Proponent from WUT	
Title and degree	PhD
Name and surname	Bartosz Janaszek
Faculty	Electronics and Information Technology
E-mail address in the WUT domain	Bartosz.janaszek@pw.edu.pl
Phone number	+48 518617489

The person proposed as a visiting professor	
Title and degree	Professor Emeritus of Electrical & Computer Engineering, PhD
Name and surname	Igor Zuckerman (legal name) a.k.a. Igor Tsukerman (publications)
Exact affiliation	Department of Electrical & Computer Engineering, the University of Akron, OH, USA
E-mail address	igor@uakron.edu
Description of achievements (1/2-1 page)	Igor Tsukerman is Professor Emeritus of Electrical and Computer Engineering at the University of Akron, Ohio, USA, where he has been a faculty member since 1995. His research focuses on the simulation of nanoscale systems, applied electromagnetics and photonics. He teaches a variety of undergraduate and graduate courses (Circuits, Electromagnetic Fields, Programming for Engineers, Signals & Systems, Digital Signal Processing, Random Signal Analysis, Simulation of Nanoscale Systems, and others). Tsukerman has over 200 refereed publications. He has authored the monograph *Computational Methods for Nanoscale Applications: Particles, Plasmons and Waves* (Springer 2008, 2020), co-edited another book, *Plasmonics and Plasmonic Metamaterials* (World Scientific 2011), and acted as Editor-in-Chief of a five-volume reference set on electromagnetic analysis and simulation (World Scientific, 2020). He is currently working on a 3rd edition of *Computational Methods for Nanoscale Applications*, to appear in early 2026. Tsukerman, his students and collaborators have advanced a variety of computational methods, algorithms and software for electromagnetic eddy current problems, coupled field-circuit problems, computer simulation of electric machines, generalized finite element and finite difference methods with Trefftz approximations; developed a homogenization theory of metamaterials and an impedance-based approach to problems in topological photonics. Before coming to the University of Akron, Tsukerman worked at the Department of Electrical & Computer Engineering, the University of Toronto (1990–1995). His academic degrees are from St. Petersburg Polytechnic in Russia: a BSc/MSc degree with honors in Control Systems (1982) and a PhD in Electrical Engineering (1988).

Code of the course	4606-VP-ES-00029	Name of the course	Polish	Symulacja systemów w skali molekularnej i nanoskali
			English	Simulation of Nanoscale and Molecular-Scale Systems
Type of the course	Specialty subject/~~researcher's workshop~~			
Course coordinator		Course teacher	Igor Tsukerman	
Implementing unit	Faculty of Electronics and Information Technology	Scientific discipline / disciplines*	- automation, electronics, electrical engineering and space technologies; - physical sciences; - information and communication technology	

Level of education	Doctoral studies	Semester	fall		
Language of the course	English				
Type of assessment	Homework, projects, final report, project evaluation	Number of hours in a semester	60	ECTS credits	4
Minimum number of participants	10	Maximum number of participants	15	Available for students (BSc, MSc)	Yes

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	4				
	in a semester	24		36		

* does not apply to the Researcher's Workshop

1. Prerequisites
Basic knowledge of calculus, linear algebra; introductory electromagnetics; programming skills in Python or Matlab.

2. Course objectives
This course is designed to provide PhD students with a comprehensive theoretical and practical foundation in advanced computational methods for nanoscale systems. A primary objective is to develop proficiency in a range of numerical simulation techniques, including finite difference and finite element methods, approaches for modeling long-range interactions (e.g., Ewald summation), and computational photonics frameworks. The course further seeks to establish a rigorous theoretical background that enables students to critically analyze, implement, and extend these methodologies to complex physical problems. Particular emphasis will be placed on the integration of computational practice with theoretical modeling, thereby preparing students to independently design and conduct computational studies that advance their own research agendas. Applications will be drawn from dynamically developing research areas, such as metamaterials, nanoplasmonics, nonlinear optics, and novel low-dimensional materials, including MXenes. By situating numerical methods within the context of these rapidly evolving fields, the course aims to prepare students to engage with the methodological challenges and research opportunities characteristic of contemporary photonics and materials science. Upon completion, students will possess the skills necessary to establish computational workshops within their doctoral research, and to contribute effectively to the development of innovative solutions at the forefront of nanoscale science and engineering.

3. Course content (separate for each type of classes)
Lecture
The scope of the lecture part of the course can be divided into few main topics as follows: 1. Introduction to nanoscale problems. 2. Computational physics methods (finite differences, FDTD, FEM; variational principles). 3. Long-range interactions: explicit models, Ewald methods, implicit solvent models. 4. Optics and photonics (photonic crystals, plasmonics, metamaterials, intro to topological photonics). 5. Review and summary.
Project classes
An integral part of the course is the individual research project, designed to consolidate theoretical knowledge and practical skills acquired during lectures and workshops. Each student will identify a specific problem relevant to their doctoral research or to one of the cutting-edge areas covered in the course (e.g., metamaterials, nanoplasmonics, nonlinear optics, MXenes, or related domains). The project will require students to: • Formulate a well-defined research question and identify the appropriate computational framework for addressing it. • Implement selected nanoscale simulation techniques (finite difference, finite element, Ewald methods, or photonic modeling tools) to investigate the chosen system. • Critically interpret the obtained results in light of the underlying theoretical framework. • Discuss the broader implications of the findings in relation to current trends and challenges in modern photonics and materials science. The outcome of the project will be presented in the form of a written report and an oral presentation. The report should demonstrate methodological rigor, clarity of argumentation, and the ability to connect computational results with theoretical analysis. The presentation will provide an opportunity to defend the approach and findings in a research-oriented setting, fostering academic discussion and peer feedback. Through this project, students will gain first-hand experience in applying advanced computational tools to original research problems, thereby preparing them for independent contributions to their doctoral studies and future scientific work.

4. Learning outcomes			
Type of learning outcomes	Learning outcomes description	Reference to the learning outcomes of the WUT DS	Learning outcomes verification methods*
Knowledge			
K_01	Knowledge of theoretical foundations and latest scientific achievements in the area of computational physics methods applied to nanoscience .	SD_W2	homework; project evaluation; Presentation, report

K_02	Knowledge of main development trends in photonics and metamaterials .	SD_W3	homework; project evaluation
Skills			
S_01	Apply appropriate tools, e.g., finite difference and finite element methods, to solve complex nanoscale problems with previously defined research hypothesis	SD_U1	Presentation, report, project evaluation
S_02	Perform critical analysis of simulation results and evaluate their usefulness and validity in practical realization	SD_U2	Presentation, report, project evaluation
S_03	Communicate within specialized topics of photonics, metamaterials and electromagnetic simulation	SD_U4	presentation
S_04	participate in scientific discourse, present appropriate arguments in scientific discussion and public debates on photonics	SD_U5	presentation
S_05	communicate in English at B2+ level of the Common European Framework of Reference for Languages to the extent allowing for participation in international scientific and professional environment	SD_U6	Presentation; report
S_06	plan and implement – in a methodologically correct way – individual and group research in the field of photonics/metamaterials	SD_U7	report, project evaluation
Social competences			
SC_01	critically assess the achievements and own contribution to the development of the discipline of photonics	SD_K1	Presentation, report
SC_02	acknowledge the essentiality of knowledge and academic achievements in solving cognitive and practical problems	SD_K2	Presentation, report

*Allowed learning outcomes verification methods: exam; oral exam; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria

Homework (mini-projects): 50%; Final project (report + oral presentation): 50%.

6. Literature

Primary references:

[1] Lecture notes and slides to be provided.

[2] I. Tsukerman, Computational Methods for Nanoscale Applications, Springer, 2020 (2nd ed).

[3]

Secondary references:

[1] Jian-Ming Jin. The Finite Element Method in Electromagnetics (Wiley-IEEE Press, multiple editions).

[2] Allen Taflove & Susan C. Hagness. Computational Electrodynamics: The Finite-Difference Time-Domain Method (FDTD) (Artech House).

[3] Costas M. Soukoulis & Martin Wegener. Past achievements and future challenges in the development of three-dimensional photonic metamaterials. Nature Photonics 5, pp. 523–530, 2011.

7. PhD student’s workload necessary to achieve the learning outcomes**

No.	Description	Number of hours
1	Hours of scheduled instruction given by the academic teacher in the classroom	24
2	Hours of consultations with the academic teacher, exams, tests, etc.	16
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	40
4	Amount of time devoted to the preparation for exams, test, assessments	10
	Total number of hours	90
	ECTS credits	3

** 1 ECTS = 25-30 hours of the PhD students work (2 ECTS = 60 hours; 4 ECTS = 110 hours, etc.)

8. Additional information	
Number of ECTS credits for classes requiring direct participation of academic teachers	
Number of ECTS credits earned by a student in a practical course	