. 8(b)

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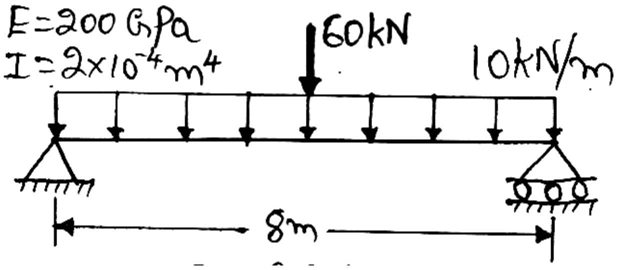
UNIT - V

9 a. For a beam element, derive an expression for load vector due to uniformly distributed load. 6

b. For the beam shown in Fig. 9(b), determine the nodal displacement and slopes. 14



10 a. Briefly explian the different boundary conditions used in steady state heat trnasfer problems. 6

b. A composite wall consists of three mateials as shown in Fig. 10(b). 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. 14

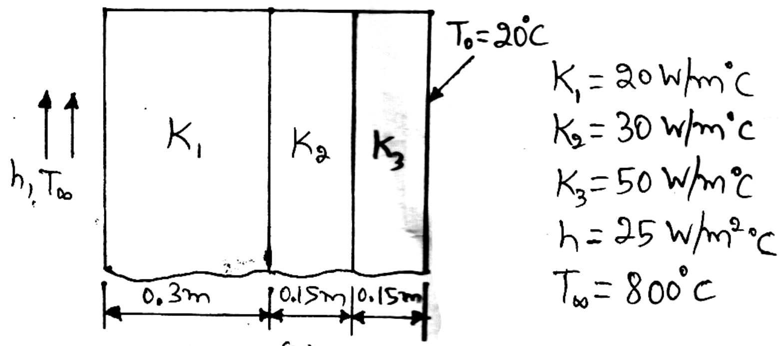


Fig. 10(b)

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