MNE3115: MICROELECTROMECHANICAL SYSTEMS

Effective Term
Semester A 2024/25

Part I Course Overview

Course Title
Microelectromechanical Systems

Subject Code
MNE - Mechanical Engineering
Course Number
3115

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
MNE2029/BME2029 Electrical and Electronic Principles I or equivalent

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

The aim of this course is to provide students with the understanding of the functioning and construction of micro-sensors and micro-actuators integrated into micro electro mechanical systems (MEMS). Students will learn about design and fabrication fundamentals for MEMS, including the on-chip implementations for sensors and actuators of micron-scale dimensions. Apart from learning details of microstructure fabrication with the aid of microtooling, mechanics of silicon and thin-film materials will also be covered as well as principles of thermal micromechanics, electrostatic force, piezoresistivity, and capacitance-based detection of motion. Application examples will focus on micro-sensors (primarily of pressure and acceleration). Characteristics of some of these devices will be determined in laboratory experiments. Students will have the opportunity to discover and innovate in these domains.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	DESCRIBE the mechanics of silicon and thin-film materials, principles of thermal micromechanics, electrostatic force, piezoresistivity, and capacitance-based detection of motion.			x	
2	IDENTIFY key microstructures related to the MEMS functions and fabrication protocols.			x	
3	EVALUATE features of micro-transducers.			x	
4	DEVELOP MEMS systems using feasible sensing or/and actuation principles based on theoretical models and analysis of system characteristics for optimal system performance.		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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Students will engage in formal lectures to gain knowledge about key concepts of MEMS.	1, 2, 3, 4	2 hrs/week
2	Tutorial / Group Presentation	Students will engage in tutorial activities and participate in group presentations.	2, 3, 4	1 hr/week

3	Laboratory Work	Students will engage in laboratory work that will be group activity requiring teamwork. The group activities will emphasise opportunities for discovering key concepts in microfabrication and MEMS design.	3, 4	3 hrs/week for two weeks

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Test	1, 2	20	20% marks, 1.5 hours
2	Laboratory Reports	3, 4	10	Lab reports to be submitted
3	Group Presentation	2, 3, 4	20	Group presentations on selected topic.

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

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

Laboratory Reports

Criterion

Ability to explain the methodology and procedure, analyse the experimental data, and discuss the experimental findings.

Excellent (A+, A, A-)

Strong evidence of critical thinking; good organization, capacity to analyse and synthesize; superior grasp of subject matter; evidence of extensive knowledge of the experimental matters concerned.

Good (B+, B, B-)

Evidence of grasp of subject, some evidence of critical capacity and analytic ability; reasonable understanding of issues; evidence of familiarity with experiment.

Fair (C+, C, C-)

Student who is profiting from the laboratory class; understanding of the subject; ability to develop solutions to concerning the experiment.

Marginal (D)

Sufficient familiarity with the laboratory content to enable the student to move onto other laboratory materials.

Failure (F)
Little evidence of familiarity with the laboratory class materials; weakness in critical and analytic skills; limited, or irrelevant use of data.

Assessment Task
Group Presentation

Criterion
Make group presentations on selected topic to demonstrate discovery learning.

Excellent (A+, A, A-)
Strong evidence of original thinking; excellent organization; evidence of extensive knowledge; excellent presentation skill.

Good (B+, B, B-)
Significant evidence of original thinking; good organization; evidence of extensive knowledge; good presentation skill.

Fair (C+, C, C-)
Fair evidence of original thinking; fair organization; evidence of knowledge; fair presentation skill.

Marginal (D)
Some evidence of original thinking; poor organization; poor presentation skill.

Failure (F)
Little evidence of original thinking; very poor organization; very poor presentation skill.

Assessment Task
Test

Criterion
Apply the concepts of MEMS to solve problems and answer the questions correctly and properly.

Excellent (A+, A, A-)
Strong evidence of original thinking; good organization, capacity to analyse and synthesize; superior grasp of subject matter; evidence of extensive knowledge base.

Good (B+, B, B-)
Significant evidence of grasp of subject, some evidence of critical capacity and analytic ability; reasonable understanding of issues; evidence of familiarity with course matter.

Fair (C+, C, C-)
Student is profiting from the university experience; understanding of MEMS; ability to develop solutions to simple problems in the course.

Marginal (D)
Basic familiarity with the subject matter to enable the student to progress without repeating the course.

Failure (F)
Little evidence of familiarity with the subject matter; weakness in critical and analytic skills; very limited demonstration of correct use knowledge in MEMS.

Assessment Task

Examination

Criterion

Ability to explain the methodology and procedure related to microfabrication, and to design and model MEMS.

Excellent (A+, A, A-)

Strong evidence of original thinking; good organization, capacity to analyse and synthesize; superior grasp of subject matter; evidence of extensive knowledge base.

Good (B+, B, B-)

Significant evidence of grasp of subject, some evidence of critical capacity and analytic ability; reasonable understanding of issues; evidence of familiarity with course matter.

Fair (C+, C, C-)

Student is profiting from the university experience; understanding of MEMS; ability to develop solutions to simple problems in the course.

Marginal (D)

Basic familiarity with the subject matter to enable the student to progress without repeating the course.

Failure (F)

Little evidence of familiarity with the subject matter; weakness in critical and analytic skills; very limited demonstration of correct use knowledge in MEMS.

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

Micro-sensors, micro-actuators, and micro electro mechanical systems (MEMS); design and fabrication for MEMS, on-chip implementations; microtooling; mechanics of silicon and thin-film materials, thermal micromechanics, electrostatic force, piezoresistivity, and capacitance-based detection of motion; micro-mirror displays and semiconductor and optical micro-sensors.

Reading List

Compulsory Readings

	Title
1	Franssila, S. (2004, and 2010). Introduction to microfabrication. Hoboken, New Jersey, John Wiley & Sons Inc.

Additional Readings

	Title
1	Lee, K. B. (2011). Principles of microelectromechanical systems. Hoboken, New Jersey, John Wiley & Sons Inc.