STUDY MODULE DESCRIPTION FORM

Name of the module/subject		Code
Fluid Mechanics		**1010601141010600432**
Field of study: **Aerospace Engineering**	Profile of study (general academic, practical): **general academic**	Year /Semester: **2 / 4**
Elective path/specialty: **Aircraft Engines and Airframes**	Subject offered in: **Polish**	Course (compulsory, elective): **obligatory**
Cycle of study: **First-cycle studies**	Form of study (full-time,part-time): **full-time**	
No. of hours: Lecture: **18** Classes: **9** Laboratory: **9** Project/seminars: **-**		No. of credits: **4**
Status of the course in the study program (Basic, major, other): **other**	(university-wide, from another field): **university-wide**	
Education areas and fields of science and art: **technical sciences** **Technical sciences**		ECTS distribution (number and %): **4 100%** **4 100%**

Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Basic knowledge in the field of mathematics, physics and the basics of numerical methods.
2	**Skills**	Can acquire information from literature, databases and other sources. He can work individually and in a team; is able to develop and implement a schedule of work to ensure that deadlines are met.
3	**Social competencies**	He is aware of the responsibility for his own work and readiness to comply with the rules of working in a team and bearing the responsibility of his role. Is aware of the importance of behaving in a professional manner, observing the rules of professional ethics and requirements of this from others.

Assumptions and objectives of the course:

Knowledge of selected theoretical results in the field of fluid mechanics. Familiarization with various fluid models (Newtonian and non-Newtonian) and their behavior during flow. Familiarization with selected issues of numerical modeling of fluid flow and interaction between liquids and solid bodies. Learning the principles of operation of thermal-flow machines and mechanisms responsible for the transport of mass, momentum and energy.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. has a structured, theoretically founded general knowledge covering key issues in the field of fluid mechanics, in particular aerodynamics, ie liquids and perfect gases, Newton and non-Newtonian viscous liquids, theory of thermal-flow machines - [K1A_W11]

Skills:

1. can carry out elementary technical calculations in the field of fluid mechanics, and thermodynamics, such as thermal and mass balances, pressure losses in flows around technical flying objects and their modules, choose the parameters of fans, compressors and turbines for flow systems, and calculate thermodynamic waveforms in thermal machines - [K1A_U10]

2. is able to plan and conduct a research experiment using measuring equipment, computer simulations, is able to perform measurements, such as temperature measurements with liquid thermometers, thermometers, thermocouples, speed and flow rate using turbine, laser and ultrasonic flowmeters, and interpret results and draw conclusions - [K1A_U11]

Social competencies:

1. can interact and work in a group, taking on different roles in it - [K1A_K03]

Assessment methods of study outcomes

Lecture:
? assessment of knowledge and skills demonstrated in the written exam.
Calculation exercises:
? periodic written tests.
Laboratory exercises:
? testing and rewarding the knowledge necessary to implement the set problems in a given area of ??laboratory tasks,
? continuous assessment, at each class - rewarding the increase in the ability to use the principles and methods learned,
? assessment of knowledge and skills related to the implementation of the task, evaluation of the report on the exercise.
Obtaining additional points for activity during classes, especially for:
? proposing to discuss additional aspects of the issue,
? effectiveness of using the acquired knowledge while solving a given problem,
? ability to cooperate within a team practically performing a detailed task in a laboratory,
? comments related to the improvement of didactic materials,
? aesthetic diligence in the preparation of reports and tasks as part of your own learning.

Course description

Physical and chemical basics of fluid mechanics. Fluid classification. Knudsen criterion and applicability of fluid mechanics equations. Pressure as a scalar size. Equation of fluid balance in static conditions. Pressure plate for flat and curved surfaces, swimming and stability condition. Moment equations: in stress, Navier-Stokes, Euler and Bernoulli. Equation of wall reaction to fluid. The principle of operation of flow machines. Flow resistance in channels and aerodynamic resistance. Discussion of the meaning of the hydrodynamic boundary layer and the principles of its analysis in laminar and turbulent flows. Selected issues of viscous fluid flow. Analysis of decomposition and evaporation of vortices in viscous fluid. Selected issues of numerical fluid mechanics, principles of numerical description of streams. Selected topics: gas dynamics and energy applications.

Basic bibliography:

1. Tuliszka E. Mechanika płynów, PWN, Warszawa 1980.
2. Prosnak W.J. Mechanika płynów, tom I i II, PWN, Warszawa 1970.
3. Ciałkowski M. Mechanika płynów, Wyd. Politechniki Poznańskiej, Poznań 2015.
4. pod red. Ciałkowski M. Mechanika płynów, Wyd. Politechniki Poznańskiej, Poznań 2008.

Additional bibliography:

1. Kundu P.K., Cohen I.M., Dowling D.R.. Fluid Mechanics, Elsevier 2012.
2. Graebel W.P. Advenced fluid mechanics, Elsevier 2007.
3. Sengupta T.K., Instabilities of flows and transition to turbulence, CRC Press Taylor & Francis Group, 2012.

Result of average student's workload

Activity	Time (working hours)
1. Participation in classes	60
2. Preparation for classes	25
3. Consolidation of the message	10
4. consultations	5
5. Preparation for the exam and credit	20
6. Exam and pass	5

Student’s workload

Source of workload	hours	ECTS
Total workload	89	4
Contact hours	40	2
Practical activities	49	2