



M.E DEGREE EXAMINATIONS: JUNE 2017

(Regulation 2015)

Second Semester

STRUCTURAL ENGINEERING

P15SET201: Finite Element Analysis

COURSE OUTCOMES

CO1: Explain various aspects of finite element method for structural analysis

CO2: Formulate shape functions for various elements

CO3: Apply finite element method for structural analysis

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

- The materials which exhibits symmetry w.r.to planes within the body are called, CO1 [K₂]
 - Isotropic materials
 - Orthotropic materials
 - Anisotropic materials
 - Symmetric material
- For a fixed beam subjected to UDL of w / unit weight over the entire span l , the equivalent nodal loads using structural analysis approach are CO3 [K₂]
 - $\left[\frac{wl}{2} \quad \frac{wl^2}{12} \quad \frac{wl}{2} \quad -\frac{wl^2}{12} \right]$
 - $\left[-\frac{wl}{2} \quad \frac{wl^2}{12} \quad -\frac{wl}{2} \quad -\frac{wl^2}{12} \right]$
 - $\left[\frac{wl}{2} \quad -\frac{wl^2}{12} \quad \frac{wl}{2} \quad -\frac{wl^2}{12} \right]$
 - $\left[-\frac{wl}{2} \quad -\frac{wl^2}{12} \quad -\frac{wl}{2} \quad \frac{wl^2}{12} \right]$
- An element with no internal nodes is classified as CO1 [K₂]
 - Lagrange element
 - Serendipity element
 - Laplace element
 - Hermite element
- Matching type item with multiple choice code CO1 [K₂]

| List I (End Condition) | List II (Critical load) |
|---|-------------------------|
| A. Triangular Plane stress element | 1. 2 |
| B. A structural Thin shell Triangular element | 2. 18 |
| C. Beam Element | 3. 6 |
| D. Truss element | 4. 1 |

| | A | B | C | D |
|----|---|---|---|---|
| a) | 3 | 2 | 1 | 4 |
| b) | 2 | 4 | 3 | 1 |
| c) | 4 | 2 | 2 | 4 |
| d) | 1 | 2 | 3 | 4 |

5. Curved boundary is better modelled by using CO2 [K₂]
- a) Non-dimensional shape function b) Higher order element
- c) Isoparametric element d) More number of simple elements
6. Bandwidth is more if numbering is in _____ direction. CO2 [K₂]
- a) Longer b) Shorter
- c) Either a or b d) Both a and b
7. Assertion (A): Six noded triangular element is known as LST element CO2 [K₂]
Reason (R): It has a linear strain throughout.
- a) A is true But R is False b) Both A and R are False
- c) Both A and R are True. And R is the correct reason for A. d) Both A and R are True. But R is not the correct reason for A.
8. Number of stress components per node calculated for a triangular axisymmetric element is CO3 [K₂]
- a) 2 b) 3
- c) 4 d) 5
9. ANSYS uses CO3 [K₂]
- a) Frontal solution b) Banded matrix solution
- c) Cramer's rule d) Cholesky decomposition
10. NISA stands for CO3 [K₂]
- a) Non-Linear Incremental Stress Analysis b) Non-Linear Incremental Strain Analysis
- c) Non-Linear Incremental Structural Application d) Non-Linear Incremental Structural Analysis

PART B (10 x 2 = 20 Marks)

11. List the applications of Finite element method. CO1 [K₂]
12. What is Galerkin's method? CO1 [K₂]
13. Classify the coordinate systems. CO1 [K₂]

- | | | | |
|-----|---|-----|-------------------|
| 14. | Why polynomial types of interpolation functions are preferred over trigonometric functions? | CO2 | [K ₂] |
| 15. | What are the conditions for a problem to axisymmetric? | CO2 | [K ₂] |
| 16. | Define bandwidth. | CO2 | [K ₂] |
| 17. | Write the stiffness matrix for the spring system shown in Fig.1. | CO3 | [K ₂] |
| 18. | What is meant by Subparametric element? | CO3 | [K ₂] |
| 19. | What are the assumptions made in plate theory? | CO3 | [K ₂] |
| 20. | Name some of the standard FEA packages. | CO3 | [K ₂] |

PART C (6 x 5 = 30 Marks)

- | | | | |
|-----|---|-----|-------------------|
| 21. | Compare plane stress and plane strain elements. | CO1 | [K ₃] |
| 22. | For the truss shown in Fig.2, determine the Nodal displacements. Take area of Element 1 = 2000mm ² Element 2 = 2500mm ² Element 3 = 2500mm ² | CO3 | [K ₃] |
| 23. | List the convergence requirements of polynomial shape functions. | CO2 | [K ₂] |
| 24. | Using Lagrangian functions derive the shape functions for 4 noded rectangular element and plot their shapes. | CO2 | [K ₃] |
| 25. | What is axisymmetric element? Derive the stress-strain relationship matrix for axisymmetric element. | CO2 | [K ₃] |
| 26. | List the desirable features of FEA packages. | CO3 | [K ₂] |

Answer any FOUR Questions

PART D (4 x 10 = 40 Marks)

- | | | | |
|-----|---|-----|-------------------|
| 27. | Apply Galerkin method to calculate the max deflection of a simply supported beam with uniformly distributed load throughout its length 'l'. | CO1 | [K ₃] |
| 28. | List the various steps involved in finite element analysis. Explain each step in detail. | CO1 | [K ₂] |

29. An Axial Load $P = 200 \text{ kN}$ is applied on a bar as shown in Fig.3. Determine the nodal displacement in each element. CO3 [K4]
30. Derive the jacobian matrix for the Isoparametric quadrilateral element. CO3 [K4]
31. Derive the shape function for a tetrahedron element. CO2 [K4]

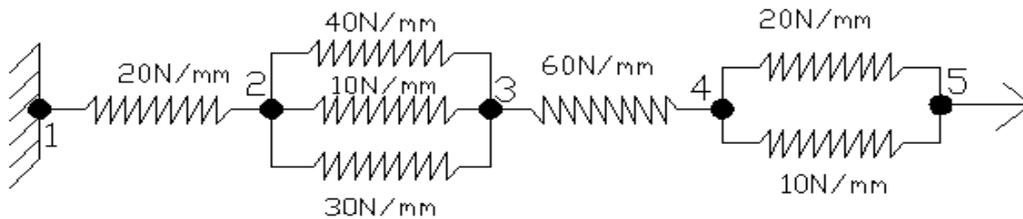


Fig.1

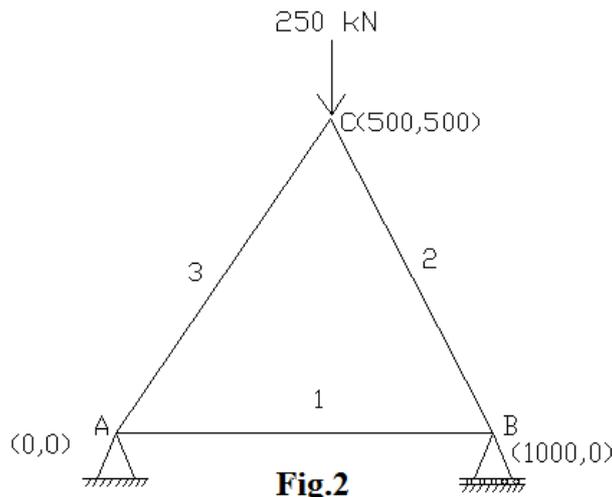


Fig.2

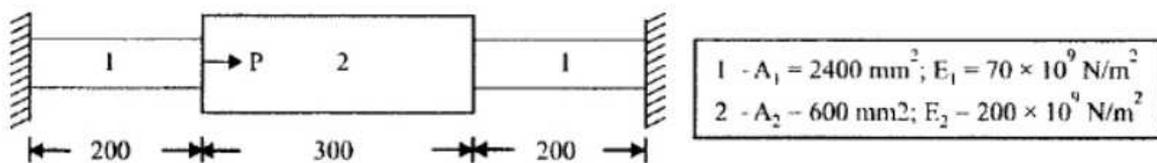


Fig.3
