Theoretical hydrodynamics - BMEEOVVDT71

I. Subject Specification

1. Basic Data

1.1 Title

Theoretical hydrodynamics

1.2 Code

BMEEOVVDT71

1.3 Type

Module with associated contact hours

1.4 Contact hours

Type	Hours/week / (days)
Lecture	2

1.5 Evaluation

Exam

1.6 Credits

3

1.7 Coordinator

name	Dr. János Józsa
academic rank	Professor
email	jozsa.janos@bme.hu

1.8 Department

Department of Hydraulic and Water Resources Engineering

1.9 Website

https://epito.bme.hu/BMEEOVVDT71
https://fiek2.mywire.org/course/view.php?id=2496

1.10 Language of instruction

hungarian and english

1.11 Curriculum requirements

Ph.D.

1.12 Prerequisites

Recommended courses: Any courses on hydrodynamics and partial differential equations and vector fields.

1.13 Effective date

1 September 2022

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2. Objectives and learning outcomes

2.1 Objectives

The aim of the subject is to familiarize the student with the mathematical foundations and basic equations of fluid dynamics.

2.2 Learning outcomes

Upon successful completion of this subject, the student:

A. Knowledge

1. Knowledge of the basic concepts of partial differential equations and vector fields.
2. Knowledge of the basic kinematic and dynamic concepts necessary to describe the liquid as a continuum.
3. Knowledge of the basic equation of fluid dynamics and its most important features.
4. Knowledge of the vorticity transport equation derived from the basic equation of fluid dynamics. Knowledge of the general geometric formulation of two- and three-dimensional hydrodynamics.

B. Skills

1. Advanced problem-solving capacity in mathematics and physics, especially on algebraic manipulations.
2. Ability to formulate a hydrodynamic model, such as the complex of physical environment, mathematical equations and boundary conditions.

C. Attitudes

1. Cooperates with the instructor during the learning process.
2. Continuously and actively seeks ways of gaining knew knowledge even beyond the required curriculum and employs the internet for finding intuitive answers to research problems.

D. Autonomy and Responsibility

1. Participates in lectures and prepares for the exam.

2.3 Methods

Lectures on theory.

2.4 Course outline

Week	Topics of lectures and/or exercise classes
1.	Introduction: partial differential equations and vector fields.
2.	Introduction: partial differential equations and vector fields.
3.	Introduction: partial differential equations and vector fields.
4.	The continuum model of the fluid. Velocity, acceleration. The acceleration as a Lie-derivative.
5.	Description of streamlines. The velocity field as a transformation on streamlines. Continuous transformation groups.
6.	Conservation of the matter. Divergence of the velocity field.
7.	Rotation of a fluid element. Vorticity of the velocity field.
8.	Incompressible and irrotational plane flows. Laplace equation.
9.	The vorticity of the acceleration. Lie-bracket of vector fields. Commuting flows.
10.	Circulation. Vortex theorems.
11.	The Cauchy stress tensor. Navier-Stokes equations.
12.	Navier-Stokes, Euler, and Bernoulli equations.
13.	The vorticity transport equations. Geometric picture of fluid flows.
14.	Dimensionless numbers. The dimensionless form of Navier-Stokes equations. The appearance of viscosity, as a symmetry breaking.

The above programme is tentative and subject to changes due to calendar variations and other reasons specific to the actual semester. Consult the effective detailed course schedule of the course on the subject website.

2.5 Study materials

a) Textbooks:

1. Andreev, V.K., et al., 1998. Application of Group-Theoretical Methods in Hydrodynamics, Kluwer.
2. Arnold, V.I., 1974. Mathemtical Methods of Classical Mechanics, Springer.
3. Batchelor, G.K., 1967. An Introduction to Fluid Dynamics, Cambridge University Press.
4. Olver, P. J., 1986. Application of Lie Groups to Differential Equations, Springer.

2.6 Other information

None

2.7 Consultation

Time of consultations: previously agreed times.

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This Subject Datasheet is valid for:

Inactive courses

II. Subject requirements

Assessment and evaluation of the learning outcomes

3.1 General rules

Evaluation of the participant's learning progress described in 2.2. is performed by an oral exam.

3.2 Assessment methods

Evaluation form	Abbreviation	Assessed learning outcomes
Oral exam	V	A.1-A.4; B.1-B.2; C.1-C.2; D.1

The dates of deadlines of assignments/homework can be found in the detailed course schedule on the subject's website.

3.3 Evaluation system

Abbreviation	Score
V	100%
Sum	**100%**

3.4 Requirements and validity of signature

At least 70% of the attendance of the classes is expected.

3.5 Grading system

If the grade for the exam is at least satisfactory, the final grade is the grade for the exam.

3.6 Retake and repeat

3.7 Estimated workload

Activity	Hours/semester
participation in contact classes	14×2=28
study from notes, textbooks, preparation for the exam	62
Sum	**90**

3.8 Effective date

1 September 2022

This Subject Datasheet is valid for:

Inactive courses