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10ME64

Sixth Semester B.E. Degree Examination, June/July 2014
Finite Element Methods

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. What is FEM? Sketch the different types of elements used based on geometry in finite element analysis. (1D, 2D and 3D). **(04 Marks)**

b. Explain with a sketch plane stress and plane strain. **(06 Marks)**

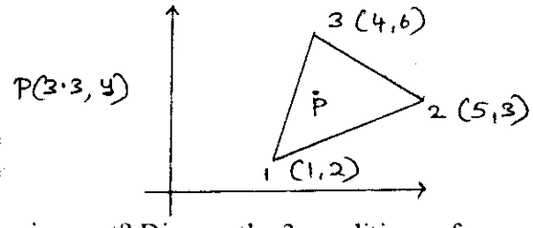
c. Derive the equilibrium equation in elasticity subjected to body force and traction force. **(10 Marks)**

2 a. A cantilever beam of span 'L' is subjected to a point load at free end. Derive an equation for the deflection at free end by using RR method. Assume polynomial displacement function. **(10 Marks)**

b. Write the properties of stiffness matrix and derive the element stiffness matrix (ESM) for a 1D bar element. **(10 Marks)**

3 a. A modal co-ordinate of the triangular element is shown in Fig.Q.3(a). At the interior point 'P' the co-ordinate is 3.3 and $N_1 = 0.3$. Determine 'N_2' and 'N_3' and the y co-ordinate at point P. **(05 Marks)**

Fig.Q.3(a)



b. What is convergence requirement? Discuss the 3 conditions of convergence requirement. **(05 Marks)**

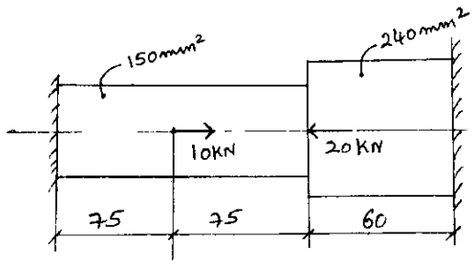
c. Derive the shape function of a 4 noded quadrilateral element. **(10 Marks)**

4 a. Consider the bar shown in Fig.Q.4(a). Using elimination method of handling boundary conditions. Determine the following:

i) Nodal displacements.
ii) Stress in each element.
iii) Reaction forces.

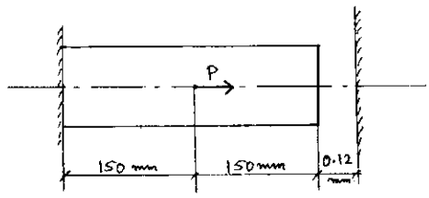
Take E = 200GPa. **(10 Marks)**

Fig.Q.4(a)



b. Consider the bar shown in Fig.Q.4(b). An axial load P = 60 × 10^3N is applied at its midpoint. Using penalty method of handling boundary condition. Determine: i) Nodal displacements; ii) Stress in each element; iii) Reaction at supports. Take A = 250mm^2; E = 200GPa. **(10 Marks)**

Fig.Q.4(b)



PART – B

5 a. Derive the shape function for a quadratic bar element using Lagrange's interpolation. **(05 Marks)**

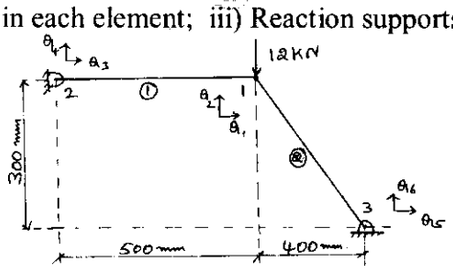
b. Evaluate $I = \int_{-1}^{+1} \left(3e^{\xi} + \xi^2 + \frac{1}{\xi + 2} \right) d\xi$ using 1P and 2P Gaussian quadrature. **(06 Marks)**

c. Derive Lagrange quadratic quadrilateral element (9 noded quadrilateral element). **(09 Marks)**

6 a. List out the assumptions made in the derivation of a truss element. **(04 Marks)**

b. For the truss shown in Fig.Q.6(b), determine:
i) Nodal displacement; ii) Stress in each element; iii) Reaction supports.

Fig.Q.6(b)

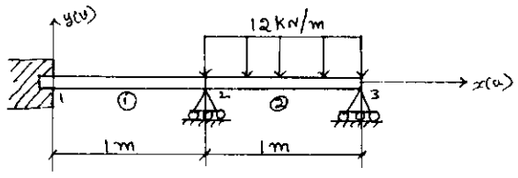


A = 200mm^2; E = 70GPa. **(16 Marks)**

7 a. Derive the Hermite shape function for a beam element. **(08 Marks)**

b. For the beam and loading shown in Fig.Q.7(b). Determine:
i) Slopes at 2 and 3; ii) Vertical deflection at the midpoint of the load.
Take E = 200 GPa; I = 4 × 10^6mm^4. **(12 Marks)**

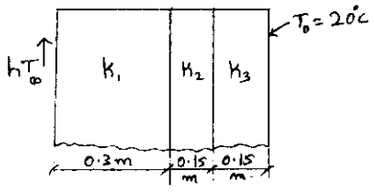
Fig.Q.7(b)



8 a. Bring out the differences between continuum methods and FEM. **(06 Marks)**

b. Solve the temperature distribution in the composite wall using 1D heat elements, use penalty approach of handling boundary conditions. (Fig.Q.8(b)). **(14 Marks)**
K_1 = 20W/m°C; K_2 = 30W/m°C; K_3 = 50 W/m°C; h = 25 W/m^2°C; T_∞ = 800°C

Fig.Q.8(b)



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