U.S.N

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

(An Autonomous Institution affiliated to VTU, Belgaum)

First Semester, M. Tech - Mechanical Engineering (MMDN)

Semester End Examination; Jan/Feb. - 2016

Finite Element Method

Time: 3 hrs *Max. Marks: 100*

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

UNIT - I

1	a.	What are the requirements of convergence? Explain briefly.	4
	b.	With the help of Pascal tetrahedron explain briefly how geometric isotropy is achieved in 3-D problems.	6
	c.	For a 3 - D elastic body derive the expression for the potential energy functional.	5
	d.	Explain briefly the principal of virtual work or deriving the element equations.	5
2	a.	For the one dimensional quadratic bar element write the shape functions.	3
	b.	Derive the expression for element load vector for a bar element due to, i) Body force ii) Traction iii) Force applied at a point and acting along the length of the bar.	5
	c.	A bar of length 1000 mm is made of brass and aluminium and subjected to loads as shown in Fig. Q 2(c). AC is made of brass. Its length is 500 mm with area 1000 mm^2 and E_b = 105 GPa. CE is made of aluminium. Its length is 500 mm, area 2000 mm^2 and E_a = 70 GPa. The loads are applied at the mid points of AC and CE. Compute the stress developed in the two materials.	12

UNIT - II

3	a.	With the examples briefly explain : i) Plane stress ii) Plane strain problems.	4
	b.	Write the shape functions for a nine noded quadrilateral element in natural coordinates.	8
	c.	Derive the Jacobian matrix for a 4 - noded quadrilateral (QUAD 4) element.	8
4	a.	With neat sketches show the variation of shape functions for a CST element.	6
	b.	The nodal coordinates of a CST element are in cm: 1 (2, 2), 2(4, 3) and 3(3, 6). Derive the strain-displacement matrix.	8
	c.	Evaluate the shape functions N_1, N_2 and N_3 at the interior pint P for the triangular element shown in Fig. Q 4C.	6

UNIT - III

5	a.	Derive the element stiffness matrix for a triangular torus, whose vertical cross section is a plane triangle.	12

Contd…2

b. Derive the expression for the : 8

i) Distributed body force ii) Surface force for an axisymmetric element.

6 a. Derive the expression for the element stiffness matrix for a plane truss element in global coordinate system. 6

b. Compute the nodal displacements and stresses in the elements of the truss structure shown in Fig. Q 6(b). Take; E = 200 GPa, Area of member AB is 20 cm^2 and its length is 5 m. Members BC and AC have the same area and is equal to 25 cm^2. 14

UNIT - IV

7 a. Write the Hermite shape functions in natural coordinate system, showing their variation along the length of the beam element. 6

b. For the beam shown in Fig. Q 7b, compute the maximum deflection and slope at the support points. 14

8 a. Evaluate the element consistent and lumped mass matrices for a 2 noded element of length *l*. 8

b. Evaluate the natural frequencies of axial vibration of the bar shown in Fig. Q 8b, considering two element. 12

UNIT - V

9 a. What are :

i) Initial conditions ii) Essential conditions 3

iii) Natural conditions in a heat transfer problem.

b. Derive the expression for element conduction matrix for one dimensional two noded element considering conduction only using Galerkin's approach. 8

c. A composite wall consists of three materials as shown in Fig. Q 9(c). The outer temperature is T_0 = 20ºC. Convection heat transfer takes place on the inner surface of the wall with t_∞ = 800ºC and h = 25 W/m^2 ºC. Determine the temperature distribution in the wall. 9

10. The length of a bar is 12 m and its C/s area is a circle of radius 1.5 cm. The conductivity of the bar is 300 W/mºC. The left end is maintained at 200ºC and the right end is maintained at 100ºC. The bar is subjected to convection. The convective heat transfer coefficient is 2000 W/m^2 ºC and surrounding temperature is 25ºC. Determine the temperature distribution along the length of the bar taking four elements. 20

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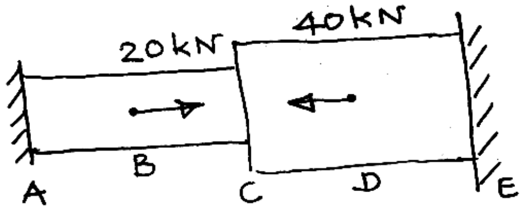

Fig Q 2C.

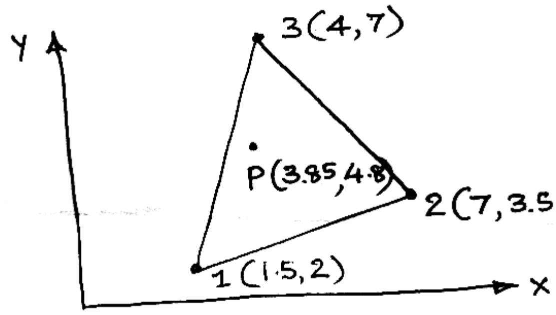

Fig Q 4C

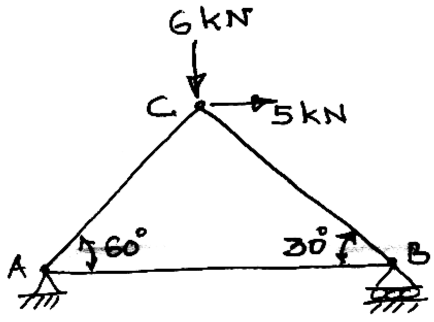

Fig Q 6b

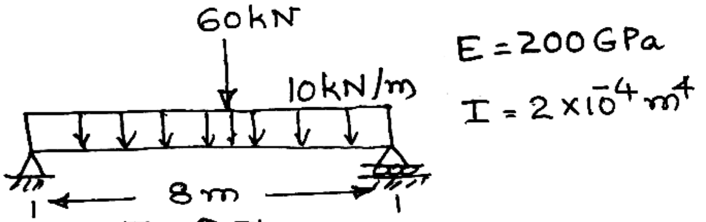

Fig Q 7b

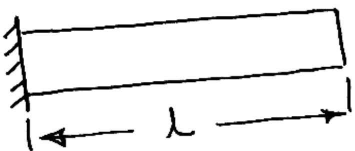

Fig Q 8b

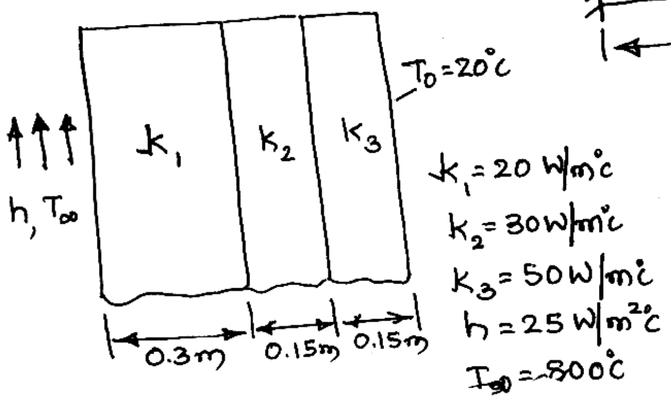

Fig. Q 9C.

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