MNE4005: FINITE ELEMENT ANALYSIS

Effective Term
Semester A 2026/27

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
MNE3118 Mechanics of Materials

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 the basic principles, techniques and issues underlying finite-element modelling and computer-aided analysis of engineering structures and 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 app.)	DEC-A1	DEC-A2	DEC-A3
1	Discuss the basic theory, concepts and procedures of the finite element method.			x	
2	Explain the formulation and solution procedures of stiffness-based finite-element analysis for structural problems.			x	
3	Explain the behaviour and application of common finite elements, including spring, bar/truss, beam, two-dimensional and axisymmetric elements.			x	
4	Elaborate the basic principles of finite-element analysis and their applications in stress/strain analysis, heat transfer and thermal stress analysis.			x	
5	Use finite-element methods and an appropriate computer-aided engineering software to analyse engineering structures and interpret the quality of the numerical results.			x	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 of finite-element analysis, including stiffness method, element formulation, assembly procedures, structural analysis, heat transfer, thermal stress, vibration and dynamics, and weighted residual method.	1, 2, 3, 4	3 hrs/week
2	Laboratory Work	Use finite-element methods and appropriate computer-aided engineering software to analyse engineering structures and interpret numerical results.	5	3 hrs/week for 2 weeks

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Test / Assignments	1, 2, 3	20	-	Yes
2	Laboratory Exercises / Project Reports	4, 5	20	2 sets of laboratory/ project exercises; 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

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

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

- Introduction to finite element method: basic concepts of FEM; discretization of engineering problems; degrees of freedom; governing equations and boundary conditions; introduction to finite element analysis examples.
- Prerequisite knowledge: matrix algebra; linear elasticity; energy principles.
- Stiffness method: stiffness matrix of spring element; direct stiffness method; assembly of global stiffness matrix; properties of global stiffness matrix.
- Finite elements for structural analysis: bar/truss elements in local, 2D and 3D coordinates; beam elements in local, 2D and 3D coordinates; two-dimensional problems; constant-strain triangular element; other 2D elements; axisymmetric elements; isoparametric formulation for 2D and 3D elements; numerical integration; plate bending element.
- Finite-element analysis in advanced topics: nonlinearity; heat transfer; thermal stress; vibration and dynamics; weighted residual method.
- Computer-aided finite-element analysis: practical considerations of finite element modelling; use of symmetry; static condensation; substructures; equation solving; nature and convergence of FE solutions; software implementation using ABAQUS.

Reading List

Compulsory Readings

	Title
1	Daryl L. Logan, A First Course in the Finite Element Method, 4th Edition, PWS Publishing.

Additional Readings

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