

# MNE4005: FINITE ELEMENT ANALYSIS

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## Effective Term

Semester A 2025/26

## Part I Course Overview

### Course Title

Finite Element Analysis

### Subject Code

MNE - Mechanical Engineering

### Course Number

4005

### Academic Unit

Mechanical Engineering (MNE)

### College/School

College of Engineering (EG)

### Course Duration

One Semester

### Credit Units

3

### Level

B1, B2, B3, B4 - Bachelor's Degree

### Medium of Instruction

English

### Medium of Assessment

English

### Prerequisites

MNE2109/BME2109 Engineering Mechanics AND  
MNE2116 Engineering Graphics or  
MNE3007 CAD/CAM or equivalent

### Precursors

Nil

### Equivalent Courses

Nil

### Exclusive Courses

Nil

### Additional Information

#Prerequisites which are not part of the Major Requirement are waived for students admitted with Advanced Standing.

## Part II Course Details

### Abstract

The aims of this course are to develop:

- an understanding of basic principles, techniques and issues underlying modelling and computer-aided analysis of parts, products and other engineering systems; and
- a practical awareness of the above through the application of appropriate computer-aided engineering software.

### Course Intended Learning Outcomes (CILOs)

CILOs		Weighting (if DEC-A1 DEC-A2 DEC-A3 app.)		
1	Discuss the basic theory and methods on spline-based modelling.		x	
2	Explain methods and algorithms on mesh generation from a given surface or solid model.		x	
3	Explain properties of geometric models and methods for their evaluation.			
4	Elaborate the basic principles of finite-element analysis and their applications in stress/strain analysis and thermal stress analysis.		x	
5	Use finite-element methods and an appropriate computer aided engineering software to analyse parts, products and other engineering systems.		x	

#### A1: Attitude

Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

#### A2: Ability

Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

#### A3: Accomplishments

Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

### Learning and Teaching Activities (LTAs)

LTAs		Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Explain key concepts, theories and methods on modelling, mesh generation, property evaluation and finite element analysis.	1, 2, 3, 4	3 hrs/week
2	Laboratory Work	Use finite-element methods and appropriate computer aided engineering software to analyze parts or systems.	5	3 hrs/week for 2 weeks

**Assessment Tasks / Activities (ATs)**

	<b>ATs</b>	<b>CILO No.</b>	<b>Weighting (%)</b>	<b>Remarks ("- " for nil entry)</b>	<b>Allow Use of GenAI?</b>
1	Test and Assignments	1, 2, 3	20	-	Yes
2	Laboratory Exercises	4, 5	20	2 sets of exercises; developed reports should be submitted by students	Yes

**Continuous Assessment (%)**

40

**Examination (%)**

60

**Examination Duration (Hours)**

2.5

**Minimum Continuous Assessment Passing Requirement (%)**

30

**Minimum Examination Passing Requirement (%)**

30

**Additional Information for ATs**

For a student to pass the course, at least 30% of the maximum mark for both coursework and examination should be obtained.

**Assessment Rubrics (AR)****Assessment Task**

Test and Assignments

**Criterion**

Ability to explain key concepts, theories and methods on topics covered in relevant lectures.

**Excellent (A+, A, A-)**

High

**Good (B+, B, B-)**

Significant

**Fair (C+, C, C-)**

Moderate

**Marginal (D)**

Basic

**Failure (F)**

Not even reaching marginal levels

### Assessment Task

Laboratory Exercises

#### Criterion

Ability to use an appropriate computer aided engineering software to analyse parts or structures.

#### Excellent (A+, A, A-)

High

#### Good (B+, B, B-)

Significant

#### Fair (C+, C, C-)

Moderate

#### Marginal (D)

Basic

#### Failure (F)

Not even reaching marginal levels

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### Assessment Task

Examination

#### Criterion

Ability to explain key concepts, theories and methods on modelling, mesh generation, property evaluation and finite element analysis.

#### Excellent (A+, A, A-)

High

#### Good (B+, B, B-)

Significant

#### Fair (C+, C, C-)

Moderate

#### Marginal (D)

Basic

#### Failure (F)

Not even reaching marginal levels

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### Additional Information for AR

Note: For a student to pass the course, at least 30% of the maximum mark for both coursework and examination should be obtained.

## Part III Other Information

### Keyword Syllabus

- Modelling and engineering shape representation: Polynomials and polynomial functions. Spline-based modelling. NURBS for representing commonly used engineering shapes and geometries.

- Mesh generation: Delaunay triangulation. Parametric approaches and direct approaches for mesh generation. Advancing-front method for mesh generation. Surface mesh generation. Volume mesh generation.
- Evaluation of global geometric and mass properties: Curve length. Cross-sectional area. Surface area. Volume. Centroid. Mass. Moment of inertia.
- Finite-element analysis of mechanical structures: Types of elements, such as trusses, beams, and 2D and 3D solids. Model formulation. Boundary and loading conditions. Application in stress/strain analysis.
- Finite-element analysis in heat transfer and thermal stress: Fourier law of heat conduction and governing equation for steady-state conduction. Boundary conditions: specified temperature, specified heat flux and convection. Application in thermal stress calculation.

## Reading List

### Compulsory Readings

Title	
1	Nil

### Additional Readings

Title	
1	David F. Rogers, “An Introduction to NURBS: with Historical Perspectives” , Academic Press, San Francisco, 2001.
2	Ibrahim Zeid, “CAD/CAM Theory and Practice” , McGraw-Hill, New Delhi, 1991.
3	Joe F. Thompson, Bharat K. Soni and Nigel P. Weatherill, “Handbook of Grid Generation” , CRC Press, New York, 1999.
4	Charles E. Knight, “The Finite Element Method in Mechanical Design” , PWS-KENT Publishing Co., 1993.
5	Kenneth H. Huebner, Donald L. Dewhurst, Douglas E. Smith and Ted G. Byrom, The Finite Element Method for Engineers, John Wiley & Sons, Inc., New York, 2001.
6	Thomas J. R. Hughes, “The Finite Element Method: Linear Static and Dynamic Finite Element Analysis” , Dolver Publications Inc, New York, 2012.
7	J. Austin Cottrell, Thomas J. R. Hughes, Yuri Bazilevs, "Isogeometric Analysis: Toward Integration of CAD and FEA", John Wiley & Sons, 2009.