



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Mechanical Engineering (CAD/CAM)

Subject Code: DI04065051

Subject Name: Finite Element Analysis

<b>w. e. f. Academic Year:</b>	2025-26
<b>Semester:</b>	4 <sup>th</sup>
<b>Category of the Course:</b>	Professional Elective - II

<b>Prerequisite:</b>	Basic mathematics, Basics of engineering mechanics, Basics of strength of materials
<b>Rationale:</b>	Finite Element Analysis (FEA) has become a fundamental tool in modern mechanical design and manufacturing. CAD-CAM engineers frequently work with CAD models, simulations, and virtual prototyping. This course enables students to understand how engineering components behave under loads, reduce physical prototyping cost, and improve design reliability. Learning FEA empowers students to create basic FE models, solving simple problems and interpret simulation results.

### Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
CO1	Understand the basic concept of finite element analysis.
CO2	Identify different element types & their degrees of freedom for specific engineering applications.
CO3	Describe mathematical modelling, shape functions, and basic formulation techniques used in FEA.
CO4	Formulate and solve simple 1-D bars and beams problems.
CO5	Perform pre-processing and post-processing operations using FEA software for simple industrial components.

### Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE(E)	PA(M)	PA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Mechanical Engineering (CAD/CAM)

Subject Code: DI04065051

Subject Name: Finite Element Analysis

## Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	<b>Concept of Finite Element Analysis</b> Introduction, Stresses and equilibrium, Boundary conditions, Strain-displacement relations, Stress-strain relations, Temperature effects, Need Advantages and Limitations of FEA, Applications of FEA, Errors in FEA.	10	20
2.	<b>Element Types &amp; Degrees of freedom</b> Introduction, Line elements (Bar, truss, beam, and frame element), Plane elements (Triangular, rectangular, quadrilateral, sector), Solid elements (Tetrahedron and hexahedron), Axisymmetric elements & their uses, Degrees of freedom	4	10
3.	<b>Mathematical Modeling &amp; Formulation</b> Introduction, Shape functions, Step by step procedure in FEA, Basic concept of variational approach and Galerkin's methods in FEA.	9	20
4.	<b>1-D Problems</b> Introduction, Finite element modeling of 1-D structures, Coordinate and linear shape function, Stiffness matrix, Load vector, Bar and Beam, Temperature effects.	14	30
5.	<b>Introduction to FEA Software &amp; Practical Applications</b> Introduction, Overview of FEA Software, Geometry Creation, Meshing, Material Assignment, Types of Loading & Boundary Conditions, Solution, Post processing, Industrial Applications (Simple models like Bar, Bracket, C-clamp, Bell-Crank Lever, Plate with Hole, etc.)	8	20
<b>Total</b>		<b>45</b>	<b>100</b>

## Suggested Specification Table with Marks (Theory):

Unit No.	Unit Name	Teaching Hours	Distribution of Theory Marks						Total Marks
			R	U	A	N	E	C	
1	Concept of Finite Element Analysis	10	8	7	0	0	0	0	15
2	Element Types & Degrees of freedom	4	3	2	2	0	0	0	7
3	Mathematical Modeling & Formulation	9	2	4	3	3	2	0	14
4	1-D Problems	14	3	5	7	4	1	0	20



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Mechanical Engineering (CAD/CAM)

Subject Code: DI04065051

Subject Name: Finite Element Analysis

5	Introduction to FEA Software & Practical Applications	8	2	4	4	2	1	1	14
<b>Total</b>		45	18	22	17	9	4	1	70

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

## References/Suggested Learning Resources:

### (a) Books:

1. Introduction to Finite Elements in Engineering – Tirupathi R. Chandrupatla, Ashok D. Belegundu
2. Finite Element Analysis for Engineering and Technology – R. K. Jain
3. A First Course in Finite Element Method – Daryl L. Logan
4. Finite Element Method – S. S. Rao
5. Finite Element Method: Fundamentals and Applications” – J. N. Reddy

### (b) Open source software and website:

1. <http://www.calculix.de>
2. <https://www.freecad.org/>
3. [www.elmerfem.org/](http://www.elmerfem.org/)
4. NPTEL video course on Basics of Finite Element Analysis
5. NPTEL video series on Introduction to Finite Element Method

## Suggested Course Practical List: If any

Sr. No	Title of Experiment	Time Required (Hours)
1	Introduction to FEA Software Interface	2
2	Create Simple Geometry using CAD/FEA Software	2
3	Applying Meshing to Geometry	2
4	Applying Boundary Conditions and Loadings on Geometry	2
5	FEA of a Uniform Bar With 1-D Element	4
6	FEA of a Stepped Bar With 1-D Element	4
7	FEA of a Tapered Bar With 1-D Element	4
8	FEA of Bar Under Temperature Effect With 1-D Element	4
9	Post-processing and Result Interpretation	2



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Mechanical Engineering (CAD/CAM)

Subject Code: DI04065051

Subject Name: Finite Element Analysis

---

10	Mini Project: Simple Engineering Component Analysis	4
----	---	---

## List of Laboratory/Learning Resources Required:

Sr.No.	Equipment Name with Broad Specification
1	Computer system with latest configuration.
2	Related software. (Any parametric modeling and analysis software like Creo, SolidWorks, Ansys, etc.)

## Suggested Project List:

1. FEA of a Cantilever Beam under Point Load
2. Stress Analysis of a Bolted Joint Using 1-D Elements
3. Thermal Stress Analysis of a Metal Rod Using FEA
4. Deflection Analysis of a Simply Supported Beam Using FEA
5. Study of Mesh Density Effect on Accuracy of Results
6. FEA of a Bracket under Static Loading
7. Parametric Study of Bar Element with Variable Cross-Section
8. Modal Analysis of a Simple Mechanical Component

## Suggested Activities for Students: If any

1. Identify components suitable for FEA in the workshop.
2. Practice discretization of basic shapes on graph paper.
3. Perform boundary condition identification for real components.
4. Evaluate effect of temperature load on a 1D element.
5. Perform pre-processing and create mesh refinements.
6. Post-process stress results from sample FEA files.
7. Prepare a report on applications of FEA in industry.
8. Model and analyze a simple bracket in FEA software.
9. Prepare a report on FEA software used in industry.

\* \* \* \* \*