MA4523: INTRODUCTION TO FINITE ELEMENT METHOD

Effective Term
Semester A 2022/23

Part I Course Overview

Course Title
Introduction to Finite Element Method

Subject Code
MA - Mathematics
Course Number
4523

Academic Unit
Mathematics (MA)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

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

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
MA3525 Elementary Numerical Methods

Precursors
MA3514 Numerical Methods for Differential Equations

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course introduces basic mathematical ideas of the finite element method, the most widely used numerical method in engineering. It develops students' ability to apply such techniques in solving differential equations.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	explain clearly fundamental concepts and principles of the finite element method in one-dimensional and two-dimensional problems.	15	x		
2	create and formulate finite element systems in both one and two dimensions.	25	x	x	
3	solve boundary value problem over a domain by finite element method.	25		x	x
4	implement criteria of the finite element method, such as triangulations of domains, determination of appropriate test-/trial- space, etc. for solving a range of problems on elasticity and structural analysis.	15		x	x
5	the combination of CILOs 1-4	20	x	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.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Learning through teaching is primarily based on lectures.	1, 2, 3, 4, 5	39 hours in total
2	Take-home assignments	Learning through take-home assignments helps students understand mathematical principles of the finite element method and apply the techniques in solving differential equations and analyzing errors.	1, 2, 3, 4	after-class

3	Project	Learning through project helps students implement mathematical and computational ideas of the finite element method to real-life applications in science or engineering. It also helps students to communicate and collaborate effectively in the team.	4	after-class

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Test	1, 2	20	Questions are designed for the first part of the course to see how well students have learned the basic ideas of the finite element method, including formulation of finite element systems over domains.
2	Hand-in assignments	1, 2, 3, 4	10	These are skills based assessment which enables students to implement the finite element method in elementary mathematical problems and engineering applications.
3	Project	4	10	Students are assessed on their ability in applying the finite element method computationally to model and solve a more sophisticated physical problem, as well as on the presentation of numerical results with analysis.
4	Formative take-home assignments	1, 2, 3, 4	0	The assignments provide students chances to demonstrate their achievements on the finite element method learned in this course.

Continuous Assessment (%)

40

Examination (%)

60

Examination Duration (Hours)
3

Additional Information for ATs
40% Coursework
60% Examination (Duration: 3 hours, at the end of the semester)
For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

Assessment Rubrics (AR)

Assessment Task
1. Test

Criterion
Ability in problem solving

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
2. Hand-in assignments

Criterion
Understanding of concepts and applications

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
3. Project

Criterion
Creativity and Team work ability

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
4. Formative take-home assignments

Criterion
Study attitude

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
5. Examination

Criterion
Comprehensive ability in independent problem solving

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

Part III Other Information

Keyword Syllabus

Piecewise polynomial subspaces in one-dimension: interpolation theory and error analysis. Solution of the resulting system of linear equations. Triangulations in the plane. Piecewise linear finite element method for Poisson’ s equation.

Reading List

Compulsory Readings

	Title
1	J.N. Reddy, Introduction to Finite Element Method, McGraw-Hill Education, 4th Edition, 2019.

Additional Readings

	Title
1	Nil