BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS
FACULTY OF MECHANICAL ENGINEERING

SUBJECT DATASHEET

I. SUBJECT DESCRIPTION

1. GENERAL DATA

1.1. Subject name (in Hungarian, in English)

Computational Fluid Dynamics ● Computational Fluid Dynamics

1.2. Neptun code

BMEGEÁTBG36

1.3. Type

study unit with contact hours

1.4. Course types and number of hours (weekly / semester)

course type	number of hours (weekly)	nature (connected / stand-alone)
lecture (theory)	2	-
exercise	-	-
laboratory exercise	2	coupled

1.5. Type of assessments (quality evaluation)

mid-term grade

1.6. ECTS

4

1.7. Subject coordinator

name:	Dr. Kristóf Gergely János
post:	associate professor
contact:	kristof.gergely@gpk.bme.hu

1.8. Host organization

Department of Fluid Mechanics (http://www.ara.bme.hu)

1.9. Course homepage

http://www.ara.bme.hu/oktatas/tantargy/NEPTUN/BMEGEATBG36

1.10. Course language

hungarian, english

1.11. Primary curriculum type

mandatory

1.12. Direct prerequisites

Strong prerequisite: BMEGEÁTBG11
Weak prerequisite: -
Parallel prerequisite: -
Milestone prerequisite: -
Excluding condition: -
(the subject cannot be taken if you have previously completed any of the following subjects or groups of subjects)

2. AIMS AND ACHIEVEMENTS

2.1. Aim

The goal of the course is to introduce the approximate solutions applicable in various flow categories, the theoretical foundations of turbulence modeling, numerical solution methods, and the errors of numerical modeling. Overall, it develops technical thinking and perspectives. Additionally, the aim of the subject is to enable students to recognize and correctly assess mechanical engineering problems related to the course material based on the acquired knowledge.

2.2. Learning outcomes

Competences that can be acquired by completing the course:

A. Knowledge

- Knows the finite difference method and how to use it for boundary value problems.
- Knows explicit and implicit solution techniques for initial value problems and their stability properties.
- Knows the solution methods of the general convective-diffusive equation and its stability properties.
- Knowledgeable about general numerical solution methods for compressible and incompressible flows.
- Knowledgeable about the theoretical foundations of the finite volume method and the process of CFD analysis.
- Familiar with the mathematical background and physical interpretation of boundary conditions, as well as the possible methods of modeling flow engineering machines.
- Recalls the role of source members and separation conditions in flow modeling.
- Recalls the theoretical foundations of turbulence modeling and the main characteristics of each model.
- Has the knowledge of modeling thermal processes and calculating heat transfer.
- Systematizes aspects related to numerical mesh compression and quality, boundary layer meshing, and other mesh generation methods.
- He/she is aware of possible sources of errors and uncertainties typical of CFD analysis, convergence tests, and error estimation methods.
- He is aware of possible sources of errors and uncertainties typical of CFD analysis, convergence tests, and error estimation methods.

B. Ability

- It is able to determine the order of accuracy of a numerical method.
- Able to discretize and numerically solve a general initial and boundary value problem.
- Able to solve the general convective-diffusive equation.
- Selects the appropriate modeling approach.
- Selects the appropriate modeling approach for simulation analysis in technical problems.
- Creates two- and three-dimensional flow models.
- It prepares the modeling of thermal processes and the calculation of heat transfer.
- Prepares convergence tests for CFD analysis.
- Apply two- and three-dimensional flow models.
- Evaluates the applicability of simulation analysis in technical problems.

- Analyzes the applicability of simulation analysis in technical problems.
- Analyzes the errors and reliability of the numerical flow model.

C. Attitude

- Initiates cooperation with the instructor and fellow students during the expansion of knowledge.
- He expands his knowledge through continuous knowledge acquisition and broad-minded attitude.
- Open to in-depth use of modern information technology tools.
- He strives to learn about and routinely use the tool system necessary for problem-solving in fluid dynamics.
- Strives for independent, accurate, error-free, and responsible task-solving.
- He/she strives to enforce the principles of reliable operation, productivity, cost and time efficiency, energy efficiency, and environmental awareness to solve flow engineering tasks.
- He/she develops the ability to harmonize the ethical engineering attitude and long-term win-win aspects with the market competition.

D. Independence and responsibility

- Independently thinks through the tasks and problems defined in the subject and solves them based on given sources.
- Accepts well-founded critical comments and criticisms.
- In some situations - as part of a team - he cooperates with his fellow students in solving tasks.
- He/she supports a systematic approach and complex thinking.
- He/she criticizes the engineering undertakings prepared in inadequate quality.

2.3. Teaching methodology

Lectures, calculation exercises, written and oral communication, IT tools and techniques, optional tasks prepared independently and in group work, and work organization techniques. We support the lectures with electronic notes and the Teams consultation channel. In addition to computer lab exercises, we encourage the installation of software on your own hardware, as well as independent experimentation and learning outside of the class schedule, and the more detailed development of independent tasks at home.

2.4. Support materials

a) Textbooks

Lajos Tamás: Az áramlástan alapjai. 2015, ISBN 978 963 12 2885 4.

J. H. Ferziger, M. Peric: Computational Methods for Fluid Dynamics. 2002, ISBN 3-540-42074-6

b) Lecture notes

Kristóf G. (2019). Áramlások numerikus modellezése. Akadémiai Kiadó. https://doi.org/10.1556/9789634544128.

c) Online materials

https://mersz.hu/hivatkozas/m543anm_0_p1/#m543anm_0_p1

2.5. Validity of the course description

Start of validity:	2023. April 18.
End of validity:	2027. May 18.

II. SUBJECT REQUIREMENT

3. ACHIEVEMENT CONTROL AND EVALUATION

3.1 General rules

The evaluation of the learning outcomes described in point 2.2 is based on two mid-term written assessments (two summative academic performance evaluations), three partial performance assessments (homework and presentations), and participation in the practical sessions. The course concludes with a mid-term grade, with the total score (maximum 100 points) taking into account up to 50 points from the summative academic performance evaluations and up to 50 points from the partial performance assessments.

3.2 Assessment methods

A. Detailed description of mid-term assessments

1. Mid-term assessment

type:	summative assessment
count:	2
purpose, description:	The purpose of the summative performance evaluations is to assess the theoretical knowledge presented during the lectures. To obtain the mid-term grade, students must achieve at least 40% on both theoretical mid-term tests. The theoretical mid-term tests take place in the middle and at the end of the semester (typically in the 7th and 14th course weeks). There is one opportunity to make up the summative academic performance evaluations during the 14th course week.

2. Mid-term assessment

type:	formative assessment, simple
count:	3
purpose, description:	The 1st and 2nd partial performance evaluations consist of an independent modeling task and its written report in PowerPoint format, each worth a maximum of 20 points. The 1st report must be submitted by the end of the 9th course week, and the 2nd report by the end of the 13th course week by uploading the files to the Moodle system. In case of late submission, the score is reduced by 20%. The 1st report can be submitted no later than the end of the 11th course week, and the 2nd report by 12:00 on the 3rd day of the retake period. The 3rd partial performance evaluation involves a 6-8 minute presentation on the topic of the 1st or 2nd report (as designated by the practical instructor), worth up to 10 points. The presentation can be made up on the 4th day of the retake period. To pass the course, students must achieve at least 40% in each of the summative and partial performance evaluations.

B. Detailed description of assessments performed during the examination period (if relevant)

Elements of the exam:

1. written partial exam

   -

2. oral partial exam

   -

3. practical partial exam

   -

4. inclusion of mid-term results

   -

3.3 The weight of mid-term assessments in signing or in final grading

identifier	weight
1 . Mid-term assessment	50 %
2 . Mid-term assessment	50 %

3.4 The weight of partial exams in grade (if relevant)

type	weight
written partial exam	0 %
oral partial exam	0 %
practical partial exam	0 %
inclusion of mid-term results	0 %

3.5 Determination of the grade

grade • [ECTS]	the grade expressed in percents
very good(5) • Excellent [A]	above 85%
very good(5) • Very Good [B]	85% .. 85%
good(4) • Good [C]	70% .. 85%
satisfactory(3) • Satisfactory [D]	55% .. 70%
sufficient(2) • Pass [E]	40% .. 55%
insufficient(1) • Fail [F]	below 40%

The lower limit specified for each grade already belongs to that grade.

3.6 Attendance and participation requirements

Must be present at at least **70%** (rounded down) of lectures.

At least **70% of** laboratory practices (rounded down) must be actively attended.

3.7 Special rules for improving, retaken and replacement

The special rules for improving, retaken and replacement shall be interpreted and applied in conjunction with the general rules of the CoS (TVSZ).

Need mid-term assessment to individually complete?

yes

Can the submitted and accepted partial performance assessments be resubmitted until the end of the replacement period in order to achieve better results?

yes

The way of retaking or improving a summary assessment for the first time:

each summative assessment can be retaken or improved

Is the retaking-improving of a summary assessment allowed, and if so, than which form:

retake or grade-improving exam possible for each assesment separately

Taking into account the previous result in case of improvement, retaken-improvement:

out of multiple results, the best one is to be taken into account

The way of retaking or improving a partial assessment for the first time:

partial assesment(s) in this group cannot be improved or repeated, the final result is assessed in accordance with Code of Studied 122. § (6)

Completion of unfinished laboratory exercises:

missed laboratory practices may be performed in the teaching term at pre-arranged appointment, non-mandatory

Repetition of laboratory exercises that performed incorrectly (eg.: mistake in documentation):

incorrectly performed laboratory practice (e.g. Incomplete/incorrect report) can be corrected upon improved re-submission

3.8 Study work required to complete the course

Activity	**hours / semester**
participation in contact classes	56
preparation for laboratory practices	14
preparation for summary assessments	32
elaboration of a partial assessment task	12
additional time required to complete the subject	6
summary	**120**

3.9. Validity of subject requirements

Start of validity: 2024. February 1.

End of validity: 2027. May 18.

4. ADDITIONAL INFORMATION

4.1 Primary course

The primary (main) course of the subject in which it is advertised and to which the competencies are related:

Mechanical engineering

4.2 Link to the purpose and (special) compensations of the Regulation KKK

This course aims to improve the following competencies defined in the Regulation KKK>

a) knowledge

- Student is familiar with the general and specific mathematical, scientific and social principles, rules, contexts and procedures needed to operate in the field of engineering.
- Student has the comprehensive knowledge of global social and economic processes.
- Student has the knowledge of the theories and contexts of fundamental importance in the field of engineering and of the terminology which underpins them.

b) ability

- Student has the ability to apply the general and specific mathematical, scientific and social principles, rules, relationships and procedures acquired in solving problems in the field of engineering.
- Student has the ability to apply the theories and related terminology in an innovative way when solving problems in a given field of engineering.
- Student has the ability to approach and solve specific problems within student's field of specialisation in a multi-disciplinary and interdisciplinary manner.

c) attitude

- Student is open and receptive to learning, embracing and authentically communicating professional, technological development and innovation in engineering.

- Student embraces the professional and ethical values associated with the technical discipline.
- Student seeks to contribute to the development of new methods and tools in the field of engineering. A deepened sense of vocation.

d) independence and responsibility

- Student shares her acquired knowledge and experience through formal, non-formal and informal information transfer with those in her field.
- Student evaluates the work of student's subordinates and contributes to their professional development by sharing critical comments.
- Student has the ability to work independently on engineering tasks.

4.3 Prerequisites for completing the course

Knowledge type competencies

(a set of prior knowledge, the existence of which is not obligatory, but greatly facilitates the successful completion of the subject)	Fluid mechanics

Ability type competencies

(a set of prior abilities and skills, the existence of which is not obligatory, but greatly contributes to the successful completion of the subject)	Basic PC and CAD knowledge.