MNE8120: MICROFLUIDICS: FROM FUNDAMENTALS TO APPLICATIONS

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Microfluidics: From Fundamentals to Applications

Subject Code
MNE - Mechanical Engineering
Course Number
8120

Academic Unit
Mechanical Engineering (MNE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
R8 - Research Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Bachelor level Fluid Mechanics

Equivalent Courses
MNE6127 Microfluidics: From Fundamentals to Applications

Exclusive Courses
Nil

Part II Course Details

Abstract

Microfluidics technology involves systems that manipulate and process small amounts of fluids at the microscale, which has been matured into a multidisciplinary subject that profoundly impacts both scientific research and real-world products. This course is to teach the students who are seeking a degree of Doctor of Philosophy relevant to fluid mechanics, covering an introduction to the fundamental concepts, manufacturing methods, basic classifications, and practical applications of microfluidic systems. The course aims to equip students with knowledge of both fundamentals and applications of microfluidics, with deep insight into various microfluidic systems useful for tackling key issues in multidisciplinary fields such as engineering, chemistry, biology, and medicine, and with skills in analysing and designing microfluidic systems for advanced research and development applications.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe fundamental concepts, manufacturing methods, basic classifications, and practical applications of microfluidics technology.		x		
2	Explain the features and dynamics of microscale fluid flows and calculate the problems with fluid mechanics.		x	x	
3	Identify the microfluidic systems and related fluid mechanics in real-world products, reveal the underlying scientific principle and problem, analyse the problem with critical thinking, and demonstrate the idea with a mini-project.			x	
4	Apply the concepts, principles, and methods related to microfluidics to the analysis and design of microsystems for advanced research and development applications.			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	Taken place in the classroom, the main teaching activities will be in the form of lectures, which will be given on the topics of the keyword syllabus.	1, 2, 3, 4	2 hrs/week

2	Tutorial	Taken place in the classroom, tutorials are problem-solving sessions used to strengthen students' understanding of the contents by learning different microfluidics applications.	1, 2, 3, 4	1 hr/week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Test/Assignments	1, 2	20	
2	Mini-projects	3, 4	40	
3	Examination	1, 2		

Continuous Assessment (%)

60

Examination (%)

40

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

0

Minimum Examination Passing Requirement (%)

0

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/Assignments (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to understand basic concepts related to microfluidics.

Excellent

(A+, A, A-) 75%-100%

Good

(B+, B, B-) 60%-74%

Fair

(C+, C, C-) 45%-59%

Marginal

(D) 40%-44%

Failure
(F) <40%

Assessment Task
Mini-projects (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
Ability to explain in detail and apply the learned knowledge to the analysis and design of systems using microfluidic components for advanced scientific research and practical applications.

Excellent
(A+, A, A-) Strong evidence of critical thinking; good capacity to analyze; superior grasp of subject matter; evidence of extensive knowledge of the project concerned.

Good
(B+, B, B-) Evidence of grasp of subject matter, some evidence of critical thinking and analysis; reasonable understanding of concepts; ability to develop the project.

Fair
(C+, C, C-) Student who is profiting from the project; understanding of the subject matter; evidence of familiarity with the project.

Marginal
(D) Basic familiarity with the subject matter to enable the student to use knowledge in the project.

Failure
(F) Little evidence of familiarity with the subject matter to accomplish the project.

Assessment Task
Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
Ability to understand the key concepts, principles, methods, and applications of microfluidic systems used in both scientific research and real-world products.

Excellent
(A+, A, A-) 75%-100%

Good
(B+, B, B-) 60%-74%

Fair
(C+, C, C-) 45%-59%

Marginal
(D) 40%-44%

Failure
(F) <40%

Assessment Task
Test/Assignments (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Ability to understand basic concepts related to microfluidics.

Excellent
(A+, A, A-) 75%-100%

Good
(B+, B) 65%-74%

Marginal
(B-, C+, C) 50%-64%

Failure
(F) <50%

Assessment Task
Mini-projects (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Ability to explain in detail and apply the learned knowledge to the analysis and design of systems using microfluidic components for advanced scientific research and practical applications.

Excellent
(A+, A, A-) Strong evidence of critical thinking; good capacity to analyse problem; superior grasp of subject matter; evidence of extensive knowledge of the project concerned.

Good
(B+, B) Evidence of grasp of subject matter, some evidence of critical thinking and analysis; reasonable understanding of concepts; ability to develop the project.

Marginal
(B-, C+, C) Student who is fairly profiting from the project; mediocre understanding of the subject matter; fair evidence of familiarity with the project.

Failure
(F) Little evidence of familiarity with the subject matter to accomplish the project.

Assessment Task
Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Ability to understand the key concepts, principles, methods, and applications of microfluidic systems used in both scientific research and real-world products.

Excellent
(A+, A, A-) 75%-100%

Good
(B+, B) 65%-74%

Marginal

(B-, C+, C) 50%-64%

Failure

(F) <50%

Part III Other Information

Keyword Syllabus

Microfabrication, Microscale fluid mechanics, Electrokinetics, Micromixing, Surface wettability, Droplet microfluidics, Digital microfluidics, Inertial microfluidics, Open microfluidics, Microfluidics-enabled soft manufacture

Reading List

Compulsory Readings

	Title
1	Nam-Trung Nguyen, Steven T. Wereley and Seyed Ali Mousavi Shaegh "Fundamentals and Applications of Microfluidics", Artech House, 3rd Edition, 2019.
2	Yuxiang Zhang and Liqiu Wang, "Microfluidics: Fabrication Droplets, Bubbles and Nanofluids Synthesis". Advances in Transport Phenomena 171-294, Springer-Verlag, Heidelberg, 2011.
3	Patrick Tabeling "Introduction to Microfluidics", OUP Oxford, 2005.
4	Edited by Bingcheng Lin, "Microfluidics: Technologies and Applications", Springer Berlin Heidelberg, 2011.
5	Jean Berthier, "Micro-Drops and Digital Microfluidics", Elsevier, 2nd Edition, 2013.
6	Jean Berthier, Kenneth A Brakke and Erwin Berthier, "Open Microfluidics", John Wiley & Sons, 2016.
7	Pingan Zhu and Liqiu Wang, "Microfluidics-Enabled Soft Manufacture", Springer Nature, 2022.

Additional Readings

	Title
1	Students are encouraged to seek out related research publication to widen their scope in the subjects.