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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; June - 2017

Finite Element Methods

Time: 3 hrs Max. Marks: 100

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

UNIT - I

1 a. Explain the following with suitable example:
(i) Boundary value problem and initial value problem — 8
(ii) Essential boundary conditions and non-essential conditions.

b. Define body force and traction force and give any two examples for each. — 4

c. With suitable example, explain the concept of plane stress and plane strain problems. Write stress-strain relations for each problem. — 8

2 a. Explain how node numbering scheme in the discritization process affects bandwidth of stiffness matrix. — 4

b. Solve the following system of simultaneous equations using general algorithms of gauss elimination method. — 10

$x_1+x_2+x_3=9$

$x_1-2x_2+3x_3=8$

$2x_1+x_2-x_3=3$

c. Evaluate the integral using Gauss quadrature so that the result is exact. — 6

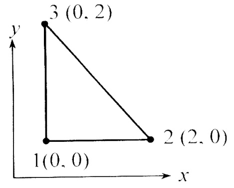
$$I=\int_{-1}^{1}\left(7-3x+x^2\right)dx$$

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 natural co-ordinate systems. — 6

c. Derive Jacobean matrix for a CST element and use this expression to determine Jacobean for the triangular plate shown FigQ.3(c). — 8



All coordinates are in mm

Fig. Q3(c)

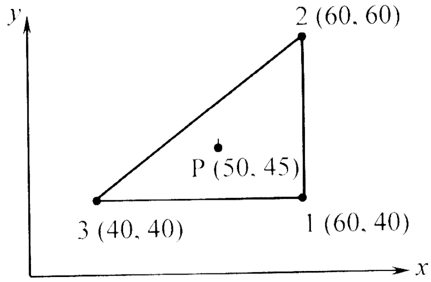
4 a. Write a note on Lagrangian interpolation function and derive functions for a 4-noded quadrilateral element using it. 12

b. The nodal displacements of a triangular element shown in Fig.Q4(b) are given by,

$u_1 = 0.0$ mm; $u_2 = 0.03$ 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 a point P whose x and y coordinate are (50, 45) mm. 8



All coordinates are in mm

Fig. Q 4(b)

UNIT - III

5 a. A 2-noded bar element is subjected to a body force (force/unit volume) and surface forces (force/unit length), derive expressions for element load vectors due to the above forces. 10

b. Derive strain-displacement matrix B and strain matrix for a linear triangular element and show that they are constant. 10

6. A stepped bar member is loaded as shown in Fig.Q.6. Determine the nodal displacement, stresses in each bar and support reactions. Use Penalty method to handle the boundary conditions. Take E = 200 GPa. 20

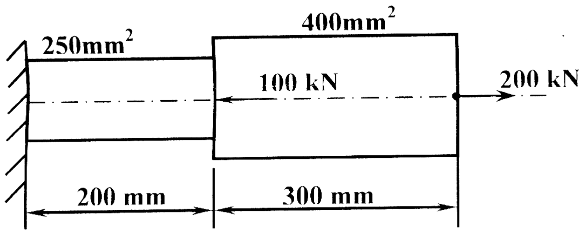


Fig. Q 6

UNIT - IV

7 a. What is transformation matrix? Mention how it is useful in the analysis of truss problems. 4

b. For the truss structure shown in Fig.Q7 (b), determine the nodal displacements, stress in horizontal member and reactions at top support. Take E =200 GPa and A=200 mm^2 16

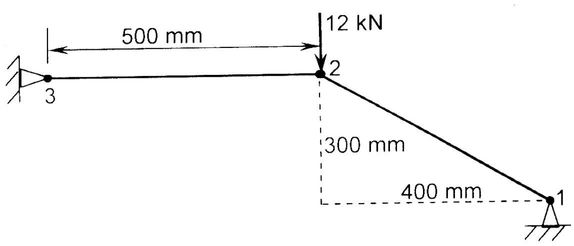
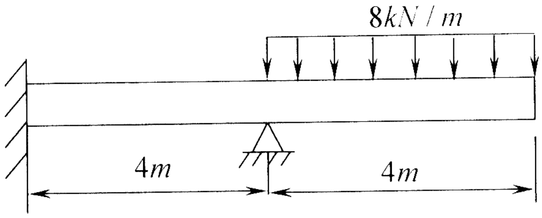


Fig. Q 7(b)

8 a. Write the expressions of Hermite's shape functions of a 2-noded beam element and draw their variation along the element. Why they are called Harmite's shape functions? 6

b. For the beam shown in Fig. Q.8(b). Determine the nodal deflections and slops. Take E = 70 GPa, I = 3x10^{-4} m^4



$E = 200GPa, I = 4\times10^{-4} m^4$ 14

Fig. Q 8(b)

UNIT - V

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

b. Consider a brick wall Fig. Q.9(b) of thickness, L = 0.3 m, K = 0.7 W/m°C. The inner surface is at 28°C and the outer surface is exposed to cold air at -15°C. The heat transfer coefficient associated with the outside surface is h = 40 W/m^{2}K. Determine the steady-state temperature distribution within the wall and also the heat flux through the wall. Use a two-element model.

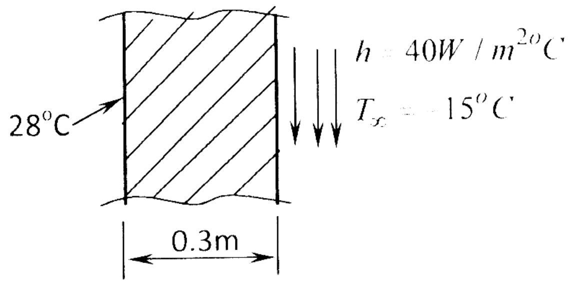


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Fig. Q 9(b)

10. A metallic fin, shown in Fig. Q.10. with thermal conductivity K = 360 W/m°C, 0.1 cm thick and 10cm long extends form a wall whose temperature is 235°C. Determine the temperature distribution and amount of heat transferred from the fin to air at 20°C with h = 9 W/m^2 K. Take the width of fin to be 1m and use three-element model. 20

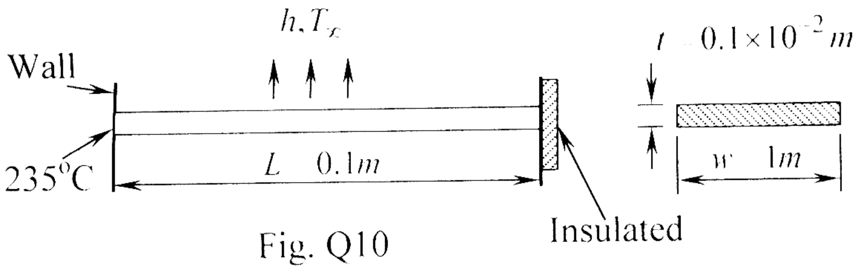

Fig. Q10

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