

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER-VII EXAMINATION – WINTER 2025

Subject Code:3172008

Date:20-11-2025

Subject Name:Finite Element Analysis

Time:10:30 AM TO 01:00 PM

Total Marks:70

Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

MARKS

- Q.1** (a) Discuss applications of Finite Element Method. **03**
 (b) Compare Finite Element Solution to the Exact Solution for a Beam. **04**
 (c) Explain general steps of the Finite Element Method in detail **07**
- Q.2** (a) Explain source of error in FEA **03**
 (b) Explain the significance of the following terms related to a Finite Element Problem. **04**
 i. Approximation function
 ii. Boundary conditions
 (c) What is shape function? Derive linear shape functions for 1- dimensional bar element in terms of natural coordinate. Also plot variation of shape functions within this element **07**
- OR**
- (c) For the spring assemblage shown in Figure 1, Find (a) the global stiffness matrix, (b) the displacements of nodes 3 and 4, (c) Reaction force at node 1 and 2. **07**

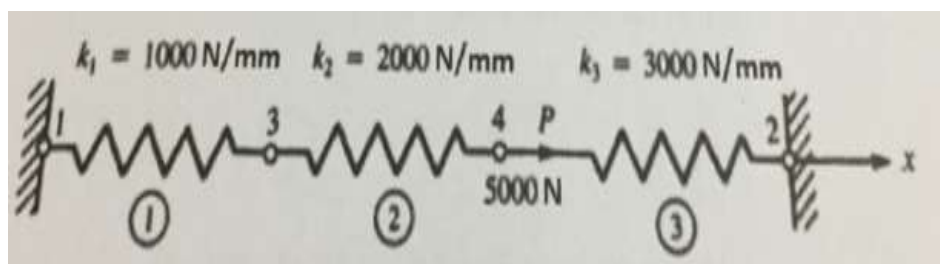
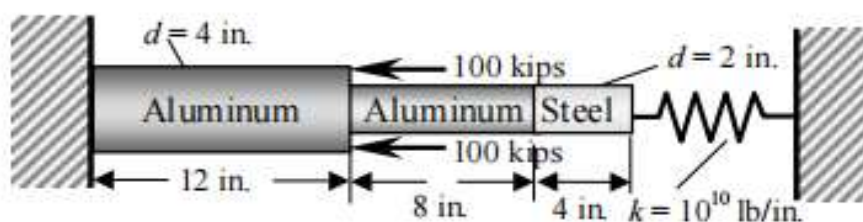


Figure-1

- Q.3** (a) Enlist types of software used in FEA. **03**
 (b) What do you mean by 'Discretization'? State precautions required during discretization **04**
 (c) Analyze the stepped bar with its right end supported by a linear axial spring (see below Figure-2). The boundary condition at $x = 24$ in is $EA(du/dx) + ku = 0$ **07**



Steel, $E_s = 30 \times 10^6$ psi, Aluminum, $E_a = 10 \times 10^6$ psi

Figure-2

OR

- Q.3 (a)** What are the conditions necessary to be followed for considering a problem as axisymmetric? **03**
- (b)** Differentiate between spring, bar and beam elements from general and application point of view. **04**
- (c)** A three bar truss is subjected to loading, as shown in figure-3. The modulus of elasticity for bar material is 200 GPa. The cross section area of each bar used for truss is 50 mm. If the length of the horizontal and vertical bars are 750 mm and 1000 mm respectively. Determine (a) The global stiffness matrix; (b) the nodal displacements; **07**

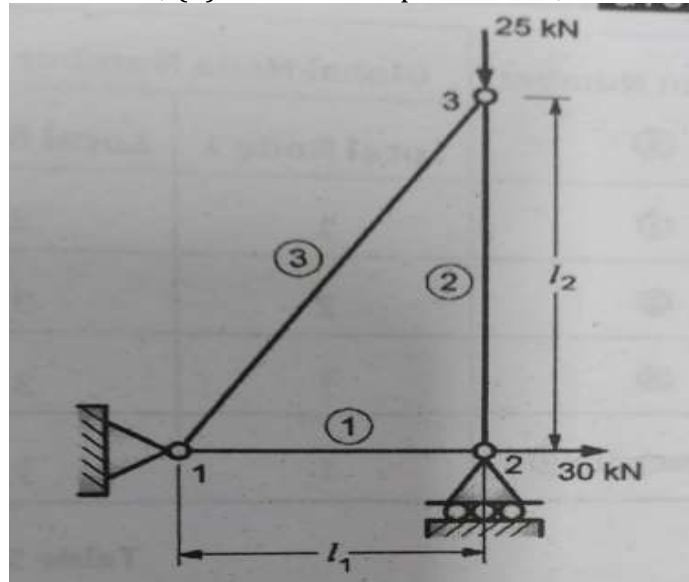


Figure-3

- Q.4 (a)** Define local and global coordinate system in trusses **03**
- (b)** Differentiate between plane stress and plane strain analysis giving a suitable example. **04**
- (c)** Find the stresses and compression in each section of the composite member shown in below Figure-4. Use $E_s = 30 \times 10^6$ psi, $E_a = 10^7$ psi, $E_b = 15 \times 10^6$ psi, and the minimum number of linear elements. **07**

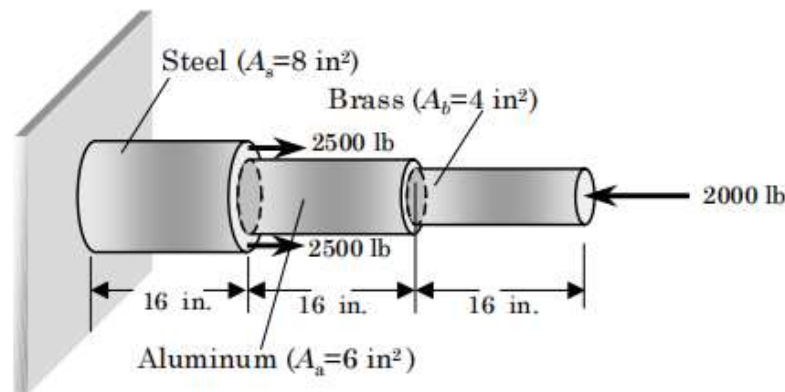


Figure-4

OR

- Q.4 (a)** Explain penalty approach used to solve FEA problem **03**
- (b)** What do you mean by thermal effects of temperature? How it is included in calculation for 1-D elements? **04**

- (c) Discuss the importance of dynamics in Finite Element Analysis. Also explain the different types of non-linearities. **07**
- Q.5** (a) What are the ways which a 3D problems can be reduced to a 2D approach? **03**
- (b) Draw a sketch of 2D and 3D elements used in FEA. **04**

- (c) Find the Jacobian matrices for triangle shown in following Figure-5 **07**

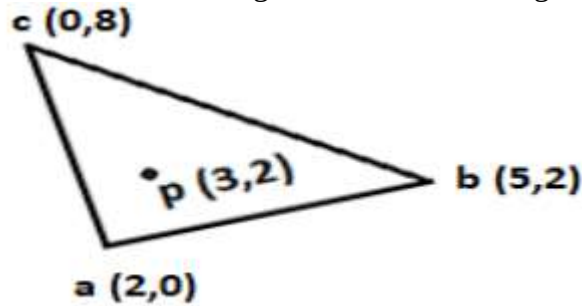


Figure-5

OR

- Q.5** (a) Explain evaluation of eigenvalues and eigenvectors in dynamic consideration. **03**
- (b) Explain in brief : CST & LST **04**
- (c) Discuss the different types of elements used in FEA with its application **07**
