COURSE DESCRIPTION CARD - SYLLABUS

Course name
Intergrated aircraft engine design system [S1Lot2-SLiPL>ZSPSL]

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
30

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

The student should have basic knowledge and skills in mathematics, especially in the field of multivariable differential calculus, vector calculus and linear algebra, as well as thermodynamics, fluid mechanics and aerodynamics, and knowledge of the theory of aircraft engines.

Course objective

- Teaching principles: design of electric drive components, including: Analytical design of flow components; Creation of portable (CAD) models for the needs of CAE systems and basic use of CAE systems to perform analyze flow mass and heat

Course-related learning outcomes

Knowledge:
1. 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

2. has basic knowledge of metallic, non-metallic and composite materials used in
machine construction, 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.
3. has basic knowledge of the mechanisms and laws governing human behavior and psyche

Skills:
1. is able to obtain information from various sources, including literature and databases, both in Polish and English, integrate them correctly, interpret and critically evaluate them, draw conclusions, and comprehensively justify the opinions he/she formulates
2. is able to properly plan and perform experiments, including measurements and computer simulations, interpret the obtained results, and correctly draw conclusions from them
3. is able to formulate and solve tasks related to civil aviation, apply appropriately selected methods, including analytical, simulation or experimental methods
4. is able to properly select materials for simple aircraft structures, indicate differences between fuels used in aviation
5. is able to design means of transport with appropriate external requirements (e.g. regarding environmental protection)

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 have led to serious
financial, social losses or serious loss of health or even life
3. correctly identifies and resolves dilemmas related to the profession of an aerospace 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. Complete group project (analytical calculations, geometry project, CFD analysis) (65%)
2. Grade from a small individual project (35%)
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 I:
Analysis of heat and mass flow phenomena, transport equations, methods of discretization of transport equations,
numerical analysis procedure, introduction to requirements for computational grids,
Laboratory semester I:
Conducting simple flow analyses for incompressible and compressible flows based on
the ideal gas model on the provided computational grids. Creating two-dimensional
structured and unstructured grids.
PART - 66 (PRACTICE - 22.5 hours)
MODULE 16. PISTON ENGINE
16.7 Supercharging/turbocharging
Principles and objectives of supercharging and its effect on engine parameters;
Design and operation of the supercharging and turbocharging system; [2]

Course topics

1. Heat and Mass Flow Phenomena in Fluid Dynamics Fundamental concepts of heat and mass transfer
Transport mechanisms: conduction, convection, and diffusion Applications in fluid mechanics and thermal engineering
2. Transport Equations and Their Physical Meaning
Derivation of fundamental transport equations
Conservation laws for mass, momentum, and energy

Role of transport equations in computational fluid dynamics (CFD)
3. Methods of Discretization of Transport Equations
Finite difference, finite volume, and finite element methods
Comparison of discretization techniques and their applications Numerical stability and accuracy considerations
4. Computational Grids and Their Requirements
Structured vs. unstructured grids: advantages and disadvantages
Grid refinement and resolution requirements
Best practices for computational grid generation
5. Numerical Analysis Procedure in Fluid Flow Simulations
Steps in setting up and solving a numerical fluid flow problem
Iterative solvers and convergence criteria
Error analysis and validation of numerical results
6. Practical Applications: Incompressible and Compressible Flow Analysis Conducting flow analyses using the ideal gas model
Hands-on experience with computational grids
Case studies of incompressible and compressible flows
7. Case studies on turbochargers and superchargers flows

Teaching methods

1. Chalkboard lecture (or Whiteboard lecture)
Laboratory in a computer room
Computational projects using publicly available programming tools

Bibliography

Basic:
1. Cumpsty, N. A., Heyes, A. L. – Jet Propulsion: A Simple Guide to the Aerodynamic and Thermodynamic Design and Performance of Jet Engines (Cambridge University Press, 2015)
2. Boyce, M. P. – Gas Turbine Engineering Handbook (Butterworth-Heinemann, 2012)

Additional:
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Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	35	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	1,50