

MNE6127: 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

6127

Academic Unit

Mechanical Engineering (MNE)

College/School

College of Engineering (EG)

Course Duration

One Semester

Credit Units

3

Level

P5, P6 - Postgraduate Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

Nil

Precursors

Bachelor level Fluid Mechanics

Equivalent Courses

MNE8120 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 Master of Science 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 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
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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

Continuous Assessment (%)

60

Examination (%)

40

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**

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 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 scientific research and practical applications.

Excellent

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

Good

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

Marginal

(B-, C+, C) 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 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.