Seat No./Enrollment No.: _____

GUJARAT TECHNOLOGICAL UNIVERSITY
BACHELOR OF ENGINEERING – SEMESTER 7 – EXAMINATION – SUMMER 2026

Subject Code: 3171920 **Date: 26/05/2026**

Subject Name: Finite Element Methods

Time: 02:30 PM TO 05:00 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.**

Q.1	**(a)**	Why FEA gives an approximate solution.	**03**
	(b)	What do you understand by discretization? What are the factors to be considered for discrediting the domain ?	**04**
	(c)	Explain step by step procedure for finite element method in detail.	**07**
Q.2	**(a)**	Enlist the three key Properties of the Global Stiffness Matrix ($\mathbf{K}$) when assembled for a general mechanical system.	**03**
	(b)	Comparison & contrast the Elimination Approach and the Penalty Approach for applying essential boundary conditions. Under what conditions is the Penalty Approach less accurate?	**04**
	(c)	A 2D truss is to be analyzed. Show the element stiffness matrix in the global coordinate system. Then, detail the procedure for Skyline Assembly of the Global Stiffness Matrix, assuming a specific optimal node numbering scheme	**07**

OR

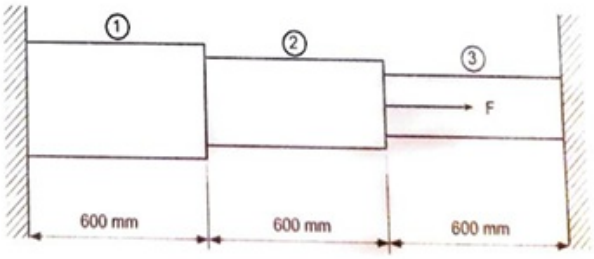
Q.2	**(c)**	Compare the solution obtained by Galerkin's method with exact solution for X= 0.5 and 1 for the following differential equation. $$\frac{d^2u}{dx^2} + u = x^2; 0 \le x \le 1$$ Consider quadratic polynomial function ($u = a_0 + a_1 x + a_2 x^2$).	**07**
Q.3	**(a)**	Draw different types of 1D, 2D and 3D elements.	**03**
	(b)	Critically evaluate and justify the importance of using Symmetry and Antisymmetry conditions for FE analysis of frames, specifically focusing on the computational benefits.	**04**
	(c)	Illustrate the Plane Frames element with neat sketch indicating degree of freedoms. How it is differed from beam element. Write element stiffness matrix K ,transformation matrix L and load vector F.	**07**

OR

Q.3	**(a)**	What are the ways through which 3D problems can be reduced to a 2D approach?	**03**
	(b)	Explain Evaluation of eigenvalues in dynamic consideration.	**04**

(c) A stepped shaft is shown in figure. Determine stresses and the deflections in each of the sections. **07**

Take E=90GPa and axial force F =50KN.



Q.4 **(a)** Source of error in FEA. **03**

(b) For a 3D truss, formulate the modified stiffness equations for an Inclined Support-Plane Constraint (a node can only move in a defined plane). Justify why this constraint requires special treatment. **04**

(c) Write short notes on:Gaussian quadrature integration technique. **07**

OR

Q.4 **(a)** Define shape function. What are the characteristics of shape function? **03**

(b) Define Iso-parametric element. **04**

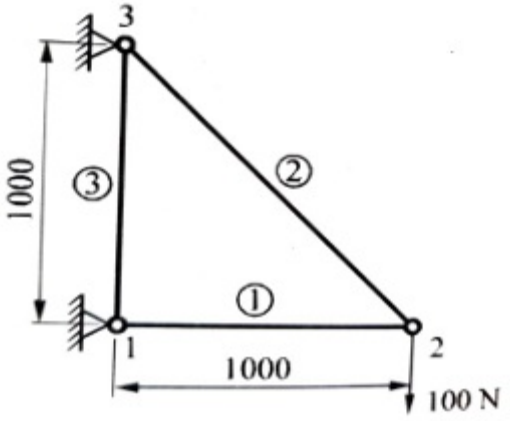
(c) Give potential energy approach to derive beam element equation **07**

Q.5 **(a)** Differentiate between the Axisymmetric Formulation and the Plane Stress/Strain Formulation in FEM, specifically regarding the degrees of freedom and the stress components involved. **03**

(b) How are the thermal effects considered in the analysis of 1 d linear elements. **04**

(c) Evaluate the deflection at node 2 for the truss element shown in figure. **07**

Take AE/L value as 1000 N/mm.



OR

Q.5 **(a)** What is element connectivity? **03**

(b) Discuss the applications of Finite Element Method. **04**

(c) Write properties of stiffness matrix K. Show the general node numbering scheme and the half bandwidth. **07**

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