COURSE OUTLINE

(1) GENERAL

SCHOOL	Engineering		
ACADEMIC UNIT	Mechanical Engineering		
LEVEL OF STUDIES	*Undergraduate*		
COURSE CODE	EN0701	**SEMESTER**	7th
COURSE TITLE	Modelling and Simulation using the Software Environment OpenFoam		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures, Practical Exercises	5	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialized general knowledge, skills development*	Elective. General background, development of skills, application of general core principles
PREREQUISITE COURSES:	N/A
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	No
COURSE WEBSITE (URL)	https://www.mie.uth.gr/?page_id=18391&lang=en

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

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

- Construct meshes for modeling simple and complex topologies in 2D and 3D geometries.
- Spatially modify meshes to address points with discontinuities or boundary layers.
- Assign boundary conditions for temperature, pressure, velocity, and other thermodynamic and flow properties according to the specific problem.
- Utilize the OpenFOAM computational toolbox to solve physical problems involving transport phenomena.
- Use visualization software for processing and calculating physical quantities.
- Prepare technical reports that present all problem parameters, assumptions, and solution methodology.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
	Respect for difference and multiculturalism
Adapting to new situations	*Respect for the natural environment*

Decision-making *Working independently* *Team work* *Working in an international environment* *thinking Working in an interdisciplinary environment* *Production of new research ideas*	*Showing social, professional and ethical responsibility and sensitivity to gender issues* *Criticism and self-criticism* *Production of free, creative and inductive* *……* *Others…* *…….*

Understanding fundamental principles of modeling physical systems and processes

Searching, analyzing, and synthesizing data and information using technological tools

Teamwork

Autonomous work

Producing a comprehensive solution and description for physical and technological problems

(3) SYLLABUS

3.1 Problem Modeling

Distinguishing between 2D and 3D problems, and between time-dependent and steady-state problems. Formulating assumptions and algebraically expressing equations. Selecting appropriate solvers for problem resolution.

3.2 Geometry & Mesh Generation

Using suitable software for geometry construction with the boundary representation (BREP) methodology. Generating geometries with the constructive solid geometry method. Introduction to using Boolean operators for constructing complex geometries. Identifying critical points for local mesh optimization. Constructing orthogonal and non-orthogonal meshes. Mesh quality criteria.

3.3 Assumption Selection

Simplifying N-S equations based on the problem type: 1. time-dependent/steady-state, 2. with or without turbulence, 3. with heat/mass transfer, 4. multiphase or not, 5. phase change. Selecting a turbulence model. Choosing appropriate thermophysical models.

3.4 Boundary Condition Modeling

Assigning appropriate periodic conditions to the generated geometry. Algebraic formalization of boundary conditions. Initializing boundary conditions. Initializing the field. Modeling source terms. Distinguishing between different types of boundary conditions (general, wall, moving, symmetric).

3.5 Problem Solving

Selecting the appropriate solver for each quantity being solved. Choosing the corresponding algorithm (PISO, SIMPLE, PIMPLE). Defining solver limits. Using and adjusting multigrid solvers. Adjusting time steps according to the Courant number. Adjusting residual coefficients.

3.6 Results Processing

Using OpenFOAM's utility programs for results extraction. Using ParaView for results visualization. Extracting results and performing calculations on them within the ParaView environment. Creating contours and streamlines.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY ***Face-to-face, Distance learning, etc.***	In class lectures.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of geometry generation software • Use of computational mesh generation software • Use of physical process modeling software • Use of results processing software
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non- directed study according to the principles of the ECTS*	See workload table below
STUDENT PERFORMANCE EVALUATION ***Description of the evaluation procedure*** *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open- ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Language of assessment: Greek Assessment methods: Inferential reasoning, Problem-solving, Written assignments, Report, Public presentation

Activity	*Semester workload*
Lectures	55
Self-evaluating exercises	15
Problem solving	45
Software use	*25*
Tutorials	10
TOTAL	*150*

(5) **ATTACHED BIBLIOGRAPHY**

- Suggested bibliography:

The Finite Volume Method in Computational Fluid Dynamics: An Advanced Introduction with OpenFOAM® and Matlab

Roache, P. J. (1998). Verification and validation in computational science and engineering (Vol. 895): Hermosa Albuquerque, NM.

H. Versteeg, W. Malalasekra - An Introduction to Computational Fluid Dynamics_ The Finite Volume Method Approach-Prentice Hall (1996)