APPLIED FINITE ELEMENT ANALYSIS

Department of Mechanical Engineering – SEAS

SRM UNIVERSITY A.P

Registration Number: _____

Name: _____

Branch & Section: _____

SRM UNIVERSITY AP
Andhra Pradesh

SRM UNIVERSITY – AP, ANDHRA PRADESH

End Term Examination, May 2025

[Question Paper ID: **008982]**

Subject Title	: APPLIED FINITE ELEMENT ANALYSIS	**Subject Code**	: MCE 705
Batch	: 2023, 2024	**Max Marks**	: 100
Degree	: Ph.D	**Duration**	: 3 hours
Branch	: CE, ME	**QP Set**	: ---

Section A (5 × 5 Marks = 25 Marks)

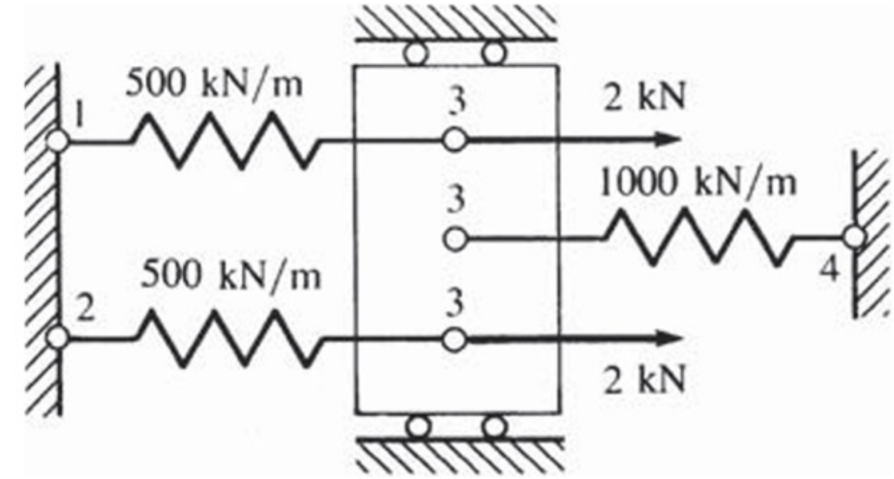
Answer **any 5** Questions

			Marks	BL	CO
1.	(a) Define the Finite Element Method (FEM) and explain its basic purpose in engineering analysis. [3 Marks] (b) Distinguish between continuous systems and discrete systems with suitable examples. [2 Marks]	**5**	5	2	1
2.	(a) Differentiate between classical (analytical) methods and numerical methods used in engineering analysis. [2 Marks] (b) What is the purpose of discretizing a continuum in numerical simulations, and what are the key advantages of this approach? [3 Marks]	**5**	5	3	1
3.	List and briefly explain the different types of finite elements used in Finite Element Analysis (FEA). [5 Marks]	**5**	5	2	2
4.	What types of errors affect the accuracy of FEA results? Discuss them briefly. [5 Marks]	**5**	5	2	2
5.	Explain the concept of shape functions in Finite Element Method. What are their key properties, and why are they important in the formulation of finite element equations? [5 Marks]	**5**	5	2	1
6.	What is the role of numerical integration in Finite Element Method (FEM), and how does the Gauss Quadrature method help in this process?	**5**	5	3	1
7.	Explain the concept of iso-parametric elements in Finite Element Analysis. How do they differ from sub-parametric and super-parametric elements? Discuss their advantages in numerical simulations. [5 Marks]	**5**	5	3	1

Section B (5 × 15 Marks = 75 Marks)

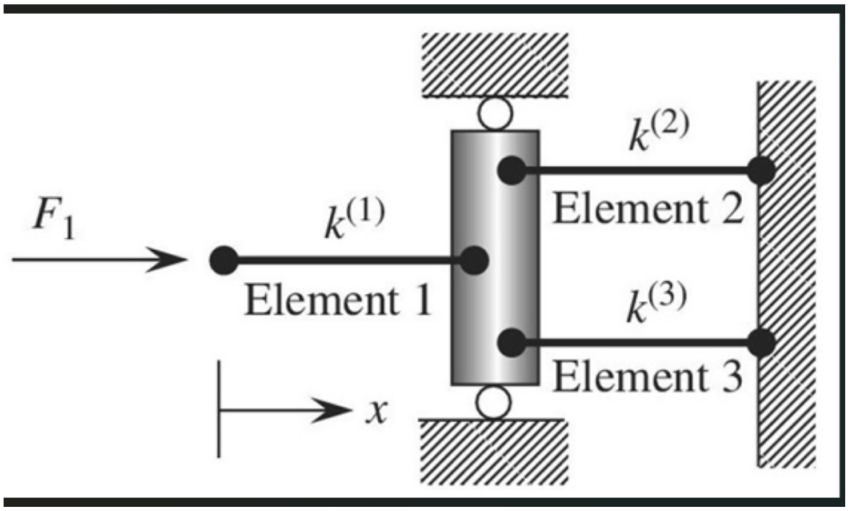
Answer **any 5** Questions

			Marks	BL	CO
8.	Explain the fundamental steps involved in the Finite Element Method (FEM) and discuss each step in detail with suitable examples. [15 Marks]	**15**	15	2	2
9.	(a) Define the State of Stress and State of Strain at a Point in a material? What are the rectangular stress and strain components, and how are they represented mathematically? [5 Marks] (b) What are the fundamental concepts of theory of elasticity and equations connecting these concepts and explain them briefly? [10 Marks]	**15**	15	2	1
10.	Name three commonly used methods for deriving the finite element equations. Briefly describe them. [15 Marks]	**15**	15	2	1
11.	For the spring assemblage shown in Figure, determine the nodal displacements, the forces in each element, and the reactions. Draw the Free Body Diagram of the Structure, and discuss the results. [15 Marks]				



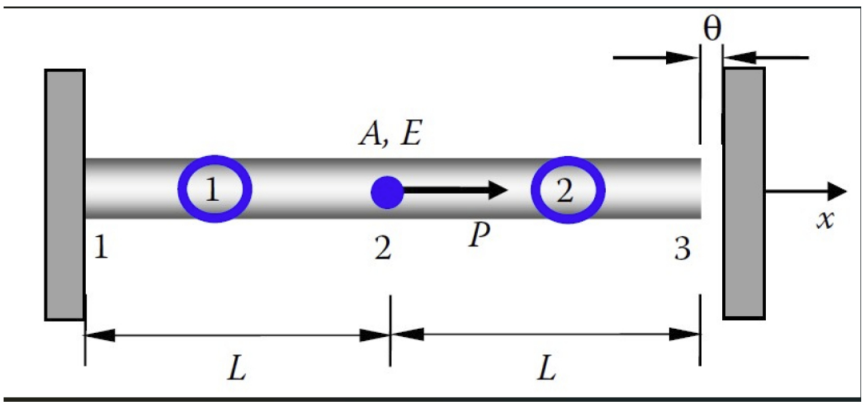
15 15 4 3

12. Consider an assembly of three two force members as shown in Figure (one dimensional structure with three uniaxial bar elements). Motion is restricted to one dimension along the axis. Determine the displacement of the rigid member, element forces, and reaction forces from the wall. Assume $k^1 = 50$ N/cm, $k^2 = 30$ N/cm, $k^3 = 70$ N/cm. and $F_1 = 40$ N. Draw the Finite Element Model, Free Body Diagram of the Structure, and discuss the results. [15 Marks] **15** **15** **4** **3**



13. Determine the support reaction forces at the two ends of the bar as shown in Figure. Determine the element forces and draw the free-body diagram to verify that the equilibrium of the forces is satisfied. [15 Marks] **15** **15** **4** **3**

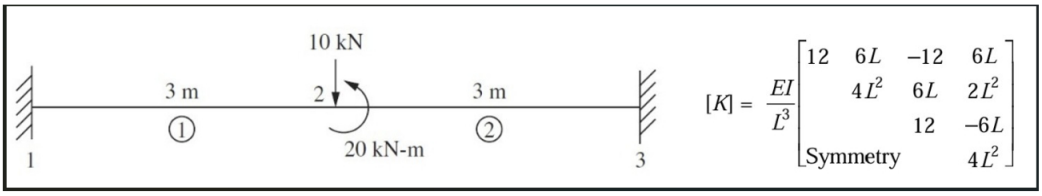
P = 6 x 10^4 N; E = 2.0 x 10^4 N/mm^2; A = 250 mm^2; L = 150 mm; θ = 1.2 mm



14. Fixed-fixed beam subjected to applied force and moment at the center of the beam as shown in Figure. The beam has been discretized into the two elements. A downward force of 10 kN and an applied moment of 20 kN-m act at the center of the beam.
E = 210 GPa and I = 4 x 10^{-4} m^4 throughout the beam length.

Determine (i) the displacement and rotation at the center of the beam, (ii) local nodal forces and moments for element; (iii) shear force and bending moment diagrams for each element [15 marks]

15 **15** **4** **3**



$$[K] = \frac{EI}{L^3}\begin{bmatrix} 12 & 6L & -12 & 6L \\ & 4L^2 & 6L & 2L^2 \\ & & 12 & -6L \\ \text{Symmetry} & & & 4L^2 \end{bmatrix}$$

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