MNE3115: MICROELECTROMECHANICAL SYSTEMS

Effective Term
Semester A 2022/23

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
MBE2003/MNE2003 Mechanics or
MBE2109/BME2109/MNE2109 Engineering Mechanics AND
MBE2029/BME2029/MNE2029 Electrical and Electronic Principles I or equivalent

Precursors
Nil

Equivalent Courses
MBE3115 Microelectromechanical Systems

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, fluidic damping, 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, fluidic damping, 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.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Introduction of key concepts, and the project and guidelines.	1, 2, 3, 4	3 hrs/week

2	Laboratory Work	Laboratory work will be group activity requiring teamwork. The large- and small-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	Laboratory Reports	3, 4	15	Lab reports to be submitted
2	Group Presentation	2, 3, 4	15	Group presentations on selected topic.
3	Test	1, 2	20	20% Marks, 1.5 hours

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 and analyse the experimental results obtained in the laboratories. Make group presentations on selected topic.

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
Group Presentation

Criterion
Ability to explain and analyse the experimental results obtained in the laboratories. Make group presentations on selected topic.

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
Test

Criterion
Answer the questions correctly and properly.

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 the methodology and procedure related to microfabrication, and to design and model microelectromechanical systems.

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
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, fluidic damping, 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.
2	Schomburg, W. K. (2011). Introduction to Microsystem Design. New York, Springer Press.

Additional Readings

	Title
1	Lee, K. B. (2011). Principles of microelectromechanical systems. Hoboken, New Jersey, John Wiley & Sons Inc.
2	Liu, C. (2011). Foundations of MEMS. Upper Saddle River, New Jersey, Prentice Hall.