POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Numerical thermomechanics [S2EJ1>NT]

Course

Field of study Nuclear Power Engineering	Year/Semester 1/2
Area of study (specialization) –	Profile of study general academic
Level of study second-cycle	Course offered in Polish
Form of study full-time	Requirements elective

Number of hours

Lecture 30	Laboratory classes 30	Other 0
Tutorials 0	Projects/seminars 0	

Number of credit points

5,00

Coordinators

dr hab. inż. Magda Joachimiak prof. PP
magda.joachimiak@put.poznan.pl

Lecturers

Prerequisites

Students entering the subject should have a basic knowledge of mathematics (mathematical analysis, linear algebra, differential and integral calculus), physics, thermodynamics, fluid mechanics and classical mechanics.

Course objective

Acquiring knowledge and skills in numerical calculations and analysis of the obtained results for thermally loaded components. Determination of temperature and thermal stress fields using various computational tools. Analysis of thermal-fluid processes for heating and cooling of machine and power equipment components.

Course-related learning outcomes

Knowledge:
1. The student knows the basic methods of numerical calculations. The student has a structured, theoretically supported knowledge of applied mathematics allowing the selection of discretization schemes and applied numerical methods for the analyzed problem.
2. The student has knowledge of methods of description of heat flow processes and fundamentals of

fluid mechanics.
3. The student has knowledge of heat load analysis.

Skills:
1. The student is able to calculate temperature fields in thermally loaded elements.
2. The student is able to apply CFD tools to thermal-fluid analyses.
3. The student is able to combine computational skills based on numerical modeling with issues of heat, momentum and mass transfer, with prediction based on analytical and empirical methods including relating the obtained results to experimental values.

Social competences:
1. The student understands the need for continuous education.
2. The student understands the need to critically evaluate the obtained results of numerical calculations.
3. The student is aware of the need to consult applied mathematics, numerical analysis, thermodynamics, mechanics, CFD tools in order to perform correct numerical calculations on thermomechanics.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture
Written exam on the content presented in the lecture.
The list of issues will be made available to students at the beginning of the semester.
A positive grade will be given to students who score above 50%.
Laboratories
Completion of computational tasks during classes and completion of a small project.
The activity and independence of students during the performance of computational tasks in laboratories will be taken into account.

Programme content

Lectures
Basic concepts and equations describing heat conduction, convection and radiation. Types of boundary conditions in thermal-fluid analyses. Methods of discretization of differential equations and their application to the heat conduction equation. Explicit and implicit methods of solving PDEs applied to heat flow analysis. Numerical algorithms to help solve heat load analysis problems (function approximation and interpolation, Newton's method, numerical integration, solving systems of linear equations). Problems of coupled heat transfer between fluid and solid.
Laboratories
Thermal-fluid analyses of machine and equipment components using CFD tools. Creating meshes and the influence of the quality of the mesh on the obtained results. Performing steady and unsteady CHT (conjugate heat transfer) analyses.

Course topics

Topics of classes according to the content of the curriculum.

Teaching methods

Lectures: multimedia presentation supplemented by explanations given on the blackboard.
Laboratories: calculations performed using publicly available software tools and CFD (computer room).

Bibliography

Basic:
1. Wiśniewski, S., Wiśniewski, T., Wymiana ciepła, WNT, 2002.
2. Björck A, Dahlquist G., Metody numeryczne, PWN, 1983.
3. Kincaid D., Cheney W., Analiza numeryczna, WNT, W-wa 2006.

Additional:

1. Incropera, F., DeWitt, D., Fundamentals of heat and mass transfer, Wiley, 2008
2. Suhas V. Patankar, Numerical Heat Transfer and Fluid Flow, Taylor & Francis, 1980.
3. Joachimiak, M., Joachimiak, D. and Ciałkowski, M. (2022), “Investigation on thermal loads in steady-state conditions with the use of the solution to the inverse problem”, Heat Transfer Engineering, pp. 1-7.
4. Joachimiak, M., Ciałkowski, M. and Frąckowiak, A. (2019), "Stable method for solving the Cauchy problem with the use of Chebyshev polynomials", International Journal of Numerical Methods for Heat & Fluid Flow, Vol. 30 No. 3, pp. 1441-1456.

Breakdown of average student's workload

	Hours	ECTS
Total workload	127	5,00
Classes requiring direct contact with the teacher	62	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	65	2,50