COURSE DESCRIPTION CARD - SYLLABUS

Course name

Numerical termomechanics [S1Lot2-SLiPL>NT]

Course

Field of study

Aviation

Year/Semester

3/6

Area of study (specialization)

Aircraft Engines and Airframes

Profile of study

general academic

Level of study

first-cycle

Course offered in

Polish

Form of study

full-time

Requirements

elective

Number of hours

Lecture	Laboratory classes	Other
15	30	0

Tutorials	Projects/seminars
0	0

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

Basic knowledge of 3D geometry modeling, knowledge of heat flow processes in thermal-flow machines and devices. Ability to describe and define complex heat flow processes. Ability to effectively self-educate in the field related to the chosen professional field. Is aware of the need to expand their competences, readiness to cooperate within a team.

Course objective

Mastering engineering tools for solving thermal flow problems using numerical modeling. Learning methods for describing various heat flow processes occurring in the assumed thermal and mechanical energy conversion processes in order to modernize or reconstruct technological systems in areas related to thermal energy, heating and cooling. Practical mastering of the ability to describe the implementation of effective thermal processes involving heat, momentum and mass exchange processes.

Course-related learning outcomes

Knowledge:

Has advanced and in-depth knowledge of mathematics, including algebra, calculus, differential equations, probability theory, and analytical geometry, as well as physics, covering the fundamentals of

classical mechanics, optics, electricity and magnetism, solid-state physics, and thermodynamics, which are essential for formulating and solving complex technical problems in aviation engineering and modeling.
Possesses structured and theoretically grounded general knowledge of engineering and various air transport systems, including the life cycle of transportation means, both hardware and software, with a particular focus on key processes occurring within them.
Has structured and theoretically grounded general knowledge of key technical issues and specialized knowledge in selected aspects of air transport. Is familiar with basic techniques, methods, and tools used in solving engineering-related aviation transport problems.
Has structured and theoretically grounded general knowledge in technical thermodynamics and fluid mechanics, particularly in aerodynamics.
Possesses structured and theoretically grounded knowledge in engineering graphics and machine construction, including technical drawing, object projection, fundamental engineering graphics principles, and the use of CAD (Computer-Aided Design) software in machine design.
Has detailed knowledge of selected topics related to the construction of manned and unmanned aircraft, onboard equipment, control systems, communication and recording systems, automation of individual systems, and basic knowledge of flight simulation training devices and simulation methods applied to aviation transport issues.
Has structured and theoretically grounded knowledge in data processing for MES (Finite Element Method) and CFD (Computational Fluid Dynamics), numerical simulations, quantitative and qualitative data analysis, and data visualization.
Possesses advanced knowledge of material strength, including elasticity and plasticity theories, stress hypotheses, methods for calculating beams, membranes, shafts, joints, and other structural elements, as well as methods for testing material strength and analyzing deformation and stress in structures. Additionally, has basic knowledge of key areas of technical mechanics: statics, kinematics, and dynamics of material points and rigid bodies.
Has basic knowledge of metallic, non-metallic, and composite materials used in machine construction, particularly regarding their structure, properties, manufacturing methods, heat and thermochemical treatments, and the effects of plastic processing on their strength. Also understands fuels, lubricants, technical gases, refrigerants, and other related substances.
Has knowledge of self-learning using modern educational tools such as online lectures, websites, databases, educational software, and e-books. Understands fundamental dilemmas of contemporary civilization.

Skills:
Is able to gather information from various sources, including literature and databases, in both Polish and English, properly integrate them, interpret and critically evaluate them, draw conclusions, and comprehensively justify formulated opinions.
Can effectively use information and communication technologies applicable at various stages of aviation projects.
Can appropriately select materials for simple aviation structures and identify differences between aviation fuels.
Can communicate using various techniques in professional and other environments, utilizing formal construction documentation, technical drawings, and specialized terms and definitions relevant to the field of study.
Can solve problems using basic knowledge of aerodynamics, flight mechanics, and fluid dynamics.
Can design-according to a given specification-and construct typical devices, objects, systems, or implement processes relevant to the field of study using appropriately selected methods, techniques, tools, and materials, considering external requirements (e.g., environmental protection).
Can critically analyze technical objects and solutions, search for ready-made machine and equipment components in catalogs and manufacturer websites, and assess their suitability for use in personal technical and organizational projects.
Can apply mathematical language (differential and integral calculus) to describe simple engineering problems.
Can plan and organize work-both individually and in a team-taking on various roles, collaborate within team projects (including interdisciplinary ones), set priorities for achieving self-assigned or team-assigned tasks, and participate in debates by presenting, evaluating, and discussing various opinions and perspectives.
Can plan and execute a process of continuous self-learning and is aware of further educational opportunities (Master’s and PhD studies, postgraduate courses, training, and exams conducted by

universities, companies, and professional organizations).
Social Competencies:
Understands that in technology, knowledge and skills become obsolete very quickly.
Is aware of the importance of knowledge in solving cognitive and practical problems and seeks expert opinions when encountering difficulties in independent problem-solving. Knows examples and understands the causes of faulty engineering projects that have led to significant financial and social losses or even severe health consequences and loss of life.
Is conscious of the social role of a technical university graduate, particularly the need to formulate and communicate information and opinions to society regarding engineering activities, technological achievements, and the legacy and traditions of the engineering profession. Engages in organizing activities for the benefit of the community and initiating actions in the public interest.
Correctly identifies and resolves dilemmas related to the profession of an aviation engineer, adheres to professional ethics, and expects the same from others.

Social competences:
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Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Performing laboratory exercises and submitting a report on the exercise
Written exam
Test

Programme content

Conduction in typical geometric configurations. Heat convection, differential equation, turbulence models, convection in closed channels, convection in flow around surfaces, convection in gaps. Thermal radiation.
Application of radiation in previously analyzed geometries. Discretization of heat, momentum and mass exchange equations. PART - 66 (PRACTICE - 22.5 hrs.)
MODULE 16. PISTON ENGINE
Types, design and principles of operation; Icing and heating

Course topics

Conduction in various geometric configurations.
Heat convection: differential equation, turbulence models.
Convection in closed channels, with flow around surfaces and in gaps.
Heat radiation and its application in analyzed geometries.
Discretization of heat, momentum and mass exchange equations.
PART-66 (Practical - 22.5 hrs.)
Module 16 - Piston engine
16.4 Engine fuel systems
16.4.1 Carburetors - types, construction and principles of operation.

Teaching methods

lecture, description, discussion, blackboard exercises, independent practical exercises, laboratories

Bibliography

Basic:
Brodowicz K.: Theory of heat and mass exchangers, PWN 1982
Hobler T.: Heat movement and exchangers, WNT 1979
Kostowski E.: Heat flow, P. Śl. Publishing House 1991
Kostowski E.: Collection of problems on heat flow, P. Śl. Publishing House 1988
Staniszewski B. Ed.: Heat exchange? tasks and examples, PWN 1965
Staniszewski B.: Heat transfer, PWN 1979
Wiśniewski St., Wiśniewski T.: Heat transfer, WNT 1997
Holman J.P., Heat transfer, London McGraw-Hill 1992

Incropera F.P., De Witt D.P.: Fundamentals of Heat and Mass Transfer, John Wiley & Sons, New York 2002

Additional:
Patankar S.V., Numerical Heat Transfer and Fluid Flow, CRC Press, 1980.
Guo Z, Shu C., Lattice Boltzmann Method and Its Applications in Engineering (Advances in Computational Fluid Dynamics), World Scientific, 2013
Mohamad A.A., Lattice Boltzmann Method: Fundamentals and Engineering Applications with Computer Codes, Springer, 2011.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	50	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	50	2,00