COURSE OUTLINE

(1) GENERAL INFORMATION

SCHOOL	SCHOOL OF APPLIED MATHEMATICAL AND PHYSICAL SCIENCES		
DEPARTMENT	SCHOOL OF APPLIED MATHEMATICAL AND PHYSICAL SCIENCES		
LEVEL OF STUDIES	POSTGRADUATE		
MSc PROGRAM	MICROSYSTEMS AND NANODEVICES		
COURSE CODE	**9964**	**SEMESTER**	**2**
COURSE TITLE	MICROFLUID MECHANICS		

INDEPENDENT TEACHING ACTIVITIES *In cases where credits are awarded to discrete parts of the course (e.g., Lectures, Laboratory Exercises, etc.), specify them. If credits are awarded as a whole, specify weekly teaching hours and total credits.*	**WEEKLY TEACHING HOURS**	**ECTS**
Lectures – Exercises	3	6
Laboratory	0	
Assignments	0	
(Additional rows may be added if necessary. Detailed descriptions of teaching organization and methods are provided in section (d).)		

COURSE TYPE *general background, specialized background, specialization, skill development*	SPECIALIZATION (for Streams or Specialization Compulsory courses)
PREREQUISITES:	[REQUIRED BACKGROUND KNOWLEDGE]: Mechanics, basic knowledge of differential and integral calculus, and fluid mechanics
LANGUAGE OF INSTRUCTION and EXAMINATION:	GREEK
COURSE AVAILABLE TO ERASMUS STUDENTS	YES (offered in English as a reading course).
COURSE WEBSITE (URL)	

(2) LEARNING OUTCOMES

Learning Outcomes

This section describes the learning outcomes of the course, specifying the knowledge, skills, and competencies at the appropriate level that students will acquire upon successful completion of the course.

Refer to Appendix A:

- *Description of the Level of Learning Outcomes for each cycle of studies according to the European Higher Education Area Qualifications Framework*
- *Descriptive Indicators for Levels 6, 7, & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B.*
- *Concise Guide to Writing Learning Outcomes*

Knowledge:

The objectives of the course are:

a) To gain insights into the differential analysis of flow in microchannels and the stresses in the flow field.

b) To understand the unique characteristics of fluid flow in microfluidic systems and the methods for predicting flow fields within them.

c) To acquire knowledge about existing microfluidic devices (e.g., micromixers, microreactors, separation devices, micropumps).

d) To gain insights into the fabrication and packaging technology of microfluidic systems and their applications in chemical and biochemical analysis.

Skills:

Upon successful completion of the course, students will be able to:

- Understand current research directions and applications of microfluidic systems.
- Grasp the unique flow characteristics in microfluidic systems and the methods for predicting flow fields within them.
- Understand methods for solving the flow field in microchannels.
- Comprehend the fundamental principles of designing microfluidic systems.

General Competencies

Considering the general competencies that graduates are expected to acquire (as stated in the Diploma Supplement), which competencies does this course aim to develop?.

Data search, analysis, and synthesis, utilizing necessary technologies	*Generation of new research ideas*
Adaptability to new situations	*Project design and management*
Decision-making	*Respect for diversity and multiculturalism*
Independent work (primarily through assignments completed at home)	*Respect for the natural environment*
Teamwork	*Exhibiting social, professional, and ethical responsibility and sensitivity to gender issues*
Working in an international environment	*Critical and self-critical thinking*
Working in an interdisciplinary environment	*Promotion of free, creative, and inductive thinking*

Competencies:

Successful completion of the course develops the ability to:

- Work independently.
- Search for, analyze, and synthesize data and information (using necessary technologies) and adapt it to specific technological problems with appropriate and reasonable approximations.
- Generate new research ideas (through literature review in contemporary research areas of microfluidics).
- Work collaboratively (through group assignments).
- Use simulation software for microfluidic systems.

(3) COURSE CONTENT

The course is divided into 5 sections:

Section A: Historical development, importance of miniaturization and integration, forecasts for commercial exploitation of microfluidic devices and systems

Section B: The basic concepts of fluids and conservation laws of fluid mechanics. Basic concepts of fluid kinematics, forces (stresses) in fluids and fluid deformation. The differences in transport phenomena in macro- and microchannels are presented.

Section C: Microfluidic systems: micromixers, microreactors, separation microdevices, micropumps.

Section D: Basic principles of mathematical modeling and simulation of microfluidic systems

Section E: Microfabrication technology, fabrication and packaging methods of microfluidic devices on Si, glass, plastic substrates and paper. Applications in (bio)chemical microanalysis and life sciences, diagnostic laboratories on a chip (Lab-on-a-chip), and organ-on-a-chip for disease diagnosis.

(4) TEACHING AND LEARNING METHODS - ASSESSMENT

TEACHING METHOD *In person, Distance Learning etc.*	In person
USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT) *Use of Information and Communication Technologies (ICT) in Lecturing, Laboratory Training, Communication with Students*	Course Notes, Assignments for Home Study **(**Assignments are provided by the lecturer, and students are required to submit completed work).
ORGANIZATION OF TEACHING *A detailed description of the teaching methods and approaches used in the course, which may include:* *Lectures, Seminars, Laboratory Exercises, Fieldwork, Study and Analysis of Bibliography, Tutorials, Internships, Clinical Exercises, Art Workshops, Interactive Teaching, Educational Visits, Project Development, Report Writing/Assignments, Artistic Creation.* *The student's study hours for each learning activity, as well as hours of independent study, are outlined in accordance with ECTS principles.*	

Activity	***Semester Workload***
Lectures	13x3=39 hours
Study	13x2=26 hours
Home Assignments/Exercises	6x5 + 20 = 50 hours
Laboratory	0
Completion/Presentation of Project	20 hours
Educational Visits	0
Examinations	3 hours
Total Course Load	[ECTSx13x1,8] 138

STUDENT ASSESSMENT *Description of the Assessment Process* *Language of Assessment, Assessment Methods, Formative / Summative Assessment Methods, Multiple-choice tests, Short-answer questions, Essay-style questions, Problem-solving exercises, Written assignments, Reports, Oral examinations, Public presentations, Laboratory work, Clinical patient examinations, Artistic interpretations, Other methods, as appropriate* *The assessment criteria are clearly defined and provided to students, ensuring transparency in the evaluation process. These criteria are accessible through the course's online platform where students can review them at any time.*	Language of Assessment: Greek (for Erasmus students: English) Homework Assignments: 35% of the final grade Written Examination (problem-solving): 50% of the final grade Project Completion/Presentation: 15% of the final grade These assessment criteria will be explicitly stated on the Helios electronic platform.

(5) RECOMMENDED BIBLIOGRAPHY

Recommended Bibliography

- *A. T. Papaioannou, Fluid Mechanics, 3rd edition, 2020, Sophia Publications*
- *Bruus, Theoretical Microfluidics, 2007, Oxford University Press*
- *S. Tsaggaris, Fluid Mechanics, 2005, Simeon Publishing.*
- *F. M. White, Fluid Mechanics, 8th edition, 2015, McGraw-Hill.*
- *G. Karniadakis, A. Beskok, Microflows and Nanoflows: Fundamentals and Simulation, 2005, Springer.*
- *O. Geschke, H. Klank, P. Telleman, Microsystem Engineering of Lab-on-chip Devices, 2004, Wiley-VCH Verlag GmbH.*
- *Tserepi, Lecture Notes on "Microfluidic Systems: Fabrication Technology and Applications in Micro-Analysis" (in ppt format).*
- *Selected review articles.*