GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Computer simulations of high-frequency systems, PG_00069764		
Field of study	Informatics, Electronics and Telecommunications, Biomedical Engineering, Biomedical Engineering, Biomedical Engineering, Space and Satellite Technologies, Automatic Control, Cybernetics and Robotics		
Date of commencement of studies	February 2025	Academic year of realisation of subject	2025/2026
Education level	second-cycle studies	Subject group	
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Microwave and Antenna Engineering -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Adam Lamęcki	
	Teachers	dr hab. inż. Adam Lamęcki	

Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	15.0	0.0	0.0	30
	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	30	2.0	18.0	50

Subject objectives	The course introduces students to the theoretical foundations and practical applications of selected simulation methods in computational electrodynamics, such as the Method of Moments (MoM), Finite Element Method (FEM), Finite-Difference Time-Domain (FDTD), Integral Equations (IE), Physical Optics (PO), Mode Matching, and hybrid methods. During the course, their applications in the analysis and design of high-frequency circuits and antennas are discussed. The laboratory component enables students to apply the acquired knowledge in practice through work with industrial CAD packages for electromagnetic simulation.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U08] while identifying and formulating engineering tasks specifications and solving these tasks, can: - apply analytical, simulation and experimental methods, - notice their systemic and non-technical aspects, - make a preliminary economic assessment of suggested solutions and engineering work	Is able to use industrial CAD tools to perform electromagnetic simulations.	[SU4] Assessment of ability to use methods and tools
[K7_W02] knows and understands, to an increased extent, selected laws of physics and physical phenomena, as well as methods and theories explaining the complex relationships between them, constituting advanced general knowledge in the field of technical sciences related to the field of study	Knows the theoretical foundations of computational electrodynamics used in the analysis of high-frequency structures. Knows the principles of operation and the application scope of selected numerical methods used in electromagnetics, such as the Method of Moments (MoM), Finite Element Method (FEM), Finite-Difference Time-Domain (FDTD), Integral Equations (IE), Physical Optics (PO), and Mode Matching.	[SW1] Assessment of factual knowledge
[K7_U01] can apply mathematical knowledge to formulate and solve complex and non-typical problems related to the field of study by: - appropriate selection of source information and its critical analysis, synthesis, creative interpretation and presentation, - application of appropriate methods and tools	Understands the differences between numerical methods in terms of accuracy, computational complexity, and areas of application.	[SU3] Assessment of ability to use knowledge gained from the subject
[K7_U07] can apply advanced methods of process and function support, specific to the field of study	Student is able to formulate a numerical model of an electromagnetic problem for a selected high-frequency structure. Can select an appropriate simulation method for a given electromagnetic problem.	[SU4] Assessment of ability to use methods and tools

Subject contents

Course content – lecture

- Fundamentals of computational electrodynamics and modeling of electromagnetic problems.
- Integral methods and the Method of Moments (MoM) in the analysis of radiating and conducting structures.
- Volume methods: the Finite Element Method (FEM) and the Finite-Difference Time-Domain (FDTD) method.
- Asymptotic methods: Physical Optics (PO).
- Semi-analytical methods: Mode Matching.
- Hybrid methods for the analysis of complex electromagnetic structures.
- Applications of numerical methods in the analysis and design of high-frequency circuits and antennas.
- Accuracy, stability, and computational complexity of simulation methods.

Course content – laboratory

- Introduction to the laboratory environment and overview of commercial electromagnetic simulation tools.
- Method of Moments (MoM) practical simulations using Altair FEKO.
- Finite Element Method (FEM) modeling and analysis using Ansys HFSS.
- Finite-Difference Time-Domain (FDTD) method simulations using CST Studio Suite.
- Planar integral-equation methods (MoM for planar circuits) simulations using Keysight Momentum.
- High-frequency and mode-based techniques (e.g., Mode Matching) simulations using Microwave Wizard.
- Comparative analysis of results obtained with different methods and tools.

Prerequisites and co-requisites

Knowledge of the fundamentals of mathematical analysis, differential calculus, and electrodynamics. Knowledge of the fundamentals of microwave engineering and antenna technology.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
egzamin	50.0%	50.0%
praca na zajęciach	50.0%	50.0%

Recommended reading	Basic literature	1) Matthew N. O. Sadiku, Numerical Techniques in Electromagnetics with MATLAB, CRC Press, 2009. 2) David B. Davidson, Computational Electromagnetics for RF and Microwave Engineering, Cambridge University Press, Cambridge, 2010. 3) Jian-Ming Jin, The Finite Element Method in Electromagnetics, Wiley, 2015. 4) R. F. Harrington, Field Computation by Moment Methods, WileyIEEE Press, New York, 1993. 5) Constantine A. Balanis, Advanced Engineering Electromagnetics, Wiley, 2012.
	Supplementary literature	1) Allen Taflove, Susan C. Hagness, *Computational Electrodynamics: The Finite-Difference Time-Domain Method*, Artech House, Boston, 2005. 2) Marco Guglielmi, Roberto Sorrentino, Giuseppe Conciauro, *Advanced Modal Analysis: CAD Techniques for Waveguide Components and Filters*, John Wiley & Sons, 1999.
	eResources addresses	
Example issues/ example questions/ tasks being completed		
Practical activites within the subject	Not applicable	

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