

**SRI VIDYA COLLEGE OF ENGINEERING AND TECHNOLOGY,
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CE 6602 – STRUCTURAL ANALYSIS - II

2 MARK QUESTION BANK

UNIT III

FINITE ELEMENT METHOD

PART A

1. What is meant by Finite element method?
2. List out the advantages of FEM.
3. List out the disadvantages of FEM.
4. Mention the various coordinates in FEM.
5. What are the basic steps in FEM?
6. What is meant by discretization?
7. What are the factors governing the selection of finite elements?
8. Define displacement function.
9. Briefly explain a few terminology used in FEM.
10. What are different types of elements used in FEM?
11. What are 1-D elements? Give examples.
12. What are 2-D elements? Give examples.
13. What are 3-D elements? Give examples.
14. Define Shape function.
15. What are the properties of shape functions?
16. Define aspect ratio.
17. What are possible locations for nodes?
18. What are the characteristics of displacement functions?
19. What is meant by plane strain condition?

PART B

1. Explain the procedure of adopting finite element method.
2. Explain the discretisation process in detail.
3. Compute the nodal loads on each of the 3 elements for a fixed beam AB of span L with a point load W & 2W located at one third span from end A & B respectively .
4. Determine the element load vectors and global load vector for the system in the figure-A.

5. For the beam shown in figure-A, determine the $\{P\}$ vectors and the $\{F\}$ vector by equivalent load method.

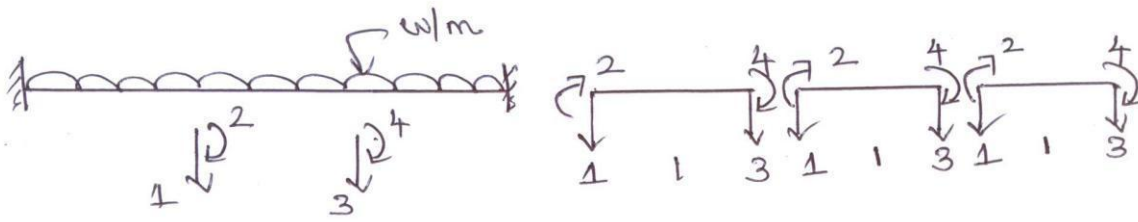
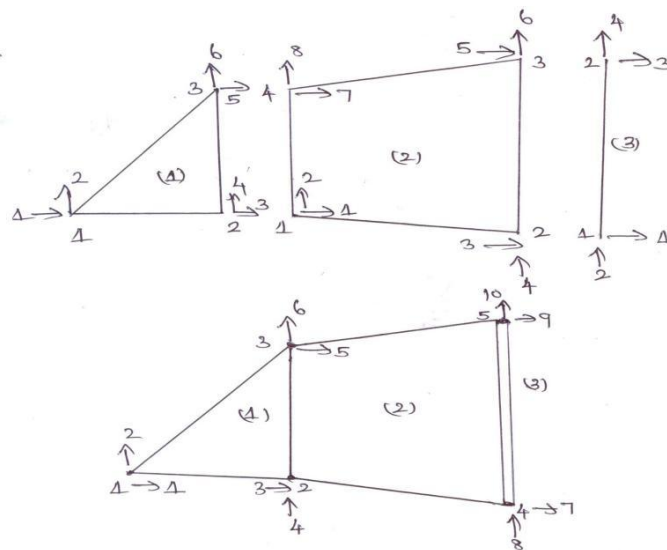


Fig - A

6. Explain the procedure for assembling of force vectors and stiffness matrices.
7. Explain the procedure for formulating the stiffness matrix for a constant strain element.
8. Explain the formulation of Pascal Triangle.
9. Assemble the elements 1,2 and 3 in the figure to develop the global load vectors and the global stiffness matrix, given that



$$\{P_1\}^T = [8 \ 0 \ 6 \ 0 \ 2 \ 0]$$

$$\{P_2\}^T = [5 \ 1 \ 3 \ 0 \ 6 \ 0 \ 9 \ 2]$$

$$\{P_3\}^T = [0 \ 2 \ 0 \ 2]$$

10. Solve the matrix equation $\{f\}=[K]\{u\}$ where $\{f\}^T=[100, 120, -10]$ and $[K]$ is

$$\begin{bmatrix} 12 & 6 & 2 \\ & 6 & 48 & 4 \\ 2 & 4 & 24 \end{bmatrix}$$

Make sure that $u_1=0$.

ANSWERS

1. What is meant by Finite element method?

Finite element method (FEM) is a numerical technique for solving boundary value problems in which a large domain is divided into smaller pieces or elements. The solution is determined by assuming certain polynomials. The small pieces are called finite element and the polynomials are called shape functions.

2. List out the advantages of FEM.

- Since the properties of each element are evaluated separately different material properties can be incorporated for each element.
- There is no restriction in the shape of the medium.
- Any type of boundary condition can be adopted.

3. List out the disadvantages of FEM.

- The computational cost is high.
- The solution is approximate and several checks are required.

4. Mention the various coordinates in FEM.

- Local or element coordinates
- Natural coordinates
- Simple natural coordinates
- Area coordinates or Triangular coordinates
- Generalized coordinates

5. What are the basic steps in FEM?

- Discretization of the structure
- Selection of suitable displacement function
- Finding the element properties
- Assembling the element properties
- Applying the boundary conditions
- Solving the system of equations
- Computing additional results

6. What is meant by discretization?

Discretization is the process of subdividing the given body into a number of elements which results in a system of equivalent finite elements.

7. What are the factors governing the selection of finite elements?

- The geometry of the body
- The number of independent space coordinates
- The nature of stress variation expected

8. Define displacement function.

Displacement function is defined as simple functions which are assumed to approximate the displacements for each element. They may assume in the form of polynomials, or trigonometrical functions.

9. Briefly explain a few terminology used in FEM.

The various terms used in FEM are explained below.

Finite element: Small elements used for subdividing the given domain to be analysed are called finite elements. These elements may be 1D, 2D or 3D elements depending on the type of structure.

Nodes and nodal points: The intersection of the different sides of elements are called nodes. Nodes are of two types – external nodes and internal nodes.

External nodes – The nodal point connecting adjacent elements.

Internal nodes – The extra nodes used to increase the accuracy of solution.

Nodal lines: The interface between elements are called nodal lines.

Continuum: The domain in which matter exists at every point is called a continuum. It can be assumed as having infinite number of connected particles.

Primary unknowns: The main unknowns involved in the formulation of the element properties are known as primary unknowns.

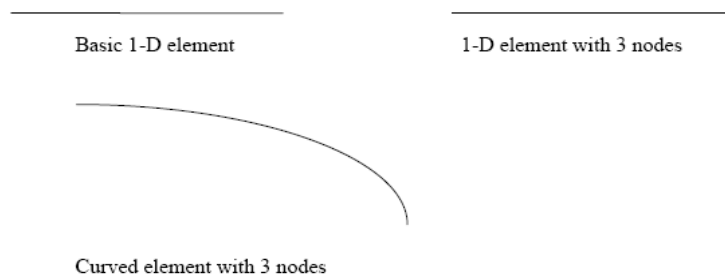
Secondary unknowns: These unknowns are derived from primary unknowns are known as secondary unknowns. In displacement formulations, displacements are treated as primary unknowns and stress, strain, moments and shear force are treated as secondary unknowns.

10. What are different types of elements used in FEM?

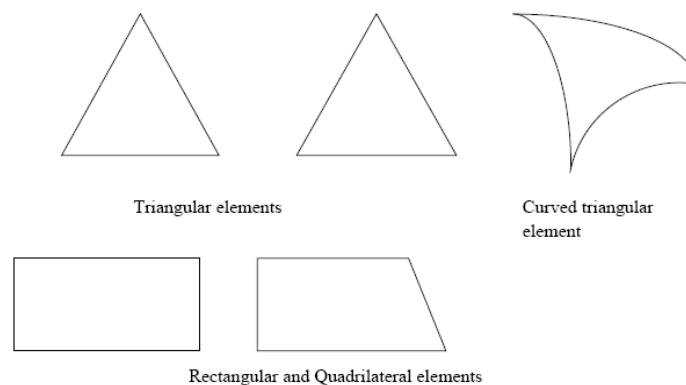
The various elements used in FEM are classified as: One dimensional elements (1D elements) Two dimensional elements (2D elements) Three dimensional elements (3D elements)

11. What are 1-D elements? Give examples.

Elements having a minimum of two nodes are called 1D element. Beams are usually approximated with 1D element. These may be straight or curved. There can be additional nodes within the element.

**12. What are 2-D elements? Give examples.**

A plane wall, plate, diaphragm, slab, shell etc. can be approximated as an assemblage of 2-D elements. Most commonly used elements are triangular, rectangular and quadrilateral elements.

**13. What are 3-D elements? Give examples.**

3-D elements are used for modeling solid bodies and the various 3-D elements are tetrahedron, hexahedron, and curved rectangular solid.

14. Define Shape function.

Shape function is also called an approximate function or an interpolation function whose value is equal to unity at the node considered and zeros at all other nodes. Shape function is represented by N_i where i = node no.

15. What are the properties of shape functions?

The properties of shape functions are:

- The no of shape functions will be equal to the no of nodes present in the element.
- Shape function will have a unit value at the node considered and zero value at other nodes.
- The sum of all the shape function is equal to 1.

16. Define aspect ratio.

Element aspect ratio is defined as the ratio of the largest dimension of the element to its smallest dimension.

17. What are possible locations for nodes?

The possible locations for nodes are:

- Point of application of concentrated load.
- Location where there is a change in intensity of loads
- Locations where there are discontinuities in the geometry of the structure
- Interfaces between materials of different properties.

18. What are the characteristics of displacement functions?

Displacement functions should have the following characteristics:

- The displacement field should be continuous.
- The displacement function should be compatible between adjacent elements
- The displacement field must represent constant strain states of elements
- The displacement function must represent rigid body displacements of an element.

19. What is meant by plane strain condition?

Plane strain is a state of strain in which normal strain and shear strain directed perpendicular to the plane of body is assumed to be zero.