GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Computational simulations for defence applications, PG_00071213		
Field of study	Nanotechnology		
Date of commencement of studies	February 2027	Academic year of realisation of subject	2026/2027
Education level	second-cycle studies	Subject group	Specialty subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	1	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Institute of Nanotechnology and Materials Engineering -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Marek Augustyniak	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	10.0	0.0	20.0	15.0	0.0	45

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	45	1.0	54.0	100

Subject objectives

This course aims to equip students with practical skills related to FEM (Finite Element Method)/CFD (Computational Fluid Dynamics) computer simulations for dual-purpose applications: civilian and military. Emphasis is placed on a variety of topics, one of which should be selected and creatively developed by participants as part of the project component of the course.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W05] has in-depth knowledge of mathematical, numerical, and simulation methods - both classical and quantum - used in the modeling of nanostructures	Student acquires knowledge allowing to model multi-scale problems.	[SW1] Assessment of factual knowledge
[K7_U03] has enhanced abilities of using advanced specialist software packages	The student deepens their skills in using advanced specialist software packages, e.g. ANSYS, LS-DYNA, OpenFoam	[SU1] Assessment of task fulfilment
[K7_U05] is able to plan and carry out theoretical and numerical calculations as well as simulations of phenomena and processes, critically analyze their results, draw conclusions, and formulate well-founded opinions in nanotechnology and related physical and natural sciences	The student is able to plan and carry out FEA / CFD simulations.	[SU1] Assessment of task fulfilment

<table>
<tr><td>Subject contents</td><td>Course content – lecture
This course covers most areas of thermomechanical engineering with military applications. The course introduces or reviews the principles of using the Finite Element Method (including its explicit approach) and fluid mechanics (CFD) to solve technical problems.
Course content – laboratory

- Static or cyclic durability of weapons, electronic devices, and vehicles
- Predicting and optimizing flow properties (e.g., fighter jet or drone aerodynamics)
- Behavior of objects under sudden loads (e.g., bullet impact on a helmet, collision of an armored vehicle with an obstacle)
- Predicting heat distribution to minimize infrared signatures
Electromagnetic issues (electronics, telecommunications, magnetic shielding/signatures, electric motors, etc.) are not included in this course.

Course content – project

The project is intended to be a creative extension of one of the selected exercises performed during the labs (e.g., performing additional flow or impact simulations of a drone), according to the participants' preferences.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>The prerequisite is that students are motivated to solve the problems posed, more from an engineering than a scientific perspective. It is recommended that students have participated in the Computer Assisted Design and Simulation classes.</td></tr>
<tr><td>Assessment methods and criteria</td><td><table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>Completing the standard exercises</td><td>70.0%</td><td>50.0%</td></tr><tr><td>Project fullfilment</td><td>70.0%</td><td>50.0%</td></tr></table></td></tr>
<tr><td>Recommended reading</td><td><table><tr><td>Basic literature</td><td>The Finite Element Method: Its Basis and Fundamentals, O.C. Zienkiewicz, 2009 (e.g. https://www.meil.pw.edu.pl/content/download/58297/306302/file/FEM_Zienkiewicz%20Vol1.pdf)</td></tr><tr><td>Supplementary literature</td><td>An Introduction to Computational Fluid Dynamics, The finite volume method, H K Versteeg and W Malalasekera
(available on the Internet)</td></tr><tr><td>eResources addresses</td><td></td></tr></table></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td>@ Penetrating a steel or composite helmet with a projectile (LS-DYNA or OpenRADIOSS)
@ Frontal collision of a tank with a wall (LS-DYNA)
@ Fighter aircraft aerodynamics (OpenFoam)
@ Drone aerodynamics (OpenFoam)
@ Modeling a minesweep (ANSYS or OnShape)
@ Thermomechanical fatigue strength of solders in an electronic device
@ Predicting the thermal properties of fabric intended for combat clothing</td></tr>
<tr><td>Practical activites within the subject</td><td>It is possible to organize a student trip, e.g. to the Naval Academy or the Maritime Technology Center.</td></tr>
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