SYLLABUS

Introduction in Computational Fluid Dynamics

University year 2025-2026

1. Information regarding the programme

1.1. Higher education institution	Babeş-Bolyai University
1.2. Faculty	Mathematics and Computer Science
1.3. Department	Mathematics
1.4. Field of study	Mathematics
1.5. Study cycle	Master
1.6. Study programme/Qualification	Advanced Mathematics
1.7. Form of education	Full-Time

2. Information regarding the discipline

2.1. Name of the discipline	**Introduction in Computational Fluid Dynamics**					Discipline code	**MME3405**
2.2. Course coordinator					Prof. dr. Teodor Grosan		
2.3. Seminar coordinator					Prof. dr. Teodor Grosan		
2.4. Year of study	**2**	2.5. Semester	**3**	2.6. Type of evaluation	**E**	2.7. Discipline regime	**DS/Optional**

3. Total estimated time (hours/semester of didactic activities)

3.1. Hours per week	**3**	of which: 3.2 course	**2**	3.3 seminar/laboratory	**1**
3.4. Total hours in the curriculum	42	of which: 3.5 course	24	3.6 seminar/laborator	14
Time allotment for individual study (ID) and self-study activities (SA)					30
Learning using manual, course support, bibliography, course notes (SA)					20
Additional documentation (in libraries, on electronic platforms, field documentation)					30
Preparation for seminars/labs, homework, papers, portfolios and essays					20
Tutorship					33
Evaluations					30
Other activities:					-

3.7. Total individual study hours	**133**
3.8. Total hours per semester	**175**
3.9. Number of ECTS credits	**7**

4. Prerequisites (if necessary)

4.1. curriculum	Numerical analysis, Fluid Mechanics
4.2. competencies	Matlab, programming

5. Conditions (if necessary)

5.1. for the course	Classroom with blackboard/video projector
5.2. for the seminar /lab activities	Classroom with blackboard/video projector, Matlab software

6.1. Specific competencies acquired [1]

[1] One can choose either competences or learning outcomes, or both. If only one option is chosen, the row related to the other option will be deleted, and the kept one will be numbered 6.

Professional/essential competencies	C4.1 Defining basic concepts, theory and mathematical models C4.2 Interpretation of mathematical models C4.3 Identifying the appropriate models and methods for solving problems
Transversal competencies	CT1 Application of efficient and rigorous working rules, manifest responsible attitudes towards the scientific and didactic fields, respecting the professional and ethical principles. CT3 Use of efficient methods and techniques for learning, information, research and development of abilities for knowledge acquiring, for adapting to the needs of a dynamic society and for communication in a widely used foreign language

6.2. Learning outcomes

Knowledge	The graduate knows fundamental notions related to CFD methods and can apply them to areas of science related to Mathematics, Mechanics and Engineering.
Skills	The graduate is able to explain theoretical notions, problem-solving methods, paradigms, etc. used in various branches of Mathematics. The graduate is able to introduce new and innovative elements in the mathematical and numerical modeling.
Responsibility and autonomy:	The student has the ability to work independently to obtain and solve numerically different problems of Fluid Mechanics.

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	Knowledge, understanding and use of main concepts and results related to numerical methods for fluid dynamics equations.
7.2 Specific objective of the discipline	Mathematical manipulation of mathematical theories, concepts and numerical methods.

8. Content

8.1 Course	**Teaching methods**	**Remarks**
1. Fluid Mechanics. Introduction	Lecture, discussion, discussion of case.	

2. Fluid Mechanics. Basic equations.	Lecture, discussion, discussion of case.	
3. Heat transfer. Basic equations.	Lecture, discussion, discussion of case.	
4. Numerical methods for ODE	Lecture, discussion, discussion of case. .	
5.Numerical methods for BVP	Lecture, discussion, discussion of case.	
6. Finite difference method for PDE I.	Lecture, discussion, discussion of case.	
7. Case study	Lecture, discussion, discussion of case.	
8. Finite difference method for PDE II.	Lecture, discussion, discussion of case.	
9. Case study	Lecture, discussion, discussion of case.	
10. Finite volume method	Lecture, discussion, discussion of case..	
11. Case study	Lecture, discussion, discussion of case.	
12. Finite elements method.	Lecture, discussion, discussion of case.	
13. Application. Lid driven fluid flow	Lecture, discussion, discussion of case.	
14. Application. Differentially heated cavity	Lecture, discussion, discussion of case.	

Bibliography

Kundu, Pijush K.; Cohen, Ira M. (2008), Fluid Mechanics (4th revised ed.), Academic Press, ISBN 978-0-12-373735-9

Currie, I. G. (1974), Fundamental Mechanics of Fluids, McGraw-Hill, Inc., ISBN 0-07-015000-1

White, Frank M. (2003), Fluid Mechanics, McGraw–Hill, ISBN 0-07-240217-2

Anderson, John D. (1995). Computational Fluid Dynamics: The Basics With Applications. Science/Engineering/Math. McGraw-Hill Science. ISBN 0-07-001685-2

Patankar, Suhas (1980). Numerical Heat Transfer and Fluid Flow. Hemisphere Series on Computational Methods in Mechanics and Thermal Science. Taylor & Francis. ISBN 0-89116-522-3

Petrila, T; Trif, D. (2005) BASICS OF FLUID MECHANICS AND INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS, Springer.

8.2 Seminar / laboratory	**Teaching methods**	**Remarks**
1. Fluid Mechanics. Basic Equations	Discussion, problem solving, self-study, team work.	
2. Numerical methods for ODE	Discussion, problem solving, self-study, team work.	
3. Numerical methods for BVP	Discussion, problem solving, self-study, team work. .	
4. Finite difference method I.	Discussion, problem solving, self-study, team work.	
5. Finite difference method II.	Discussion, problem solving, self-study, team work.	
6. Finite volumes method	Discussion, problem solving, self-study, team work.	
7.Applications	Discussion, problem solving, self-study, team work	

Bibliography

Hoffmann, K.A; Chiang, S.T. (2000) Computational Fluid Dynamics, EES.

H K Versteeg and W Malalasekera (2007), An Introduction to Computational Fluid Dynamics, Pearson Education Limited

Anderson, John D. (1995). Computational Fluid Dynamics: The Basics With Applications. Science/Engineering/Math. McGraw-Hill Science. ISBN 0-07-001685-2

Patankar, Suhas (1980). Numerical Heat Transfer and Fluid Flow. Hemisphere Series on Computational Methods in Mechanics and Thermal Science. Taylor & Francis. ISBN 0-89116-522-3

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9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

The content of this discipline is in accordance with the curricula of the most important universities in Romania and abroad, where the applied mathematics plays an essential role. This discipline is useful in preparing future teachers and researchers in applied mathematics, as well as those who use mathematical models and methods of study in other areas (physics, chemistry, engineering, computer science).

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	Knowledge of concepts and basic results	Final Project	50%
	Ability to apply theory in modeling and solving problems		
10.5 Seminar/laboratory		Mid Term Project	50%
10.6 Minimum standard of performance			
At least grade 5 (from a scale of 1 to 10) at both written exam			

11. Labels ODD (Sustainable Development Goals)[2]

	General label for Sustainable Development							
								9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

[2] Keep only the labels that, according to the *Procedure for applying ODD labels in the academic process*, suit the discipline and delete the others, including the general one for *Sustainable Development* – if not applicable. If no label describes the discipline, delete them all and write „*Not applicable*.”.

Date:
11.04.2025

Signature of course coordinator

Prof. Dr. Teodor Grosan

Groșan Teodor

Signature of seminar coordinator

Prof. Dr. Teodor Grosan

Groșan Teodor

Date of approval:
25.04.2025

Signature of the head of department

Prof. dr. Andrei Mărcuș