COURSE DESCRIPTION CARD - SYLLABUS

Course name
Theory of aircraft engines 2 [S1Lot2-SLiPL>TSL2]

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
15

Laboratory classes
0

Other
0

Tutorials
15

Projects/seminars
0

Number of credit points

2,00

Coordinators

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Lecturers

Prerequisites

The student should have basic knowledge and skills in thermodynamics (concepts of enthalpy, entropy, heat, ideal gas model, basic gas transformations), fluid mechanics (forces exerted by the fluid on the flow channel, classification of flows, isentropic flows, viscous phenomena and their influence on the flow field), aerodynamics (wing and profile aerodynamics, criterion numbers, boundary layer theory, turbulence) and knowledge from the subject Theory of aircraft engines from the previous semester.

Course objective

Expand your knowledge of flow-through aircraft engines from the previous semester to include the mechanics and thermodynamics of their components, as well as the principles of cooperation between flow-through components.

Course-related learning outcomes

Knowledge:
1. has extended and deepened knowledge of mathematics including algebra, analysis, theory of differential equations, probability, analytical geometry as well as physics including the basics of classical mechanics, optics, electricity and magnetism, solid state physics, thermodynamics, useful for

formulating and solving complex technical tasks related to aeronautical engineering and modeling
2. has structured and theoretically based general knowledge of key issues of technology and detailed knowledge of selected issues related to air transport, knows basic techniques, methods and tools used in the process of solving tasks related to air transport, mainly of an engineering nature
3. has knowledge of the method of presenting research results in tabular and graph form, performing measurement uncertainty analysis
4. has basic knowledge of research methods and the method of preparing and conducting scientific research, and knows the principles of writing a scientific paper
5. has extended knowledge in the field of strength of materials, including the theory of elasticity and plasticity, stress hypotheses, methods of calculating beams, membranes, shafts, connections and other structural elements, as well as methods of testing the strength of materials and the state of deformation and stress in structures and also has basic knowledge in the main areas of technical mechanics: statics, kinematics and dynamics of a material point and a rigid body
6. has basic knowledge of metallic, non-metallic and composite materials used in machine construction, and in particular their structure, properties, methods of production, heat and thermochemical treatment and the influence of plastic processing on their strength as well as fuels, lubricants, technical gases, refrigerants, etc.
7. has basic knowledge of environmental protection in transport, is aware of the threats related to environmental protection and understands the specific impact of mainly air transport on the environment and the social, economic, legal and other non-technical conditions of engineering activities
8. has the ability to self-educate using modern teaching tools, such as remote lectures, websites and databases, teaching programs, e-books

Skills:
1. is able to obtain information from various sources, including literature and databases, both in Polish and English, integrate it properly, interpret and critically evaluate it, draw conclusions, and comprehensively justify the opinions he/she formulates
2. is able to properly use information and communication techniques that are used at various stages of implementing aviation projects
3. is able to properly plan and perform experiments, including measurements and computer simulations, interpret the results obtained, and correctly draw conclusions from them
4. is able to formulate and solve tasks related to civil aviation, apply appropriately selected methods, including analytical, simulation or experimental methods
5. is able to properly select materials for simple aircraft structures, indicate differences between fuels used in aviation
6. is able to communicate using various techniques in a professional environment and other environments using a formal record of the structure, technical drawing, concepts and definitions of the scope of the field of study studied
7. is able to design elements of means of transport using data on environmental protection
8. the student is able to use theoretical probability distributions. The student is able to analyze and interpret statistical data. The student is able to apply methods and tools of mathematical statistics in engineering practice
9. is able to apply the language of mathematics (differential and integral calculus) to describe simple engineering issues.
10. the student is able to make a comprehensive assessment of the ecological parameters of the aircraft propulsion unit based on the values of emission indicators of harmful gaseous compounds and particulate matter
11. is able to prepare a short scientific paper, observing basic editorial principles. Is able to select appropriate methods for the research carried out and is able to conduct a basic analysis of the results.
12. is able to organize, cooperate and work in a group, assuming different roles in it and is able to appropriately determine priorities for the implementation of a task specified by himself or others
13. is able to plan and implement the process of his own permanent learning and is familiar with the possibilities of further education (second and third cycle studies, postgraduate studies, courses and exams conducted by universities, companies and professional organizations)

Social competences:
1. understands that in technology, knowledge and skills very quickly become outdated
2. is aware of the importance of knowledge in solving engineering problems and knows examples and understands the causes of malfunctioning engineering projects that led to serious financial and social losses or to serious loss of health or even life

3. is aware of the social role of a technical university graduate, in particular understands the need to formulate and communicate to society, in an appropriate form, information and opinions on engineering activities, technical achievements, as well as the achievements and traditions of the engineering profession
4. correctly identifies and resolves dilemmas related to the performance of the profession of an aviation and astronautics engineer

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture (final grade consists of three components):
1. Written assessment/final exam (65%)
2. Assessment of a small group midterm project (20%)
3. Assessment of individual homework
(15%) Classes:
1. Written assessment of computational problems (100%)
To pass the course, it is required to obtain no less than 60% of the component points. The grading curve for the 60%-100% range is established individually in each semester.

Programme content

Lecture semester II:
Gas dynamics of air intakes; Compressors (mechanics of flat and rotating palisades, stage work, stage compression, dimensionless parameters of compression stages); Combustion chambers - Energy balance of the chamber, basics of the intra-chamber process; Turbines (mechanics of flat and rotating palisades, stage work, stage expansion, dimensionless parameters); Afterburners; Exhaust nozzles; Conditions of cooperation of flow engine components; Engine control map; Mechanics of operation of propeller drive units Exercises semester II:
Calculation of the geometry of supersonic inlets; calculation of kinematics and dynamics of compressor and turbine palisades as well as the resulting unit work of the stage, compression, work coefficients and Lieblein's
concentration coefficient; Energy and mass balance of the combustion chamber, pressure drop in the combustion chamber, calculation of afterburner efficiency and variable cross-sections of the adjustable nozzle; Determination of performance parameters and design of propellers based on one-dimensional theories
PART - 66 (THEORY - 22.5 hrs.)
MODULE 16. PISTON ENGINE
16.12 Engine monitoring and ground operations
Take-off and climb procedures;
Interpretation of engine power output and parameters;
Engine and component inspection: criteria, tolerances and data specified by the engine manufacturer. [3] 16.13 Engine storage and maintenance
Maintenance and lack of maintenance of the engine and accessories/systems. [2]

Course topics

1. Gas Dynamics of Air Intakes and Supersonic Inlet
Design Fundamentals of air intake aerodynamics
Shock waves and their impact on inlet performance
Supersonic inlet geometry calculations and optimization
2. Compressor Mechanics and Performance Analysis
Flat and rotating palisades: kinematics and dynamics
Stage work, compression ratios, and efficiency
drops and efficiency considerations Fundamentals of
combustion processes inside the chamber
4. Turbine Mechanics and Expansion Processes
Flat and rotating palisades: aerodynamics and force analysis
Stage work and expansion coefficients
Dimensionless turbine parameters and efficiency calculations
5. Afterburners and Exhaust Nozzle Dynamics

Energy balance and efficiency of afterburners
Adjustable exhaust nozzles: design and variable cross-section calculations
Impact of afterburners on thrust generation and engine performance
6. Engine Component Cooperation and Control Mapping
Integration of compressors, turbines, and combustion chambers
Engine control maps and performance parameters
Optimization of engine efficiency under different operational conditions

Teaching methods

1. Blackboard lecture
2. Auditorium exercises
3. Computational projects performed using publicly available programming tools

Bibliography

Basic:
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Additional:
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Breakdown of average student's workload

	Hours	ECTS
Total workload	70	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	1,00