ME(CIVIL) 2ND SEMESTER EXAMINATION 2014
SUBJECT: NUMERICAL METHODS FOR STRUCTURAL ANALYSIS
CE 1005

Time: 3 hours **Full Marks: 70**

*Answer any **FIVE** Questions.*
All questions are of equal value.

1.a) Explain the difference between Lagrange and Serendipity elements with the help of Pascal's triangle.
b) Derive the shape functions of 8 noded plate element using Lagrange approach. Also draw the shape functions of the plate element.
c) Define Geometric isotropy.

4+8+2

2.a)Determine the displacements at a point of load application using a one element model for the figure shown in Fig.Q.2a.

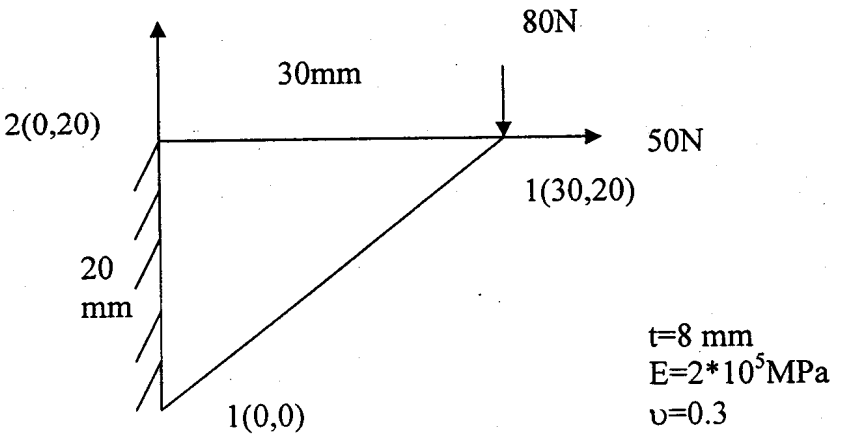
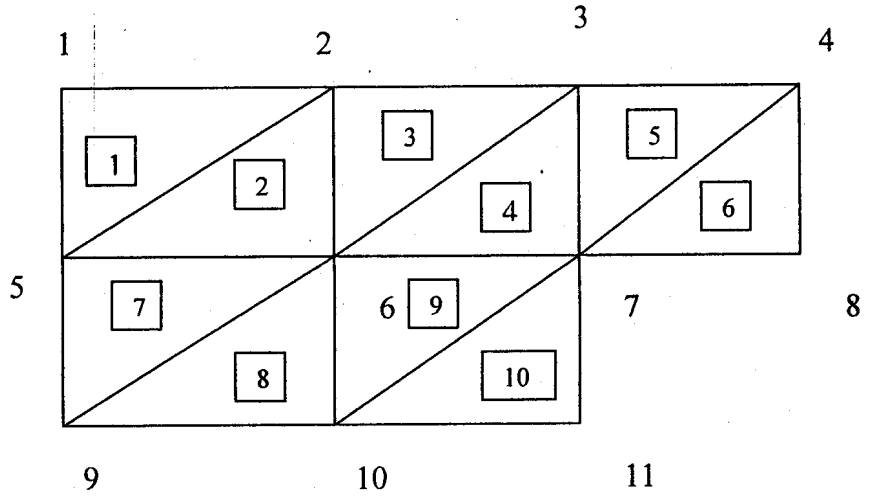


Fig.Q.2a

b) The Fig. Q.2b shows a 2-D region modeled with 10 CST elements. Determine the half bandwidth NBW.



FigQ.2b

10+4=14

3. a) Explain displacement boundary conditions.
b) Describe the methods of incorporating boundary conditions in a finite element formulation of a structure.
c) The global stiffness matrix of a fixed ended bar element (shown in Fig.Q.3c) is given below:

$$[K]=\begin{bmatrix} 0.55 & -0.55 & 0 \\ -0.55 & 0.9 & -0.25 \\ 0 & -0.25 & 0.44 \end{bmatrix} \times 10^3 \text{ kN/mm}$$

Calculate the displacement at node 2 using penalty approach.

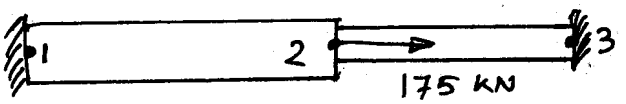


Fig. Q.3c

2+6+6=14

4. Derive the stiffness matrix and consistent mass matrix for a two noded beam element. Also calculate the natural frequencies for a cantilever beam using one element model.

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5. a) How can you obtain the element stiffness matrix of two noded frame element from the stiffness of a two noded bar and beam element?

b)Calculate the displacements for the truss shown in Fig. Q.5 using the following data: $E=2*10^{11}N/m^2$, Cross sectional area of each member $1=4*10^{-4}m^2$.

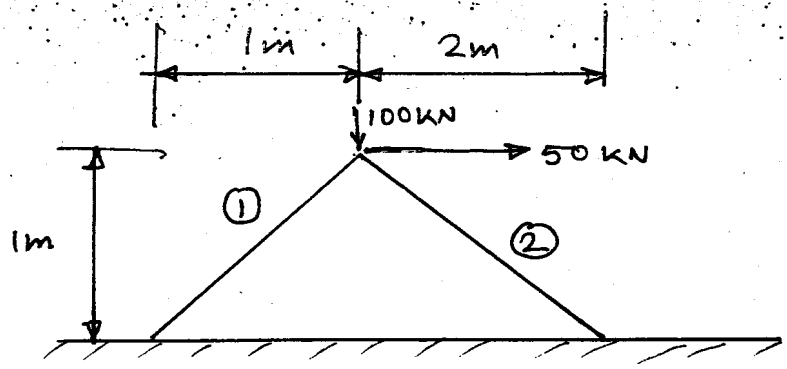

Fig. Q.5

5+9=14

6. Derive a general expression for obtaining the element stiffness matrix in finite element formulations using minimum potential energy theory. Also derive the expression for element load vector corresponding to uniformly distributed load using lumped and consistent load methods for 2 noded beam element.

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7. a)Define strong form and weak form.
b)Consider a uniform rod fixed at one end and subjected to an axial load Po. Calculate the displacement at the free end using minimum residual method.
c)Explain Galerkin's weighted residual method.

4+6+4=14

8.a) The nodal coordinates of a triangular element are (1.5,1), (5,3) and (3,5). The coordinate of an interior point P is (3.5, 3.125). Calculate the shape functions using area coordinate method.
b) What are the conditions of a CST element?

c) Calculate the Jacobian matrix for 3 noded CST element of coordinates (2,1), (10,5) and (6,7). Also calculate the area of the triangle.

6+4+4=14