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

(An Autonomous Institution affiliated to VTU, Belagavi)

Sixth Semester, B.E. - Mechanical Engineering

Semester End Examination; May/June - 2018

Finite Element Methods

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. What is finite method? List its engineering application. 6

b. Explain node numbering scheme in the discritization process. 6

c. With suitable example, explain the concept of plane stress and plane strain problems and write their stress-strain relations. 8

2 a. Solve the following simultaneous equations using Gauss elimination algorithm : 12

$x_1 + x_2 + x_3 = 9$; $x_1 - 2x_2 + 3x_3 = 8$; $2x_1 + x_2 - x_3 = 3$

b. Evaluate the integral using two point Gaussian quadrature techniques $I = \int_{-1}^{+1} (x^2 + 2x + 2)\, dx$. 8

UNIT - II

3 a. Briefly explain the convergence criteria of a displacement function. 6

b. Derive shape functions for a 3-noded triangular element in terms of Cartesian coordinate systems. 8

c. Derive Jacobian matrix for a CST element. 6

4 a. Derive shape functions for a 9-noded quadrilateral element using Lagrangian interpolation function. 12

b. The nodal displacement of a triangular element shown in Fig.Q4(b) are given by; 8

$u_1 = 0.0$ mm; $u_2 = 0.003$ mm; $u_3 = 0.0$ mm; $v_1 = 0.0625$ mm; $v_2 = 0.0$ mm; $v_3 = 0.0625$ mm;

Determine the displacement at point P whose x and y coordinates are (50, 45) mm.

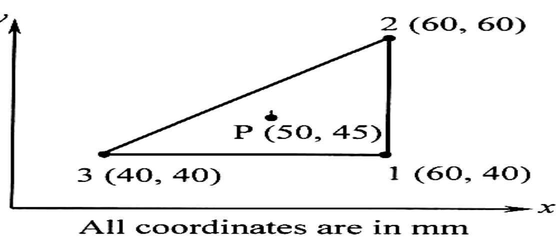

Fig. Q 4(b)

UNIT - III

5 a. For a 2-noded bar element, derive expression for element load vectors due to the body force and surface force. 10

b. Derive strain-displacement matrix B for a quadratic bar element. 10

6. Determine the nodal displacements, elements stresses and support reaction of the axially loaded bar shown in Fig.Q6. Take E = 200 GPa and load P = 300 kN. 20

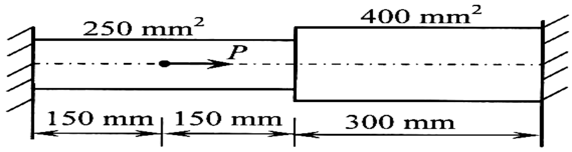

Fig. Q6

UNIT - IV

7. For the truss structure shown in Fig .Q 7(b), determine the nodal displacement, stress in each member and reaction at top support. Take E = 200 GPa and A = 200 mm^2.

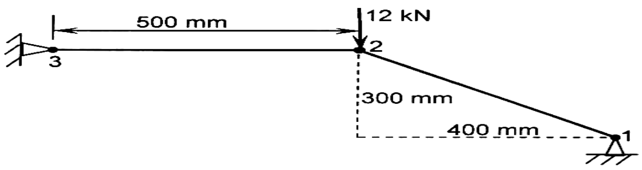

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Fig. Q 7

8 a. A 2-noded beam element is subjected for a uniformly distributed load. Derive an expression for its load vector. 6

b. For the beam shown in Fig. Q7(b), determine the nodal deflections and slops.
Take E = 70 GPa, I = 3×10^{-4} m^4.

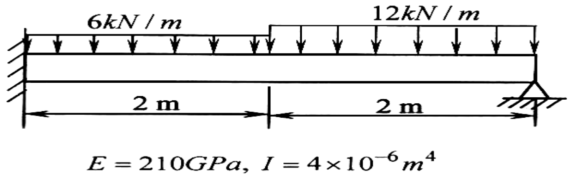

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Fig. Q 8(b)

UNIT - V

9 a. Using Galerkin's approach, derive the element conduction matrix for 1D element used for steady state heat transfer problems. 8

b. Inner surface temperature of a composite wall shown in Fig. Q9(b) is maintained at 20°C. The convective heat transfer takes place at outer surface with h = 25 W/m^2°C and T_∞ = -15°C. Determine temperature distribution in the wall.

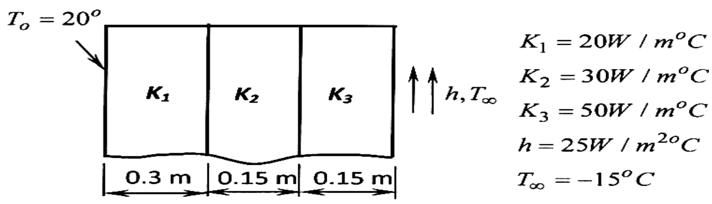

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Fig. Q9(b)

10. A metallic fin, with thermal conductivity K = 360 W/m°C, 0.1 cm thick and 10 cm long extends from a wall whose temperature is 23°C. Determine the temperature distribution and amount of heat transferred from the fin to air at 20°C with h = 9 W/m^2°C. Take the width of fin to be 1 m and use three-element model. 20

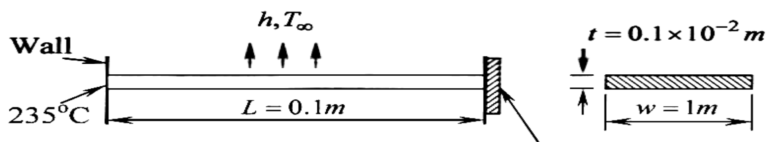

Fig. Q10

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