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 (PhD) ● Computational Fluid Dynamics (PhD)

1.2. Neptun code

BMEGEÁT4A14

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	-	-

1.5. Type of assessments (quality evaluation)

exam

1.6. ECTS

3

1.7. Subject coordinator

name:	Dr. Kristóf Gergely János
post:	university 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/BMEGEAT4A14/

1.10. Course language

hungarian, english

1.11. Primary curriculum type

komplex vizsga tárgycsoport PhD tárgy

1.12. Direct prerequisites

Strong prerequisite: -

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 aim of the course is to support individual PhD research with theoretical and practical knowledge in the field of numerical fluid science. The course is recommended for doctoral students engaged in research related to numerical flow theory. Participating students develop their independent task in individually chosen topics, which can be related to the following topics of Computational Fluid Dynamics (CFD): discretization methods: finite differences method, finite volume method, Lagrangain methods; atmospheric flows; thermo-hydraulic processes; gas dynamics; fluid machinery; turbulence modeling; hydraulics, pipeline transients; aerodynamics, fluid-elastic vibrations; building services (HVAC) applications; open surface flows; dispersed multiphase flows, phase transition.

2.2. Learning outcomes

Competences that can be acquired by completing the course:

A. Knowledge

- The student knows the chapters of Computational Fluid Dynamics (CFD) that are related to the individual PhD research topic.
- The student understands the physical theory and modeling of the investigated process.
- The student is informed in the field of computer implementation and evaluation methods.
- The student is aware of well-known modeling methods related to his research topic.
- The student distinguishes between known modeling methods.
- The student knows the numerical methods used in the chosen topic.
- The student knows model uncertainties and error estimation methods.
- The student has a comprehensive knowledge of the possibilities of changing the parameters of the model, the theoretical and practical possibilities of modifications.
- The student defines similarity parameters related to the topic.
- The student is informed about the expected impact of similarity parameters.
- The student, starting from his engineering approach, is informed about the flow characteristics of the expected results of the doctoral research.
- The student has adequate knowledge of the current state of the field of CFD.
- The student is aware of the hardware and software requirements of CFD.
- The student names the advantages and disadvantages of physical and numerical modeling forms.

B. Ability

- The student analyzes the available domestic and international literature sources on numerical flow theory.
- The student interprets the characteristics of the flow field characteristic of the PhD research area and the factors influencing them.
- The student is able to derive and calculate the quantities related to the PhD research topic.
- The student identifies the parameters related to his / her research topic, characteristics of his / her field of fluid flow, and the possibilities of their theoretical and practical modification.

- The student applies the knowledge of physical modeling important in the research field related to the PhD research topic.
- The student applies the knowledge of numerical modeling important in the research field related to the PhD research topic.
- The student is able to determine the key issues related to his / her research topic, related to important factors, parameters and physical characteristics in his / her field of fluid science.
- The student selects the appropriate methods for the specific fluid flow problem.
- The student is able to fully evaluate model results.
- The student outlines the current engineering solutions, key theoretical issues and state-of-the-art practical solutions of the subject and the research topic area.
- The student uses the concepts of subject and research topic area.
- The student identifies appropriate methods for a specific fluid flow problem.
- The student outlines the hardware and software requirements for numerical flow simulations.
- The student analyzes the physical and numerical forms of modeling in terms of advantages and disadvantages.

C. Attitude

- The student constantly monitors the own work, results and conclusions.
- The student expands the knowledge of numerical modeling by continuously gaining knowledge.
- The student is open to the use of information technology tools.
- The student seeks to learn about and routinely uses the toolkit required for numerical modeling.
- The student develops the ability to provide accurate and error-free problem solving, engineering precision, and accuracy.
- The student strives for demanding engineering work and makes a decision based on careful consideration.
- The student monitors changes in the social, economic and political system.
- The student publishes the results in accordance with the rules of the profession.
- The student publishes its opinions and views without offending others.

D. Independence and responsibility

- The student collaborates with the instructor and fellow students to expand knowledge.
- The student accepts well-founded professional and other critical remarks.
- In some situations, as part of a team, The student works with the fellow students to solve tasks.
- With the gained knowledge, the student makes a responsible, informed decision based on deep analyses.
- The student feels responsible for the sustainable use of the environment and for present and future generations.
- The student is committed to the principles and methods of systems thinking and problem-solving.
- The student assesses changes in the social, economic, and political system.
- The student is committed to publishing according to the rules of the profession.
- The student has a well-founded professional critique of the work he or others do.

2.3. Teaching methodology

In the lectures of the subject held at a given time on a pre-arranged weekly basis, the parts of the course related to the individual research topic of the students are presented in the framework of a consultation, which helps to independently acquire the parts related to the research area. During the semester, students are given an individual assignment related to their research topic, which they must solve during the semester and report on the outcome. During the solution of individual tasks, within the framework of the lectures or beyond that, consultation is possible.

2.4. Support materials

a) Textbooks

Tamás Lajos: Fundamentals of Fluid Mechanics. (Tamás Lajos, 2015.) ISBN 978 963 12 2885 4.

Ferziger, JH, Peric, M., & Street, RL (2002). Computational methods for fluid dynamics (Vol. 3, pp. 196-200). Berlin: Springer. ISBN X

b) Lecture notes

Gergely Kristóf: Numerical modeling of flows, electronic textbook, ISBN 978-963-08-1212-2, distributor: CFD.HU Kft., 2014

Gergely Kristóf: Numerical modeling of flows, electronic textbook, ISBN 978-963-08-1212-2, distributor: CFD.HU Kft., 2014

c) Online materials

http://www.ara.bme.hu/oktatas/tantargy/NEPTUN/BMEGEAT4A14/

https://mersz.hu/dokumentum/m543anm__1

http://www.ara.bme.hu/oktatas/tantargy/NEPTUN/BMEGEAT4A14/

2.5. Validity of the course description

Start of validity:	2025. January 1.
End of validity:	2025. January 1.

II. SUBJECT REQUIREMENT

3. ACHIEVEMENT CONTROL AND EVALUATION

3.1 General rules

During the semester, the student solves an independent task closely related to his / her own doctoral research topic. During the semester, the theoretical lectures give each student the theoretical knowledge and methodology needed to solve the problem. Students work independently on their own assignments, and the lecturer is regularly consulted as they progress. At the end of the semester, students present the results in front of each other and prepare a documentation. At the end of the semester, the result of the oral exam consists of the completion of the semester assignment and the quality of the presentation.

3.2 Assessment methods

A. Detailed description of mid-term assessments

1. Mid-term assessment

type: formative assessment, point-in-time personal act

count: 1

purpose, description: A project task related to PhD research to be developed during the semester, which helps to deepen the acquisition of the curriculum through theoretical and practical calculations and derivations. The aim of the partial achievement is to examine the existence of knowledge, ability, attitude, and learning outcomes belonging to the autonomy and responsibility competence group. Upon successful completion of the task, the student stabilizes the knowledge acquired in the lectures.

2. Mid-term assessment

type: formative assessment, point-in-time personal act

count: 1

purpose, description: A presentation lecture to be developed during the semester, linked to the PhD research, which helps to critically raise issues related to the doctoral topic, through theoretical and practical considerations. The aim of the partial achievement is to examine the existence of knowledge, ability, attitude, and learning outcomes belonging to the autonomy and responsibility competence group. Upon successful completion of the task, the student stabilizes and further develops the knowledge acquired before the start of the doctoral program in the field of fluid science. Particular attention should be paid to the development in the presentation compared to the previous performance appraisal, which should answer the critical questions.

3. Mid-term assessment

type: formative assessment, point-in-time personal act

count: 1

purpose, description: A project task related to PhD research to be developed during the semester, which helps to deepen the acquisition of the curriculum through theoretical and practical calculations and derivations. The aim of the partial achievement is to examine the existence of knowledge, ability, attitude, and learning outcomes belonging to the autonomy and responsibility competence group. Upon successful completion of the task, the student stabilizes the knowledge acquired in the lectures.

4. Mid-term assessment

type: formative assessment, point-in-time personal act count: 1

purpose, description: A presentation lecture to be developed during the semester, linked to the PhD research, which helps to critically raise issues related to the doctoral topic, through theoretical and practical considerations. The aim of the partial achievement is to examine the existence of knowledge, ability, attitude, and learning outcomes belonging to the autonomy and responsibility competence group. Upon successful completion of the task, the student stabilizes and further develops the knowledge acquired before the start of the doctoral program in the field of fluid science. Particular attention should be paid to the development in the presentation compared to the previous performance appraisal, which should answer the critical questions.

5. Mid-term assessment

type: formative assessment, point-in-time personal act

count: 1

purpose, description: A presentation lecture to be developed during the semester, linked to the PhD research, which helps to critically raise issues related to the doctoral topic, through theoretical and practical considerations. The aim of the partial achievement is to examine the existence of knowledge, ability, attitude, and learning outcomes belonging to the autonomy and responsibility competence group. Upon successful completion of the task, the student stabilizes and further develops the knowledge acquired before the start of the doctoral program in the field of fluid science. Particular attention should be paid to the development in the presentation compared to the previous performance appraisal, which should answer the critical questions.

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

Elements of the exam:

1. written partial exam

   obligation: mandatory (partial) exam unit, failing the unit results in fail (1) exam result

   description: In the written exam, the lecturer gives three questions and / or calculation tasks from the curriculum, which the students develop over a given period of 120 minutes. Upon successful completion of the task, the student stabilizes and further develops the knowledge acquired before the start of the doctoral program in the field of fluid science. Particular attention should be paid to the content and form of the written essay, so during the evaluation its fit into a doctoral dissertation plays an important role both in terms of content and form.

2. oral partial exam

   obligation: mandatory (partial) exam unit, failing the unit results in fail (1) exam result

   description: In the oral exam, the speaker asks three questions from the curriculum, to which the students answer in detail at the board after a few minutes of reflection time. In the oral exam, the speaker asks three questions from the curriculum, to which the students answer in detail at the board after a few minutes of reflection time. In the oral exam, the speaker asks three questions from the curriculum, to which the students answer in detail at the board after a few minutes of reflection time.

3. practical partial exam

   obligation: does not apply

   description:

4. inclusion of mid-term results

   obligation: mandatory (partial) exam unit, failing the unit results in fail (1) exam result description: Score for the project task: maximum 50%, score for the summary oral (assisted by a computer presentation): maximum 50%. The score obtained on these is 50% of the exam ticket. There are no additional rules, requirements or other ways of offsetting interim results. The score obtained on these is 50% of the exam ticket.

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

identifier	weight
1 . Mid-term assessment	100 %
2 . Mid-term assessment	100 %
3 . Mid-term assessment	50 %
4 . Mid-term assessment	50 %
5 . Mid-term assessment	50 %

The condition for signing is that the score obtained in the mid-year assessments is at least **40%**.

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

type	weight
written partial exam	50 %
oral partial exam	50 %
practical partial exam	0 %
inclusion of mid-term results	50 %

3.5 Determination of the grade

grade • [ECTS]	the grade expressed in percents
very good(5) • Excellent [A]	above 95%
very good(5) • Very Good [B]	85% .. 95%
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.

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).

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

new result overrides previous result

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

partial assesment(s) in this group can be improved or repeated once up to the end of the repeat period

3.8 Study work required to complete the course

Activity	**hours / semester**
participation in contact classes	28
exam preparation	21
additional time required to complete the subject	41
summary	**90**

3.9. Validity of subject requirements

Start of validity: 2025. January 1.

End of validity: 2029. July 15.

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 sciences PhD programme

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 has the knowledge of the general and specific mathematical, scientific and social principles, rules, contexts and procedures relevant to 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 about, 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)	Basic knowledge of BSc and MSc level flow theory and flow engineering; knowledge of physical and numerical modeling of flows; comprehensive knowledge of the design, performance and evaluation of flow simulation tests

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)	Independent, creative engineering problem-solving ability, ability to recognize and analyze the essential connections between complex flow phenomena and flow engineering processes