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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 - 2019

Finite Element Method

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 any four advantages and disadvantages of finite element method. 6

b. Briefly explain the steps involved in finite element method. 6

c. With necessary sketches, explain the following : 8

i) Location of node ii) Node numbering scheme

2 a. Solve the following system of simultaneous equation using general algorithm of Gauss elimination method: $2x_1 + x_2 - x_3 = 7$; $x_1 - 2x_2 + 3x_3 = 12$; $2x_1 + 4x_2 - 3x_3 = 10$. 12

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

UNIT - II

3 a. What is geometric isotropy? Briefly explain how it can be achieved with the help of Pascal's triangle? 8

b. Derive shape functions for a 3-noded bar element. 8

c. The nodal coordinates of a three 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. What is Lagrangian interpolation function and derive shape functions for a 4 noded quadrilateral element using it. 10

b. With necessary sketches, explain the concept of Iso, Sub and Super parametric elements. 10

UNIT - III

5 a. For a 2-noded bar element, derive expressions for element load vectors due to the body force and surface force. 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 axially loaded as shown in Fig. Q 6. Determine the nodal displacements, element stresses and support reaction use penalty method to handle boundary condition. Take E = 200 GPa. 20

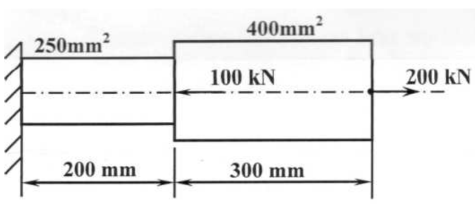

Fig. Q 6

Contd…2

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. Q 7(b), determine the nodal displacement at node 2 and stress in each member. Take; $A_1 = 1500\ mm^2$, $A_2 = 2000\ mm^2$, $E_1 = 200$ GPa, $E_2 = 70$ GPa. 16

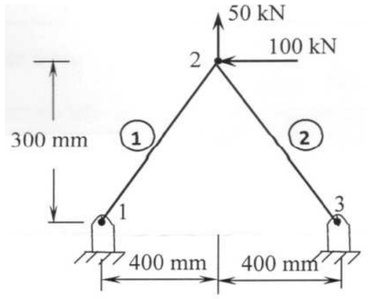

Fig. Q 7(b)

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

b. For the beam shown in Fig. Q 8(b), determine the nodal deflections and slopes.

Take; E = 70 GPa, $I = 3\times10^{-4} m^4$. 14

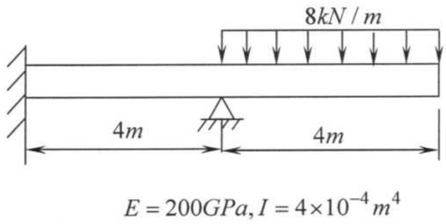

Fig. Q 8(b)

UNIT - V

9 a. Briefly explain the different boundary conditions used in stedy state heat transfer problems. 6

b. Inner surface temperature of a composite wall shown in Fig. Q 9(b) is maintained at 20°C. The convective heat transfer take place at outer surface with h = 25 W/m^2-°C and $T_\infty = -15$°C. Determine temperature distributon in the wall. 14

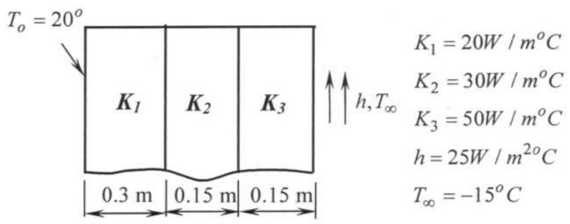

Fig. Q9(b)

10. Fig. Q 10 shows a uniform aluminium fin of diameter 20 mm. The root (left end) of the fin is mainatined at a temperature of $T_o = 100$°C while convection takes place from the lateral (circular) surface and the right (flat) edge of the fin. Assuming K = 200 W/m°C, h = 1000 W/m^2-°C and $T_\infty = 20$°C. Determine the temperature distribution in the fin using a two-element idealization. 20

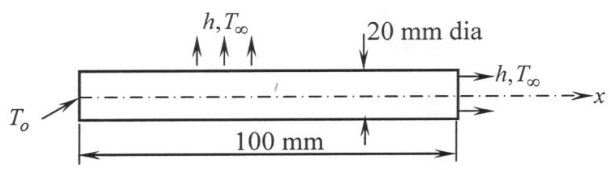

Fig. Q 10

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