



# GUJARAT TECHNOLOGICAL UNIVERSITY

**Master of Engineering**

**Subject Code: 3734704**

**Semester – III**

**Subject Name: Fundamentals of Finite Elemental Methods**

**Type of course:** Engineering

**Prerequisite:** Zeal to learn the subject

**Rationale:** This subject deals with fundamentals of Finite Element Methods and its applications, which are useful for Mechatronics engineers.

## Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

## Content:

Sr. No.	Content	Total Hrs
1	<b>Finite Element Method:</b> Basics, history and application, Comparison with other methods, Variational approach, Galerkin's Methods.	2
2	<b>Element and Boundary Condition:</b> Element shapes, interpolation function. Virtual energy principle, Rayleigh- Ritz method, stiffness matrix and properties, Boundary conditions, solution of system of equations, shape functions and characteristics, Basic equations of elasticity, strain displacement relations	4
3	<b>1-D structural problems</b> – axial bar element – stiffness matrix, load vector, temperature effects, Quadratic shape function. Analysis of Trusses – Plane Truss and Space Truss elements	4
4	<b>Analysis of beams</b> – Hermite shape functions – stiffness matrix – Load vector – Problems. <b>2-D problems</b> –CST, LST, force terms, Stiffness matrix, load vector, boundary conditions.	5
5	<b>Element types</b> - Isoparametric element – quadrilateral element, Shape functions – Numerical Integration – sub parametric and super parametric elements. <b>3-D problems</b> – Tetrahedral element – Jacobian matrix – Stiffness matrix.	5
6	<b>Dynamic Analysis</b> - Dynamic considerations, Dynamic equations – consistent mass matrix – Eigen Values, Eigen Vector, natural frequencies – mode shapes – modal analysis. Applications of numerical procedures to determine natural frequencies and mode shapes. Finite Element Method for dynamic analysis, Introduction to torsional problems	6



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Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30	30	20	10	5	5

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

### Reference Books:

1. Introduction to finite elements in Engineering by Tirupathi K. Chandrupatla and Ashok D. Belegundu.
2. Finite Element Procedures in Engineering analysis by K.J Bathe.
3. The finite element methods in Engineering – S.S. Rao - Pergamon, New York.
4. An Introduction to Finite Element Methods – J. N. Reddy – McGraw Hill.
5. A Textbook of Finite Element Analysis by P. Seshu
6. Concepts and applications of finite element analysis – Robert Cook

### Course Outcomes:

After learning the course the students should be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Learn the mathematical formulation of the finite element method and how to apply it to basic (linear) ordinary and partial differential equations.	25
CO-2	Learn how to implement the finite element method efficiently in order to solve a particular equation.	25
CO-3	Solve complicated 3D structural problems for stress analysis under impact loads.	25
CO-4	Formulate simple problems into finite elements and solve structural, impact and crash problems.	25

### List of Experiments:

1. Introduction to ANSYS – Modelling and analysis
2. Solve Problems on 1-D Spring elements
3. Solve Problems on beam elements



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4. Solve Problems on Truss element
5. Solve Problems on 2-D element
6. Solve problem on Bars with Constant and variable Cross-section Area, Stepped bars etc.
7. Solve problems on Bars of Tapered Cross section Area
8. To Perform Static analysis of a corner bracket
9. To Perform Modal Analysis of a Model Airplane Wing.
10. To Perform Interference Fit and Pin Pull-Out Contact Analysis.

### Major Equipment:

ANSYS Software or any other equivalent software

### List of Open Source Software/learning website:

NPTEL