



M.E DEGREE EXAMINATIONS: APRIL / MAY 2023

(Regulation 2018)

Second Semester

STRUCTURAL ENGINEERING

P18SET2001: Finite Element Method

COURSE OUTCOMES

- CO1:** Understand the energy principles and finite element concepts.
- CO2:** Formulate shape functions for various elements.
- CO3:** Determine the stresses and strains for 2D and 3D problems.
- CO4:** Apply finite element method for the analysis of framed structures.
- CO5:** Analyze plates and shells using Finite Element Method.

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. The following steps to be followed for the analysis of plate elements CO5 [K₂]
 - i) Computation of displacement
 - ii) Curvature
 - iii) Transverse shear strain
 - iv) Bending stressArrange the correct sequence
 - a) i,ii,iv,iii
 - b) ii,iii,iv,i
 - c) iii,i,ii,iv
 - d) iv,iii,ii,i
2. The eight node quadrilateral element belongs to..... Family of element CO2 [K₂]
 - a) Serendipity
 - b) Interdipity
 - c) Sardipity
 - d) Both a & b
3. The number of shape functions will be equal to the number of CO3 [K₂]
 - a) nodes of element
 - b) elements of the structure
 - c) size of the structure
 - d) Coordinates

4. Arrange the respective shape of element used for finite element analysis from the given list CO1 [K₁]

List I (Shape of element)	List II (Finite element analysis)
A. Bar element	i. Two dimensional element
B. Rectangular element	ii. Three dimensional element
C. Tetrahedral element	iii. One dimensional element
D. Polyhedral element	iv. Three dimensional element

- a) A-iii, B-i, C-ii, D-iv b) A-ii, B-i, C-iii, D-iv
 c) A-i, B-ii, C-iii, D-iv d) A-ii, B-iii, C-iv, D-i

5. Choose the suitable application of Functional approximation used for finite element analysis from the list below CO4 [K₂]

List I (Functional approximation)	List II (FEM Application)
A. Rayleigh-Ritz	i. Weighted residual
B. Galerkin method	ii. Complex problem
C. weighted residual method	iii. Nonstructural problem
D. Rayleigh-Ritz	iv. Variational approach

- a) A-iii, B-i, C-ii, D-iv b) A-ii, B-i, C-iii, D-iv
 c) A-iv, B-i, C-iii, D-ii d) A-ii, B-iii, C-iv, D-i

6. Advantage of using shell element in FEM CO2 [K₁]

- a) Higher load carrying capacity b) Lesser thickness
 c) Both A and B d) More support requirement

7. Assertion (A): The KES maps obtained for the bending of cantilever beam through analytical equations exactly matches with nonlinear finite elemental analysis. CO4 [K₂]

Reason (R): The analytical equations accounts for all deformations including axial stretching.

- a) Assertion and reasoning are correct and the assertion follows from the reasoning b) Assertion and reasoning are correct but the assertion does not follow from the reasoning.
 c) Assertion is correct but the statement in the reasoning is incorrect. d) Assertion is wrong and so is the reasoning.

8. In finite element analysis over a domain, an interpolation function represents a _____ CO2 [K₂]
 a) Change in variable over an element b) Change in variable over the whole domain
 c) Shape of the element d) Shape of the whole domain
9. For the equation $[k]\{u\}=F$, the vector $\{F\}$ contains CO4 [K₂]
 a) Stiffness terms b) Force terms attributable to distributed external load
 c) Primary variable term d) Terms attributable to the presence of external concentrated as well as distributed loads
10. If a domain is discretized in to 1-D elements then the number of nodes will be CO3 [K₂]
 a) N b) N+1
 c) N-1 d) 2N

PART B (10 x 2 = 20 Marks)

11. List the advantages of the finite element method. CO1 [K₁]
12. Compare structural and nonstructural problems. CO1 [K₂]
13. Label the classification of coordinates. CO2 [K₁]
14. Summarize the properties of the stiffness matrix. CO2 [K₂]
15. Develop the displacement matrix for 2D truss element. CO3 [K₂]
16. Define a plane stress problem with a suitable example. CO3 [K₁]
17. What is a constant strain triangle? CO4 [K₁]
18. Identify the application of Axisymmetric elements. CO4 [K₂]
19. Outline the assumptions made in the Thin plate theory. CO5 [K₂]
20. Examine the way in which a three-dimensional problem can be reduced to a two-dimensional approach. CO5 [K₃]

PART C (6 x 5 = 30 Marks)

21. Develop the flow chart for steps involved in finite element analysis. 5 CO1 [K₃]
22. Illustrate the concept of the super parametric element. 5 CO2 [K₂]
23. Formulate displacement, strain and slope equation for an beam using suitable beam theory. 5 CO3 [K₃]

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|-----------------------------------------------|---|-----|-------------------|
| 24. Distinguish between CST and LST elements. | 5 | CO4 | [K ₂] |
| 25. Compare plate and shell elements. | 5 | CO5 | [K ₂] |
| 26. Rephrase about natural discretization. | 5 | CO1 | [K ₂] |

**Answer any FOUR Questions
PART D (4 x 10 = 40 Marks)**

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| 27. Explain the following finite element formulation techniques | 10 | CO1 | [K ₂] |
| i) Virtual Work | | | |
| ii) Variational Principle | | | |
| 28. Formulate the shape function for a linear Isoparametric quadrilateral element. | 10 | CO2 | [K ₃] |
| 29. Write the step by step procedure for the analysis of continuous beam using finite element approach. | 10 | CO3 | [K ₂] |
| 30. Develop the shape function for an Axisymmetric element. | 10 | CO4 | [K ₃] |
| 31. Discuss the finite element analysis of shell element. | 10 | CO5 | [K ₂] |
