# COURSE DESCRIPTION CARD - SYLLABUS

Course name

Numerical Thermomechanics

## 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 studies

Course offered in

polish

Form of study

full-time

Requirements

elective

## Number of hours

Lecture

15

Laboratory classes

30

Other (e.g. online)

0

Tutorials

0

Projects/seminars

0

## Number of credit points

3

## Lecturers

Responsible for the course/lecturer:

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Maszyn Roboczych i Transportu

ul. Piotrowo 3; 60-965 Poznań

Responsible for the course/lecturer:

## Prerequisites

Basic knowledge of 3D geometry modeling. Knowledge of heat flow processes in heat-flow machines and equipment. Ability to describe and define complex heat flow processes. The ability to effectively self-study in a 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. Getting to know the methods of describing various heat flow processes occurring in the assumed processes of thermal and mechanical energy conversion in order to modernize or rebuild technological systems in areas related to thermal energy, heating and cooling. Practical mastery of the ability to describe the

implementation of effective thermal processes in which heat, momentum and mass exchange processes occur.

## Course-related learning outcomes

Knowledge

1. has extended and in-depth knowledge of mathematics including algebra, analysis, theory of differential equations, probability, analytical geometry as well as physics covering the basics of classical mechanics, optics, electricity and magnetism, solid state physics, thermodynamics, useful for formulating and solving complex technical tasks related to engineering aeronautical and modeling

2. has ordered, theoretically founded general knowledge in the field of technology and various means of air transport, about the life cycle of means of transport, both hardware and software, and in particular about the key processes taking place in them

3. has ordered and theoretically founded general knowledge in the field of key technical issues and detailed knowledge of selected issues related to air transport, knows the basic techniques, methods and tools used in the process of solving tasks related to air transport, mainly of an engineering nature

4. has ordered, theoretically founded general knowledge covering key issues in the field of technical thermodynamics, fluid mechanics, in particular aerodynamics

5. has an ordered, theoretically founded knowledge in the field of engineering graphics and machine construction: technical drawing, object projection, basic principles of engineering graphics, the use of CAD (Computer Aided Design) graphic programs in the construction of machines

6. has detailed knowledge related to selected issues in the field of manned and unmanned aircraft construction, in the field of on-board equipment, control systems, communication and recording systems, automation of individual systems, has basic knowledge of flight simulation training devices and simulation methods used to solve air transport issues

7. has ordered, theoretically founded knowledge in the field of data processing for MES and CFD, numerical simulations, quantitative and qualitative data analysis, data visualization

8. has extended knowledge in the field of material strength, including the theory of elasticity and plasticity, stress hypotheses, methods of calculating beams, membranes, shafts, joints and other structural elements, as well as methods of testing the strength of materials and the state of deformation and stress in structures, and has basic knowledge of the main departments of technical mechanics: statics, kinematics and dynamics of a material point and a rigid body

9. has basic knowledge of metal, non-metal and composite materials used in machine construction, in particular about their structure, properties, methods of production, heat and thermo-chemical treatment and the influence of plastic processing on their strength, as well as fuels, lubricants, technical gases, refrigerants e.t.c.

10. has the ability to self-study with the use of 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 in English, integrate them properly, interpret them and make a critical evaluation, draw conclusions and exhaustively justify the opinions they formulate

2. is able to properly use information and communication techniques, applicable at various stages of the implementation of aviation projects

3. is able to properly select materials for simple aviation structures, and can indicate the differences between the fuels used in aviation

4. is able to communicate using various techniques in the professional environment and other environments using the formal notation of construction, technical drawing, concepts and definitions of the scope of the study field of study

5. can solve tasks using basic knowledge of aerodynamics, flight mechanics and body flow

6. is able to design means of transport with appropriate external requirements (e.g. regarding environmental protection)

7. can analyze objects and technical solutions, can search in catalogs and on manufacturers' websites, ready components of machines and devices, including means and devices, assess their suitability for use in their own technical and organizational projects

8. can use the language of mathematics (differential and integral calculus) to describe simple engineering problems.

9. is able to organize, cooperate and work in a group, assuming various roles in it, and is able to properly define priorities for the implementation of a task set by himself or others

10. is able to plan and implement the process of own permanent learning and knows the possibilities of further education (2nd and 3rd degree 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 obsolete

2. is aware of the importance of knowledge in solving engineering problems and knows examples and understands the causes of faulty engineering projects that have led to serious financial and social losses, or to a serious loss of health and even life

3. is aware of the social role of a technical university graduate, in particular understands the need to formulate and provide the society, in an appropriate form, with information and opinions on engineering activities, technological achievements, as well as the achievements and traditions of the engineer profession

4. 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:

Performing laboratory exercises and submitting a report on the exercise

Written exam

Final test

## Programme content

Conduction in typical geometric configurations. Heat convection, differential equation, turbulence models, closed channel convection, surface flow convection, convection in gaps. Thermal radiation. The use of radiation in previously analyzed geometries. Discretization of momentum and mass heat transfer equations.

PART - 66 (PRACTICE - 22.5 hours)

MODULE 16. PISTON ENGINE

16.4 Engine fuel systems

16.4.1 Carburettors

Types, structure and principles of operation;

Icing and heating. [2]

## Teaching methods

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

## Bibliography

Basic

1. Brodowicz K.: Teoria wymienników ciepła i masy, PWN 1982

2. Hobler T.: Ruch ciepła i wymienniki, WNT 1979

3. Kostowski E.: Przepływ ciepła, Wyd. P. Śl. 1991

4. Kostowski E.: Zbiór zadań z przepływu ciepła, Wyd. P. Śl. 1988

5. Staniszewski B. Red.: Wymiana ciepła ? zadania i przykłady, PWN 1965

6. Staniszewski B.: Wymiana ciepła, PWN 1979

7. Wiśniewski St., Wiśniewski T.: Wymiana ciepła, WNT 1997

8. Holman J.P., Heat transfer, London McGraw-Hill 1992

9. 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 | 75 | 3,0 |
| Classes requiring direct contact with the teacher | 45 | 1,8 |
| Student's own work (literature studies, preparation for laboratory classes, preparation for tests) [1] | 30 | 1,2 |

[1] delete or add other activities as appropriate