Wrocław University of Science and Technology

Study programme

Organizational unit:	Faculty of Pure and Applied Mathematics
Field of study:	Applied Mathematics
Level of study:	second degree 3 semesters
Form of study:	full-time studies
Education cycle:	2025/2026

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Field of study characteristics

Basic information

Organizational unit:	Faculty of Pure and Applied Mathematics
Field of study:	Applied Mathematics
Study level:	second degree 3 semesters
Study form:	full-time studies
Education profile:	general academic profile
Language of study:	English
Valid from the education cycle:	2025/2026
Number of semesters:	3
Total number of hours of classes:	1140
Total number of ECTS points required to complete a given level of study:	90
Professional title awarded to graduates:	magister inżynier

Fields of science and scientific disciplines

Scientific disciplines to which the field of study is assigned:

Field of the exact and natural sciences

Assigning the major to the fields and disciplines to which the learning outcomes relate:

Discipline	Percentage
Maths	100%

Main discipline: Maths

Description of the field, profile of the graduate and possibilities of continuing studies

The program "Applied Mathematics" is designed for individuals who wish to master advanced mathematical tools and learn how to apply them to solve real-world problems. The curriculum focuses on developing analytical and logical thinking, the ability to model complex phenomena, and the effective use of numerical, statistical, and machine learning methods.

Applied Mathematics graduates are well-rounded experts, ready to work in interdisciplinary teams in many sectors of the economy and science. They have unique competencies in data analysis, process optimization, creating innovative solutions, and predicting trends in engineering, finance, medicine, energy, and logistics. The program prepares students for careers in research and development, data analysis, financial modeling, and the new technology sector, including areas that make intensive use of machine learning algorithms and artificial intelligence.

Graduates have the skills to:

1. perform complex analytical and numerical calculations,
2. formulate mathematical problems based on available information (e.g., data) related to a selected area of application,
3. create and use advanced mathematical models for analyzing complex real-world problems,
4. use advanced IT tools, including those related to artificial intelligence, to solve applied mathematical problems,
5. creating new IT tools, including those related to artificial intelligence, enabling the analysis of real data,

6. independently deepening knowledge in the field of advanced mathematical methods and machine learning.

Graduates are prepared to:

1. work in institutions using advanced mathematical methods and machine learning algorithms,
2. continuing their education in doctoral school.

Graduates know a foreign language at the B2 level of the Council of Europe's Common European Framework of Reference for Languages and are able to use specialized language in the field of applied mathematics.

Possibile continuation:
doctoral school, postgraduate studies.

Currentness of the study programme

Concept and goals of education

Applied Mathematics is a degree program that combines a strong mathematical foundation with its practical application to solving complex problems of the modern world. As the cornerstone of all technological advancements, mathematics is an essential component of innovative projects shaping the future. In response to dynamic challenges, the program places particular emphasis on advanced mathematical methods, which are both the foundation and the natural origin of artificial intelligence—driving innovation across a rapidly growing range of applications in many fields.

The aim of the program is to equip students with advanced mathematical, computational, and analytical skills necessary for effectively solving real-world practical problems in industry, natural sciences, and medicine.

The curriculum is designed to allow students to focus their interests within one of three specializations, each offering deeper knowledge and skills in specific areas of applied mathematics:

1. **Financial and Actuarial Mathematics**
   This specialization focuses on advanced mathematical methods used in finance and insurance. Elective courses such as Financial Risk Management, Computational Finance, Non-Life Insurance Mathematics, Risk Management in Insurance, and Actuarial Mathematics for Life Contingent Risks prepare students for careers in banking, insurance, and investment sectors. These courses teach risk modeling, financial instrument valuation, and portfolio management. Additionally, subjects such as Machine Learning for Data Analytics and Data Processing with Rust strengthen analytical competencies in the context of financial data.
2. **Industrial Mathematics**
   This specialization centers on the application of mathematics in industry and engineering. Electives such as Numerical Methods in Differential Equations, Nonlinear Dynamics, Chaos and Fractals, Introduction to Inverse Problems, Operation Research, and Perturbation Methods develop skills in modeling, simulation, and optimization of industrial processes. Moreover, courses like Physics-Informed Neural Networks for Forward and Inverse Problems and Data Processing with Rust integrate modern computational and analytical techniques into engineering-related problems.
3. **Data-Driven Modelling**
   This specialization prepares students to work with large datasets and to create data-based models, using mathematical foundations for advanced analytical techniques. Electives such as Machine Learning for Data Analytics, Analysis of Unstructured Data, Estimation Theory, Large Language Models, and Reinforcement Learning in Multi-Agent Systems develop competencies in computational statistics and artificial intelligence. In addition, modules such as Advanced Topics in Dynamic Games, Biomathematics, Stochastic Processes in Natural Sciences, and Data Processing with Rust demonstrate the broad spectrum of applications for data-driven modeling across various scientific and technical disciplines.

Specialization is assigned based on a student’s declaration, submitted in the final semester of the program. To be awarded a specialization, a student must complete at least two courses associated with the chosen specialization and prepare a thesis directly related to it. The detailed procedure for assigning specializations is established by the Dean prior to the start of each academic cycle and published on the Faculty’s website.

Information regarding the inclusion of socio-economic needs in the study programme and the compliance of the major learning outcomes with these needs

The concept behind the Applied Mathematics program is based on educating students in advanced mathematical methods and preparing them to develop dedicated algorithms and mathematical tools. Proficiency in using these tools is essential for describing and understanding the real world.

Specialized courses will provide students with knowledge in advanced mathematical modeling as well as modern (intelligent) data analysis methods. This foundation will prepare graduates to work in various fields where mathematical methods are crucial for interpreting and understanding observed phenomena. Our graduates will be equipped to create and apply advanced methods and algorithms across different areas of industry, as well as in the natural and medical sciences.

Consultations with companies from the industrial, financial, and IT sectors are a key element in ensuring the relevance of the Applied Mathematics curriculum. We maintain an ongoing dialogue with business representatives, gathering insights on the most sought-after skills and market trends to ensure that our graduates are optimally prepared for professional challenges. The process of aligning the curriculum with market demands is also informed by valuable input and recommendations from members of the Faculty of Mathematics Advisory Board at Wrocław University of Science and Technology, representing a broad range of stakeholders, as well as feedback from the Student Council. This ensures that the program meets the expectations of both employers and students.

Other important factors determining the validity of the study programme

The study program aligns with the European educational framework developed based on the standards established by the Educational Committee of ECMI (European Consortium for Mathematics in Industry, http://www.ecmi-indmath.org). The program meets the requirements of the ECMI model curricula: the Financial and Actuarial Mathematics and Industrial Mathematics specializations are consistent with the ECMI Model Master in Mathematics for Industry, while the Data-Driven Modelling specialization aligns with the ECMI Model Master in Mathematical Data Science.

The connection of the programme with the University's mission and its development strategy

The Applied Mathematics program is of great importance to the mission of Wrocław University of Science and Technology, as it directly supports the university’s goals by educating well-rounded, analytically-minded specialists. Graduates of this program, equipped with a strong mathematical foundation and the ability to apply it effectively, are prepared to solve complex problems across various sectors, contribute to research and innovation, and actively shape the future—guided by ethical standards and an awareness of global challenges.

Applied mathematics is a discipline that underpins and enables progress in most of the university’s priority research areas. As such, the Applied Mathematics program naturally supports the strategic goals of the university by developing graduates with essential analytical, problem-solving, and ethical competencies. These graduates are well prepared to become leaders and innovators, and to actively engage with the economic and social environment. This program strengthens the university’s role as a center of science, innovation, and education for future generations.

Learning outcomes

Code	Description of the directional learning outcome	Characteristics for qualifications at level 6 or 7 of the Polish Qualifications Framework	Characteristics for qualifications at level 6 or 7 of the Polish Qualifications Framework, enabling the acquisition of engineering competences
Knowledge			
K2_AMA_W01	Presents in-depth knowledge of selected branches of higher mathematics, including differential equations, optimization, functional analysis and stochastic processes.	P7S_WG	
K2_AMA_W02	Presents expert knowledge from selected specialty: financial mathematics, industrial mathematics, or data modeling and analysis.	P7S_WG	
K2_AMA_W03	Characterises advanced computer modeling techniques: simulations, numerical methods, artificial intelligence, or data analysis.	P7S_WG, P7S_WK	P7S_WG_INŻ, P7S_WK_INŻ
K2_AMA_W04	Identifies advanced mathematical models and methods used in a wide range of applications, in finance, in physics, in industry.	P7S_WG, P7S_WK	P7S_WK_INŻ
K2_AMA_W05	Presents the economic, legal and ethical conditions of professional activities related to the use of mathematical knowledge, with particular emphasis on copyright law.	P7S_WG, P7S_WK	
K2_AMA_W06	Characterises selected issues in the area of humanities or social sciences.	P7S_WG	
Skills			
K2_AMA_U01	Formulates and solves complex mathematical problems based on knowledge of selected branches of higher mathematics.	P7S_UW	
K2_AMA_U02	Solves complex problems in a selected specialty: financial mathematics, industrial mathematics, or modeling and data analysis.	P7S_UW	
K2_AMA_U03	Applies advanced simulations, statistical and numerical data analysis or artificial intelligence methods to solve practical problems.	P7S_UW	P7S_UW_INŻ
K2_AMA_U04	Uses advanced analytical methods in selected areas of mathematical applications.	P7S_UW	P7S_UW_INŻ
K2_AMA_U05	Plans and conducts teamwork, interacts with others in the execution of work.	P7S_UO	
K2_AMA_U06	Obtains specialized information from appropriately selected sources, as well as communicates the acquired knowledge to others.	P7S_UU	
Social competence			
K2_AMA_K01	Takes a critical approach to the received content, knows the limitations of his own knowledge and understands the importance of continuous education.	P7S_KK, P7S_KR	
K2_AMA_K02	Acts in an entrepreneurial manner.	P7S_KK	
K2_AMA_K03	Presents advanced mathematical solutions in a way that is understandable to representatives of other professions, is able to popularize mathematical knowledge.	P7S_KO	
K2_AMA_K04	Is aware of the importance of adhering to and developing the principles of professional ethics.	P7S_KR	
Language outcomes			

Code	Description of the directional learning outcome	Characteristics for qualifications at level 6 or 7 of the Polish Qualifications Framework	Characteristics for qualifications at level 6 or 7 of the Polish Qualifications Framework, enabling the acquisition of engineering competences
SJO_S2_U01	Be able to use a foreign language at B2+ ESCJ level and specialised terminology	P7S_UK	

Detailed information on ECTS points

Applied Mathematics

Name	Value
Total ECTS	90
Total number of hours of classes	1140
Number of ECTS points assigned to classes related to scientific activities conducted at the university in the discipline or disciplines to which the field of study is assigned (DN)	57/90 (63.33%)
Number of ECTS points allocated to classes developing practical skills (including laboratory, project) (P)	56.2
The number of ECTS points that a student will receive by completing classes that require the direct participation of academic teachers or other persons conducting classes and students (BU)	46.2
Percentage of ECTS for elective courses	63/90 (70%)
The number of ECTS points that a student will receive by completing classes in the humanities or social sciences appropriate for a given field of study	5
The number of ECTS points that a student will receive by completing classes in basic sciences (mathematics, physics/chemistry)	20

Organization of studies

Implementation of the study programme

Allowable ECTS deficit

Semester	Allowable deficit of ECTS points after a semester
Semester 1	10
Semester 2	10
Semester 3	0

Detailed requirements

Not applicable.

Methods of verifying the intended learning outcomes

Activity form	Methods of verifying the intended learning outcomes
Seminar	Multimedia presentations conducted and prepared individually or in groups; case study analysis, class participation, paper
Classes	Credit - oral, written; short test, input task, evaluation of the sub-tasks; paper
Project	Project preparation, project implementation, project documentation, case study analysis
Diploma thesis	Evaluation of work in the preparation of a diploma thesis
Laboratory	Preparation of laboratory reports; oral statements, class participation; short test, input task, evaluation of the sub-tasks
Lecture	Exam - oral, written, credit, test - oral, written

Description of the process leading to achieving learning outcomes

The process of achieving the intended learning outcomes in the Applied Mathematics studies is based on an integrated approach, combining solid theoretical foundations with intensive practical and project-based classes. Students acquire knowledge through lectures and exercises, and then develop analytical and programming skills in computer laboratories, working with real data and tools. A key element is also individual work on projects and a diploma thesis, which allows for a deep understanding of the chosen area of mathematics applications and the development of the ability to solve complex problems independently. Verification of the attainment of learning outcomes will take place through colloquia, examinations, paper tests and work in classes organized by the University.

The study program has been designed so that students can focus their interests within three specializations, which constitute a deepening of knowledge and skills in specific areas of applied mathematics. The assignment of a specialization is made on the basis of the student's declaration, submitted in the last semester of studies. The condition for assigning a specialization is to complete at least 2 subjects assigned to it and to prepare a diploma thesis, the subject of which is directly related to the chosen specialization. The detailed procedure for assigning a specialization is established by the Dean before the start of a given cycle of education and published on the Faculty's website.

List of elective subjects assigned to specializations:

Financial and Actuarial Mathematics
Financial risk management; Computational finance; Non-life insurance mathematics; Risk management in insurance; Actuarial mathematics for life contingent risks; Machine learning for data analytics; Data processing with Rust

Industrial Mathematics
Numerical methods in differential equations; Nonlinear dynamics, chaos and fractals; Introduction to inverse problems; Operation research; Perturbation methods; Physics informed neural networks for forward and inverse problems; Data processing with Rust

Data-Driven Modelling
Machine learning for data analytics; Analysis of unstructured data; Estimation theory; Advanced topics in dynamic games; Large language models; Reinforcement learning in multi-agent systems; Biomathematics; Stochastic processes in natural Sciences; Data processing with Rust

Internships

Diploma exam

According to the Study regulations at Wrocław University of Science and Technology, the diploma exam consists of a test of knowledge and skills by verifying the level of mastery of the educational content provided during studies. The Programme Committee of the Field of Study prepares a list of issues for the diploma exam in consultation with academic teachers teaching individual subjects. The list of issues for the diploma exam is published on the Faculty's website before the diploma semester begins.

Study plan

Applied Mathematics

Semester 1

Assignment of a specialty is made on the basis of the student's declaration, submitted in the last semester of study. The condition for assigning a specialty is the completion of at least 2 subjects assigned to it and the preparation of a diploma thesis, the subject of which is directly related to the selected specialty. The detailed procedure for granting a specialty is determined by the Dean before the beginning of a given educational cycle and is published on the Faculty website.

List of elective subjects assigned to the specialty:

Financial and Actuarial Mathematics
Financial risk management; Computational finance; Non-life insurance mathematics; Risk management in insurance; Actuarial mathematics for life contingent risks; Machine learning for data analytics; Data processing with Rust

Industrial Mathematics
Numerical methods in differential equations; Nonlinear dynamics, chaos and fractals; Introduction to inverse problems; Operation research; Perturbation methods; Physics informed neural networks for forward and inverse problems; Data processing with Rust

Data-Driven Modelling
Machine learning for data analytics; Analysis of unstructured data; Estimation theory; Advanced topics in dynamic games; Large language models; Reinforcement learning in multi-agent systems; Biomathematics; Stochastic processes in natural Sciences I; Stochastic processes in natural Sciences II; Data processing with Rust

Subject	Number of hours	Form of verification	ECTS points	Mandatoriness
Economathematics	Lecture: 45 Classes: 30	Exam	5	Obligatory
Partial Differential Equations with Applications in Physics and Industry	Lecture: 45 Classes: 30	Exam	5	Obligatory
Computer Modelling and Simulation of Stochastic Processes	Lecture: 45 Seminar: 30	Graded credit	5	Obligatory
Block of Specialization Courses AMAN	Lecture: 60 Total practical contact hours: 120	Graded credit	10	Obligatory group

Subject	Number of hours	Form of verification	ECTS points	Mandatoriness
Student chooses two courses				
Block Financial and Actuarial Mathematics	-	Graded credit	-	Elective group
Financial Risk Management	Lecture: 30 Classes: 30 Project: 30	Graded credit	5	Elective
Computational Finance	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Non-Life Insurance Mathematics	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Risk Management in Insurance	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Actuarial Mathematics for Life Contingent Risks	Lecture: 30 Classes: 30 Project: 30	Graded credit	5	Elective
Machine Learning for Data Analytics	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Data Processing with Rust	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Block Industrial Mathematics	-	Graded credit	-	Elective group
Numerical Methods in Differential Equations	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Nonlinear Dynamics, Chaos and Fractals	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective

Subject	Number of hours	Form of verification	ECTS points	Mandatoriness
Introduction to Inverse Problems	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Operations Research	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Perturbation Methods	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Physics Informed Neural Networks for Forward and Inverse Problems	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Data Processing with Rust	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Block Data-Driven Modelling	-	Graded credit	-	Elective group
Machine Learning for Data Analytics	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Analysis of Unstructured Data	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Estimation Theory	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Advanced Topics in Dynamic Games	Lecture: 30 Classes: 30 Project: 30	Graded credit	5	Elective
Large Language Models	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective

Subject	Number of hours	Form of verification	ECTS points	Mandatoriness
Reinforcement Learning in Multi-Agent Systems	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Biomathematics	Lecture: 30 Classes: 30 Project: 30	Graded credit	5	Elective
Stochastic Processes in Natural Sciences	Lecture: 30 Classes: 30 Project: 30	Graded credit	5	Elective
Data Processing with Rust	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Block of Social Science Courses	Seminar: 30	Graded credit	3	Obligatory group
Student chooses one course				
The Protection of Industrial Property and Copy Rights	Seminar: 30	Graded credit	3	Elective
Self-Presentation and Public Speaking	Seminar: 30	Graded credit	3	Elective
Foreign Language 2.1	Classes: 30	Graded credit	2	Obligatory group
The student chooses classes from the offer of the Department of Foreign Languages				
Foreign Language 2.1	Classes: 30	Graded credit	2	Elective
Sum	**465**		**30**	

Semester 2

Subject	Number of hours	Form of verification	ECTS points	Mandatoriness
Block of Specialization Courses AMAN	Lecture: 90 Total practical contact hours: 180	Graded credit	15	Obligatory group
Student chooses three courses				
Block Financial and Actuarial Mathematics	-	Graded credit	-	Elective group

Subject	Number of hours	Form of verification	ECTS points	Mandatoriness
Financial Risk Management	Lecture: 30 Classes: 30 Project: 30	Graded credit	5	Elective
Computational Finance	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Non-Life Insurance Mathematics	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Risk Management in Insurance	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Actuarial Mathematics for Life Contingent Risks	Lecture: 30 Classes: 30 Project: 30	Graded credit	5	Elective
Machine Learning for Data Analytics	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Data Processing with Rust	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Block Industrial Mathematics	-	Graded credit	-	Elective group
Numerical Methods in Differential Equations	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Nonlinear Dynamics, Chaos and Fractals	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Introduction to Inverse Problems	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective

Subject	Number of hours	Form of verification	ECTS points	Mandatoriness
Operations Research	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Perturbation Methods	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Physics Informed Neural Networks for Forward and Inverse Problems	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Data Processing with Rust	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Block Data-Driven Modelling	-	Graded credit	-	Elective group
Machine Learning for Data Analytics	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Analysis of Unstructured Data	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Estimation Theory	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Advanced Topics in Dynamic Games	Lecture: 30 Classes: 30 Project: 30	Graded credit	5	Elective
Large Language Models	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Reinforcement Learning in Multi-Agent Systems	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective

Subject	Number of hours	Form of verification	ECTS points	Mandatoriness
Biomathematics	Lecture: 30 Classes: 30 Project: 30	Graded credit	5	Elective
Stochastic Processes in Natural Sciences	Lecture: 30 Classes: 30 Project: 30	Graded credit	5	Elective
Data Processing with Rust	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Optimization Theory	Lecture: 45 Classes: 30	Exam	5	Obligatory
Applied Functional Analysis	Lecture: 45 Classes: 30	Exam	5	Obligatory
Block of Humanities Courses	Seminar: 30	Graded credit	2	Obligatory group
Student chooses one course				
Ethics of the New Technologies	Seminar: 30	Graded credit	2	Elective
Philosophy of Information	Seminar: 30	Graded credit	2	Elective
Foreign Language 2.2	Classes: 60	Graded credit	3	Obligatory group
The student chooses classes from the offer of the Department of Foreign Languages				
Foreign Language 2.2	Classes: 60	Graded credit	3	Elective
Sum	**510**		**30**	

Semester 3

Subject	Number of hours	Form of verification	ECTS points	Mandatoriness
Block of Specialization Courses AMAN	Lecture: 30 Total practical contact hours: 60	Graded credit	5	Obligatory group
Student chooses one course				

Subject	Number of hours	Form of verification	ECTS points	Mandatoriness
Block Financial and Actuarial Mathematics	-	Graded credit	-	Elective group
Financial Risk Management	Lecture: 30 Classes: 30 Project: 30	Graded credit	5	Elective
Computational Finance	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Non-Life Insurance Mathematics	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Risk Management in Insurance	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Actuarial Mathematics for Life Contingent Risks	Lecture: 30 Classes: 30 Project: 30	Graded credit	5	Elective
Machine Learning for Data Analytics	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Data Processing with Rust	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Block Industrial Mathematics	-	Graded credit	-	Elective group
Numerical Methods in Differential Equations	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Nonlinear Dynamics, Chaos and Fractals	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Introduction to Inverse Problems	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective

Subject	Number of hours	Form of verification	ECTS points	Mandatoriness
Operations Research	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Perturbation Methods	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Physics Informed Neural Networks for Forward and Inverse Problems	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Data Processing with Rust	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Block Data-Driven Modelling	-	Graded credit	-	Elective group
Machine Learning for Data Analytics	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Analysis of Unstructured Data	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Estimation Theory	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Advanced Topics in Dynamic Games	Lecture: 30 Classes: 30 Project: 30	Graded credit	5	Elective
Large Language Models	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Reinforcement Learning in Multi-Agent Systems	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective

Subject	Number of hours	Form of verification	ECTS points	Mandatoriness
Biomathematics	Lecture: 30 Classes: 30 Project: 30	Graded credit	5	Elective
Stochastic Processes in Natural Sciences	Lecture: 30 Classes: 30 Project: 30	Graded credit	5	Elective
Data Processing with Rust	Lecture: 30 Laboratory: 30 Project: 30	Graded credit	5	Elective
Diploma Seminar	Seminar: 30	Graded credit	2	Obligatory
Diploma Thesis	Diploma thesis: 45	Graded credit	23	Obligatory elective
Sum	**165**		**30**	

Syllabuses

Wrocław University of Science and Technology

Economathematics

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Obligatory **Block** Subjects of basic education - mathematics **Subject related to scientific research** Yes

Semester	**Examination**	**Number of ECTS points**
Semester 1	Exam **Activities and hours** Lecture: 45 Classes: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	knows the most important theorems and hypotheses of financial mathematics	K2_AMA_W01, K2_AMA_W04
PEU_W02	knows the basics of stochastic modeling in financial mathematics relating to skills	K2_AMA_W01, K2_AMA_W04
In terms of skills		
PEU_U01	can construct mathematical models used in financial mathematics relating to social competences:	K2_AMA_U01, K2_AMA_U04
In terms of social competences		

PEU_K01	can search for information in the literature, even in foreign languages	K2_AMA_K01

Program content ensuring learning outcomes

The subject introduces students to the theory of financial instrument valuation. It covers both theoretical foundations and numerical and simulation techniques. Elements of risk measures and investment portfolio optimization theory are also introduced. Students learn to solve practical problems in the areas of finance and economics.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	45
Classes	30
Credit/Exam	4
Preparaton for classes	26
Preparation for an exam/credit	20
Student workload	**Hours** 125

Wrocław University of Science and Technology

Partial Differential Equations with Applications in Physics and Industry

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Obligatory **Block** Subjects of basic education - physics **Subject related to scientific research** Yes

Semester	**Examination**	**Number of ECTS points**
Semester 1	Exam **Activities and hours** Lecture: 45 Classes: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Quotes the most important theorems from the main sections of differential equations.	K2_AMA_W01, K2_AMA_W04
PEU_W02	Explains the basics of modeling using differential equations in engineering or natural sciences, especially physics, chemistry, and biology.	K2_AMA_W01, K2_AMA_W04
In terms of skills		
PEU_U01	Analyzes advanced issues in differential equations.	K2_AMA_U01, K2_AMA_U04
PEU_U02	Constructs mathematical models using differential equations for use in specific applications of mathematics.	K2_AMA_U01, K2_AMA_U04

In terms of social competences		
PEU_K01	Searches for information in literature, including foreign languages.	K2_AMA_K01
PEU_K02	Appreciates the importance of systematic and independent work to master the course material.	K2_AMA_K01

Program content ensuring learning outcomes

The course focuses on the application of partial differential equations to modeling and solving real-world problems, such as heat flows, conservation laws, potential determination, and vibration description. The course coversmost important types of partial equations (elliptic, parabolic, and hyperbolic) and methods for solving them, both analytical and numerical. Students learn to apply their knowledge in practice, using computational tools to simulate and analyze physical phenomena in technology.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	45
Classes	30
Preparaton for classes	20
Preparation of a project	18
Preparation for an exam/credit	8
Credit/Exam	4
Student workload	**Hours** 125

Wrocław University of Science and Technology

Computer Modelling and Simulation of Stochastic Processes

Educational subject description sheet

Basic information

Field of study
Applied Mathematics

Speciality
-

Organizational unit
Faculty of Pure and Applied Mathematics

Study level
second degree 3 semesters

Study form
full-time studies

Education profile
general academic profile

Education cycle
2025/2026

Subject code

Group of classes
Yes

Lecture languages
English

Mandatoriness
Obligatory

Block
Major-specific subjects

Subject related to scientific research
Yes

Semester	Examination	Number of ECTS points
Semester 1	Graded credit **Activities and hours** Lecture: 45 Seminar: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Characterizes and compares methods for simulating stable distributions and processes.	K2_AMA_W03
PEU_W02	Characterizes and compares methods for simulating long-memory processes.	K2_AMA_W03
PEU_W03	Defines the area of possible applications of the processes analyzed during classes.	K2_AMA_W04
In terms of skills		
PEU_U01	Constructs, analyzes and uses algorithms for simulating stable distributions and processes.	K2_AMA_U01, K2_AMA_U03

PEU_U02	Constructs, analyzes and uses effective algorithms for simulating stochastic long memory processes.	K2_AMA_U01, K2_AMA_U03
In terms of social competences		
PEU_K01	It is oriented towards solving problems in various areas of science and industry using stochastic processes learned during classes.	K2_AMA_K01

Program content ensuring learning outcomes

The program content includes knowledge in the field of modeling and simulating stochastic processes. They cover issues related to stable distributions and processes as well as processes with the long memory property. They allow to acquire knowledge related to the effective simulation of selected stochastic processes and modeling various empirical data using these processes.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	45
Seminar	30
Preparaton for classes	10
Preparation of a project	20
Preparation of a report/summary/presentation/paper	10
Preparation for an exam/credit	10
Student workload	**Hours** 125

Wrocław University of Science and Technology

Financial Risk Management

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters	**Examination**	**Number of ECTS points**
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Classes: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Has sufficient knowledge of financial and actuarial risk to solve practical problems.	K2_AMA_W02, K2_AMA_W04
PEU_W02	Understands legal, accounting, tax, and financial institution regulations, including the Basel Accord.	K2_AMA_W02
In terms of skills		
PEU_U01	Applies financial and actuarial risk methods and uses them to analyze various problems	K2_AMA_U02, K2_AMA_U04, K2_AMA_U05

PEU_U02	Uses Monte Carlo methods for derivative analysis and portfolio aggregation.	K2_AMA_U02
In terms of social competences		
PEU_K01	Understands the role of innovation and creativity in performing tasks.	K2_AMA_K02

Program content ensuring learning outcomes

The course provides students with comprehensive knowledge and practical skills in financial and actuarial risk management. The curriculum covers a wide range of topics, from the basics of bonds and quantitative analysis, through derivatives and market risk measurement, to credit and operational risk management. The goal is to equip students with the ability to solve practical problems and effectively apply risk analysis methods in various financial contexts. Students also learn about legal, accounting, and tax aspects, as well as financial institution regulations, including the Basel Accord.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Classes	30
Project	30
Preparaton for classes	30
Preparation of a project	5
Student workload	**Hours** 125

Wrocław University of Science and Technology

Computational Finance

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters	**Examination**	**Number of ECTS points**
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Laboratory: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Characterizes mathematical models and computational techniques used in finance.	K2_AMA_W04
PEU_W02	Indicates techniques for numerical implementation of selected derivatives valuation methods.	K2_AMA_W03
PEU_W03	Explains the construction and modeling methods for advanced financial instruments.	K2_AMA_W02
In terms of skills		
PEU_U01	Calculates prices of selected derivatives and creates hedging strategies.	K2_AMA_U02

PEU_U02	Uses computer simulations and implementations of numerical methods to find approximate values of derivatives.	K2_AMA_U03
PEU_U03	Collaborates on the implementation of financial mathematics methods and the analysis of their results.	K2_AMA_U05
In terms of social competences		
PEU_K01	Demonstrates initiative in independently solving problems related to valuation and modeling in finance.	K2_AMA_K02

Program content ensuring learning outcomes

The program content allows to learn the concepts of algorithms and methods of computational finance. During the course, issues related to the valuation of derivatives using analytical and numerical methods are discussed, in particular using the method of partial differential equations, binomial and trinomial trees, difference schemes, Monte Carlo simulations. In addition, the program content includes sensitivity analysis, construction of hedging strategies and topics related to volatility modeling. The methods discussed during the lectures are implemented in laboratory classes in a selected programming language, and then their numerical properties are analyzed.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Laboratory	30
Project	30
Self-development of practical skills	20
Preparation of a report/summary/presentation/paper	10
Preparaton for classes	5
Student workload	**Hours** 125

Wrocław University of Science and Technology

Non-Life Insurance Mathematics

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters Semester 1, Semester 2, Semester 3	**Examination** Graded credit **Activities and hours** Lecture: 30 Laboratory: 30 Project: 30	**Number of ECTS points** 5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Formulates the most important concepts related to the collective risk model. Characterizes and proves properties of the collective risk model. Explains the importance of the collective risk model in insurance company risk management.	K2_AMA_W02, K2_AMA_W03, K2_AMA_W04
PEU_W02	Formulates the most important concepts related to the classic risk process. Characterizes and proves properties of the classic risk process. Explains the importance of the classic risk process in insurance company risk management.	K2_AMA_W02, K2_AMA_W03, K2_AMA_W04

PEU_W03	Formulates the most important concepts related to multidimensional risk process. Explains the importance of the insurer-insurer model in insurance company risk management.	K2_AMA_W02, K2_AMA_W03, K2_AMA_W04
PEU_W04	Formulates the most important concepts related to non-proportionate reinsurance. Valuates reinsurance contracts. Explains the importance of reinsurance in the risk management of an insurance company.	K2_AMA_W02, K2_AMA_W03, K2_AMA_W04
In terms of skills		
PEU_U01	Calculates properties of the variable describing the amount of the total loss. Finds the distribution of the total loss using recursive formulas for the class (a,b) of loss number distributions. Finds approximations of the total loss distribution using various analytical approximations.	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05
PEU_U02	Analyzes properties of the risk process. Calculates the matching factor for various loss distributions. It uses the Pollaczek–Khinchine formula to calculate the probability of ruin in infinite time. Compares analytical approximations of the probability of ruin in finite and infinite time.	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05
PEU_U03	Analyzes properties of a multidimensional process risk. Calculates the probability of ruin in infinite time for exponential losses for the insurer-reinsurer model.	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05
PEU_U04	Interprets various non-proportional reinsurance contracts. Calculates prices for basic non-proportional reinsurance contracts.	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05
In terms of social competences		
PEU_K01	Is oriented towards solving related problems knowing the modeling of property insurance risk limitations of their knowledge.	K2_AMA_K02

Program content ensuring learning outcomes

The program content includes knowledge of the non-life insurance mathematics. They cover issues related to the collective risk model and the risk process. They allow to gain knowledge related to estimating the distribution of a variable describing the total loss for a portfolio of insurance policies, estimating the probability of ruin for an insurance company and valuing reinsurance contracts.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Laboratory	30
Project	30
Preparaton for classes	13
Preparation of a project	12
Preparation for an exam/credit	10

Student workload	Hours 125

Wrocław University of Science and Technology

Risk Management in Insurance

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters	**Examination**	**Number of ECTS points**
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Laboratory: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Classifies risk factors in an insurance company.	K2_AMA_W02
PEU_W02	Articulates in-depth concepts of insurance mathematics in the context of risk management.	K2_AMA_W02, K2_AMA_W04
PEU_W03	Outlines the principles of the Solvency II Directive concerning the standard formula and internal models.	K2_AMA_W02, K2_AMA_W04
PEU_W04	Indicates risk mitigation and transfer techniques within an insurance company.	K2_AMA_W02, K2_AMA_W04
In terms of skills		

PEU_U01	Chooses mathematical models applied to the evaluation, mitigation, and transfer of risk within an insurance company.	K2_AMA_U02, K2_AMA_U04
PEU_U02	Utilizes in-depth mathematical methods to evaluate advanced risk transfer mechanisms.	K2_AMA_U02, K2_AMA_U04
PEU_U03	Collaborates on a project concerning the identification, assessment, and management of risks related to an insurance company, as well as the analysis of the impact of these methods on the risk profile of the company.	K2_AMA_U02, K2_AMA_U04, K2_AMA_U05
In terms of social competences		
PEU_K01	Is accountable for identifying, evaluating, and managing risks related to an insurance company, working alongside other specialists in the business community, and adhering to risk management standards within the insurance industry.	K2_AMA_K02

Program content ensuring learning outcomes

The content covers in-depth knowledge of risk management in the area of life and property insurance. It includes topics related to modern risk management methods in insurance companies, such as the actuarial function, risk management function, risk appetite, risk measures, Solvency II directive, profitability and risk exposure tests of insurance portfolios, reinsurance, risk transfer methods, and catastrophe bonds. It enables students to acquire knowledge and skills related to modern risk management methods in insurance companies.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Laboratory	30
Project	30
Self-development of practical skills	25
Preparation for an exam/credit	10
Student workload	**Hours** 125

Wrocław University of Science and Technology

Actuarial Mathematics for Life Contingent Risks

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters	**Examination**	**Number of ECTS points**
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Classes: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Explains in-depth issues in life insurance mathematics.	K2_AMA_W02, K2_AMA_W04
PEU_W02	Identifies advanced methods of stochastic modeling in financial and actuarial mathematics.	K2_AMA_W04
In terms of skills		
PEU_U01	Develops mathematical models for valuing and monitoring life insurance contracts.	K2_AMA_U02, K2_AMA_U04
PEU_U02	Estimates the risk associated with concluded life insurance contracts by calculating insurance reserves.	K2_AMA_U02, K2_AMA_U04

PEU_U03	Collaborates on a project involving the use of in-depth methods in life insurance mathematics and the interpretation of their outcomes.	K2_AMA_U02, K2_AMA_U04, K2_AMA_U05
In terms of social competences		
PEU_K01	Is responsible for the accurate valuation of life insurance contracts and the correct estimation of insurance reserves in collaboration with other professionals in a business environment.	K2_AMA_K02

Program content ensuring learning outcomes

The program content provides in-depth knowledge of the mathematics of life insurance. Topics covered include life insurance with benefit payments at the time of death or at the end of the year of death, pure endowment insurance, life annuities (both immediate and deferred), multi-life insurance, multiple decrement models, and unit-linked insurance. Students will acquire knowledge pertaining to the pricing of single and regular premiums for various insurance contracts, determining net and gross life insurance reserves in particular the determination of the insurer's loss (Hattendorff's theorem), technical profit and its distribution, Zillmer's reserve, and methods of estimating insurance reserves in the context of the Solvency II Directive.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Classes	30
Project	30
Self-development of practical skills	25
Preparation for an exam/credit	10
Student workload	**Hours** 125

Wrocław University of Science and Technology

Machine Learning for Data Analytics

Educational subject description sheet

Basic information

Field of study
Applied Mathematics

Speciality
-

Organizational unit
Faculty of Pure and Applied Mathematics

Study level
second degree 3 semesters

Study form
full-time studies

Education profile
general academic profile

Education cycle
2025/2026

Subject code

Group of classes
Yes

Lecture languages
English

Mandatoriness
Elective

Block
Specialty subjects

Subject related to scientific research
Yes

Semesters	Examination	Number of ECTS points
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Laboratory: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Explains advanced machine learning methods, including ensemble learning, probabilistic, Bayesian and federated models.	K2_AMA_W02, K2_AMA_W03
PEU_W02	Cites time series analysis methods, including traditional (ARIMA, GARCH) and deep (LSTM, Transformer).	K2_AMA_W02, K2_AMA_W03
PEU_W03	Cites interpretability techniques for ML models.	K2_AMA_W02, K2_AMA_W03
PEU_W04	Indicates methods for optimizing hyperparameters.	K2_AMA_W02, K2_AMA_W03

PEU_W05	Enumerates the most important principles of MLOps, including those related to deploying models in a production environment and monitoring their performance.	K2_AMA_W02, K2_AMA_W03
In terms of skills		
PEU_U01	Implements advanced ML and deep learning algorithms using specialized libraries.	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05
PEU_U02	Analyzes and interprets results of ML models.	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05
PEU_U03	Creates and optimizes predictive models for time series.	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05
PEU_U04	Applies “transfer learning” and “few-shot” learning techniques to classification and regression problems on small data sets.	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05
PEU_U05	Applies ML model interpretation techniques.	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05
PEU_U06	Deploys ML models in production environments.	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05
In terms of social competences		
PEU_K01	Is able to work in a team, jointly solving analytical problems using ML.	K2_AMA_K02
PEU_K02	Communicates ML analysis results to non-technical people.	K2_AMA_K02
PEU_K03	Is open to continuous self-improvement.	K2_AMA_K02

Program content ensuring learning outcomes

The course focuses on advanced machine learning methods in data analysis, with a particular emphasis on predictive modeling, model interpretability, and industrial applications. Students will explore advanced supervised and unsupervised learning techniques, deep neural networks, as well as methods for time series analysis and natural language processing.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Laboratory	30
Project	30
Self-development of practical skills	20
Conducting literature research	10
Preparation for an exam/credit	5

Student workload	Hours 125

Wrocław University of Science and Technology

Data Processing with Rust

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters	**Examination**	**Number of ECTS points**
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Laboratory: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Chooses Rust language tools suitable for solving typical programming problems.	K2_AMA_W03
PEU_W02	Identifies key data processing methods.	K2_AMA_W03
In terms of skills		
PEU_U01	Solves typical problems related to effective data processing.	K2_AMA_U03
PEU_U02	Organizes group work in programming projects.	K2_AMA_U05, K2_AMA_U06
In terms of social competences		

PEU_K01	Identifies problems related to data processing in business and industry.	K2_AMA_K02

Program content ensuring learning outcomes

Data processing incompases collecting, translating and organising digital information. This course concentrates on the programistic aspect of this process using Rust language, teaching how to perform it in systemic and numerically optimized way. This includes using functional and trait-based programming paradigms, as well as implenenting data pipelines and concurrency. These techniques are often required in industrial mathematics projects and handling of big data.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Laboratory	30
Project	30
Self-development of practical skills	20
Preparaton for classes	15
Student workload	**Hours** 125

Wrocław University of Science and Technology

Numerical Methods in Differential Equations

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters	**Examination**	**Number of ECTS points**
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Laboratory: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Describes the most important numerical techniques used in solving problems involving differential equations.	K2_AMA_W02, K2_AMA_W03, K2_AMA_W04
PEU_W02	Constructs his/her own numerical schemas.	K2_AMA_W03, K2_AMA_W04
In terms of skills		
PEU_U01	Analyzes advanced topics in differential equations with regard to the application of appropriate approximate methods.	K2_AMA_U02, K2_AMA_U03

PEU_U02	Constructs mathematical models based on differential equations and their discrete forms used in specific applications of mathematics.	K2_AMA_U03, K2_AMA_U05
In terms of social competences		
PEU_K01	Independently searches for information in the literature.	K2_AMA_K02
PEU_K02	Appreciates the need for systematic and independent work to master the course material.	K2_AMA_K02

Program content ensuring learning outcomes

The subject focuses on techniques for solving differential equations using numerical methods, which are necessary in cases where analytical solutions are difficult or impossible to obtain. The methods discussed include, among others, finite difference methods, finite element methods, which are used for approximate calculations of solutions of ordinary and partial differential equations. During the course, students learn to implement numerical algorithms, analyze their accuracy, stability and convergence, and apply them to practical engineering and scientific problems.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Laboratory	30
Project	30
Preparaton for classes	14
Preparation of a project	13
Preparation for an exam/credit	8
Student workload	**Hours** 125

Wrocław University of Science and Technology

Nonlinear Dynamics, Chaos and Fractals

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters	**Examination**	**Number of ECTS points**
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Laboratory: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Explains techniques for analyzing and modeling nonlinear dynamical systems.	K2_AMA_W03, K2_AMA_W04
PEU_W02	Distinguishes linear and nonlinear behaviors and assesses system stability.	K2_AMA_W02, K2_AMA_W04
In terms of skills		
PEU_U01	Quantifies chaotic behavior using Lyapunov exponents and fractal dimensions.	K2_AMA_U02, K2_AMA_U03
PEU_U02	Controls and synchronizes chaotic systems for practical applications.	K2_AMA_U03, K2_AMA_U05

In terms of social competences		
PEU_K01	Searches, without assistance, for necessary information in the literature.	K2_AMA_K02

Program content ensuring learning outcomes

Acquisition of techniques for analyzing nonlinear dynamics and chaos, performing stability and bifurcation analysis, quantifying chaotic behavior through Lyapunov exponents and fractal dimensions, and applying control and synchronization methods in the modeling of complex dynamic systems.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Laboratory	30
Project	30
Preparaton for classes	35
Student workload	**Hours** 125

Wrocław University of Science and Technology

Introduction to Inverse Problems

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters	**Examination**	**Number of ECTS points**
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Laboratory: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Defines the inverse problem and argues that it is ill-posed.	K2_AMA_W02
PEU_W02	Lists examples of inverse problems.	K2_AMA_W04
PEU_W03	Indicates regularization methods that allow for a stable solution of a given problem.	K2_AMA_W02, K2_AMA_W03, K2_AMA_W04
In terms of skills		
PEU_U01	Examines whether a given problem is well or ill posed.	K2_AMA_U02

PEU_U02	Demonstrates examples of inverse problems.	K2_AMA_U02, K2_AMA_U05
PEU_U03	Applies the regularization methods learned.	K2_AMA_U02, K2_AMA_U03
PEU_U04	Analyzes the results of computer simulations.	K2_AMA_U03, K2_AMA_U05
In terms of social competences		
PEU_K01	Searches, without assistance, for necessary information in the literature.	K2_AMA_K02
PEU_K02	Understands the need for systematic work on the subject.	K2_AMA_K02

Program content ensuring learning outcomes

The aim of the course is to introduce students to the theory of inverse problems, which plays a crucial role in solving various real-world problems where it is necessary to determine model parameters based on noisy or incomplete measurements. A common feature of inverse problems is that they are typically ill-posed, which requires the use of various regularization techniques to obtain a unique and stable solution.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Laboratory	30
Project	30
Preparaton for classes	10
Preparation of a report/summary/presentation/paper	10
Self-development of practical skills	15
Student workload	**Hours** 125

Wrocław University of Science and Technology

Operations Research

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters	**Examination**	**Number of ECTS points**
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Laboratory: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Characterizes key optimization techniques and defines principles of linear and integer programming.	K2_AMA_W02
PEU_W02	Selects appropriate tools, explains simulation techniques, enumerates different network models, lists critical OR applications, finds optimal solutions, and effectively applies their knowledge to practical decision-making challenges.	K2_AMA_W03
PEU_W03	Formulates mathematical models for decision-making and proves the correctness of optimization algorithms.	K2_AMA_W04
In terms of skills		

PEU_U01	Analyzes complex decision-making problems and argues the efficiency of different optimization techniques. Adapts mathematical models to practical situations, and interprets solution results.	K2_AMA_U02
PEU_U02	Combines multiple OR techniques, modifies algorithms for better efficiency, and calculates optimal solutions. Solves complex operational problems.	K2_AMA_U03
PEU_U03	Organizes data, plans project workflows, and uses software for OR applications.	K2_AMA_U05
In terms of social competences		
PEU_K01	Accepts the complexity of decision-making and defends data-driven solutions in problem-solving contexts.	K2_AMA_K02

Program content ensuring learning outcomes

The course covers the principles, methodologies, and applications of operations research. It provides a structured approach to optimization, including linear programming, network flows, integer programming, and decision theory, with real-world examples and case studies. The course emphasizes both theoretical foundations and practical problem-solving techniques, using mathematical models and computational tools. It also includes probability models, decision analysis, and simulation methods, making it suitable for professional use. The course remains a resource for learning how to apply OR techniques to complex decision-making problems across industries.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Laboratory	30
Project	30
Self-development of practical skills	15
Self-study of class topics	20
Student workload	**Hours** 125

Wrocław University of Science and Technology

Perturbation Methods

Educational subject description sheet

Basic information

Field of study
Applied Mathematics

Speciality
-

Organizational unit
Faculty of Pure and Applied Mathematics

Study level
second degree 3 semesters

Study form
full-time studies

Education profile
general academic profile

Education cycle
2025/2026

Subject code

Group of classes
Yes

Lecture languages
English

Mandatoriness
Elective

Block
Specialty subjects

Subject related to scientific research
Yes

Semesters	Examination	Number of ECTS points
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Laboratory: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Defines the notation used in asymptotic analysis.	K2_AMA_W02
PEU_W02	Distinguishes between regular and singular perturbation problems.	K2_AMA_W03, K2_AMA_W04
PEU_W03	Explains the idea of multiscale perturbation.	K2_AMA_W03, K2_AMA_W04
In terms of skills		
PEU_U01	Uses the notation used in asymptotic analysis.	K2_AMA_U02
PEU_U02	Solves mathematical problems using perturbation methods.	K2_AMA_U02

PEU_U03	Presents examples of the application of perturbation theory to real-world problems.	K2_AMA_U02, K2_AMA_U05
PEU_U04	Uses mathematical packages to solve problems and illustrate results.	K2_AMA_U02, K2_AMA_U03
In terms of social competences		
PEU_K01	Searches, without assistance, for necessary information in the literature.	K2_AMA_K02
PEU_K02	Understands the need for systematic work on the subject.	K2_AMA_K02

Program content ensuring learning outcomes

The aim of this group of classes is to introduce students to the basic methods of perturbation theory. These methods allow finding approximate solutions to various mathematical problems involving a small parameter. They are particularly useful when obtaining an exact solution to the problem under consideration is difficult or impossible and have wide application in such fields as physics, engineering and applied mathematics.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Laboratory	30
Project	30
Preparation of a report/summary/presentation/paper	10
Preparation of a project	10
Self-development of practical skills	15
Student workload	**Hours** 125

Wrocław University of Science and Technology

Physics Informed Neural Networks for Forward and Inverse Problems

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters	**Examination**	**Number of ECTS points**
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Laboratory: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Lists classical numerical methods for solving differential equations (ODEs and PDEs) and their limitations.	K2_AMA_W02, K2_AMA_W03, K2_AMA_W04
PEU_W02	Explains the concept of PINNs and its application to direct and inverse problems.	K2_AMA_W02, K2_AMA_W03, K2_AMA_W04
PEU_W03	Explains methods for training and optimizing PINNs, including strategies for reducing errors and scaling weights.	K2_AMA_W02, K2_AMA_W03, K2_AMA_W04

PEU_W04	Explains PINNs applications in various fields such as fluid mechanics, materials engineering and computational physics.	K2_AMA_W02, K2_AMA_W03, K2_AMA_W04
In terms of skills		
PEU_U01	Implements PINNs in TensorFlow/PyTorch libraries for different types of differential equations.	K2_AMA_U02, K2_AMA_U03
PEU_U02	Creates and analyzes PINNs cost functions, taking into account initial conditions, boundary conditions and additional physical constraints.	K2_AMA_U02, K2_AMA_U03
PEU_U03	It optimizes the training of PINNs using appropriate algorithms such as Adam, L-BFGS and weighting strategies.	K2_AMA_U02, K2_AMA_U03
PEU_U04	Models inverse problems with PINNs, including parameter identification and source reconstruction.	K2_AMA_U02, K2_AMA_U03
PEU_U05	Evaluates the accuracy and computational efficiency of PINNs models.	K2_AMA_U02, K2_AMA_U03
PEU_U06	Implements PINNs for realistic physical and engineering problems and interprets the results.	K2_AMA_U02, K2_AMA_U03
PEU_U07	It implements team projects using PINNs.	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05
In terms of social competences		
PEU_K01	Works in teams to implement advanced computational models.	K2_AMA_K02
PEU_K02	Is ready for further independent education in the field of artificial intelligence applications in computational sciences.	K2_AMA_K02

Program content ensuring learning outcomes

The course introduces students to the PINNs method as a tool for solving differential equations in direct and inverse problems. It covers both the theoretical foundations of PINNs, their comparison with classical numerical methods, and practical aspects of implementation in TensorFlow/PyTorch. Students learn optimization network training, modeling of physical problems, and applications in engineering and computational science.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Laboratory	30
Project	30
Self-development of practical skills	20
Preparation for an exam/credit	5
Self-study of class topics	10

Student workload	Hours 125

Wrocław University of Science and Technology

Analysis of Unstructured Data

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters	**Examination**	**Number of ECTS points**
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Laboratory: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Explains the specifics of unstructured data.	K2_AMA_W02, K2_AMA_W03
PEU_W02	Indicates algorithms for processing text data, analyzing images and audio signals.	K2_AMA_W02, K2_AMA_W03
PEU_W03	Cites the most important machine learning models used in text, image and audio analysis.	K2_AMA_W02, K2_AMA_W03
PEU_W04	Indicates software tools used in the analysis of unstructured data.	K2_AMA_W02, K2_AMA_W03

PEU_W05	Describes examples of applications of unstructured data analysis in various industries.	K2_AMA_W02, K2_AMA_W03
In terms of skills		
PEU_U01	Processes and explores unstructured data.	K2_AMA_U02, K2_AMA_U03
PEU_U02	Implements NLP algorithms.	K2_AMA_U02, K2_AMA_U03
PEU_U03	Uses image analysis methods.	K2_AMA_U02, K2_AMA_U03
PEU_U04	Analyzes audio signals and recognizes patterns.	K2_AMA_U02, K2_AMA_U03
PEU_U05	Programs in Python using advanced libraries.	K2_AMA_U02, K2_AMA_U03
PEU_U06	Designs and trains machine learning models for unstructered data.	K2_AMA_U02, K2_AMA_U03
PEU_U07	Interprets results and adjusts models.	K2_AMA_U02, K2_AMA_U03
PEU_U08	Completes a complete unstructured data analysis project.	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05
In terms of social competences		
PEU_K01	Expresses judgments on the importance of unstructured data analysis in various scientific and economic fields.	K2_AMA_K02
PEU_K02	Accepts the need for continuing education.	K2_AMA_K02
PEU_K03	Is able to work as a team in analytical projects.	K2_AMA_K02

Program content ensuring learning outcomes

The course focuses on methods for analyzing unstructured data, covering their theoretical and practical aspects. Students will become familiar with modern techniques for processing, analyzing, and visualizing text, images, and other unstructured data sources.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Laboratory	30
Project	30
Self-development of practical skills	25
Preparation for an exam/credit	10
Student workload	**Hours** 125

Wrocław University of Science and Technology

Estimation Theory

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters	**Examination**	**Number of ECTS points**
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Laboratory: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Characterizes the most important methods of parametric estimation.	K2_AMA_W02, K2_AMA_W03, K2_AMA_W04
PEU_W02	Characterizes the most important methods of non-parametric estimation.	K2_AMA_W02, K2_AMA_W03, K2_AMA_W04
PEU_W03	Presents the criteria for assessing the quality of estimation and the theoretical basis of statistical simulations.	K2_AMA_W02, K2_AMA_W03, K2_AMA_W04

In terms of skills		
PEU_U01	Uses advanced statistical methods to analyze real-world data.	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05
PEU_U02	Uses statistical packages to program complex statistical methods and conduct simulation studies.	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05
PEU_U03	Evaluates the properties of statistical methods based on simulation studies.	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05
In terms of social competences		
PEU_K01	Is able to use scientific literature in English and to work systematically to deepen knowledge to solve real-world problems.	K2_AMA_K02

Program content ensuring learning outcomes

The program content includes knowledge of parametric and non-parametric estimation methods and their properties. It includes issues related to the criteria for assessing the quality of estimation. They allow to acquire knowledge related to the theoretical foundations of statistical simulations.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Laboratory	30
Project	30
Preparaton for classes	13
Preparation of a project	12
Preparation for an exam/credit	10
Student workload	**Hours** 125

Wrocław University of Science and Technology

Advanced Topics in Dynamic Games

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters	**Examination**	**Number of ECTS points**
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Classes: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Defines most important concepts and illustrates them with examples. Knows advanced mathematical models and methods used in a wide range of applications, in finance, physics, and industry.	K2_AMA_W02, K2_AMA_W04
PEU_W02	Describes finite dynamic games with complete and incomplete information, as well as stochastic games, taking into account their applications in finance, physics, and industry.	K2_AMA_W02, K2_AMA_W04
In terms of skills		

PEU_U01	Analyzes and argues for various models and solutions.	K2_AMA_U02, K2_AMA_U04, K2_AMA_U05
PEU_U02	Solves complex problems related to dynamic games using advanced analytical methods such as backward induction, dynamic programming, and iterative algorithms.	K2_AMA_U02, K2_AMA_U04
In terms of social competences		
PEU_K01	Identifies problems related to modeling and analyzing dynamic games.	K2_AMA_K02

Program content ensuring learning outcomes

The course covers finite dynamic games, Markov decision processes, and stochastic games along with their applications. Students are introduced to advanced models and mathematical methods used across a wide range of fields, including finance, physics, and industry. Emphasis is placed on the analysis and reasoning behind various models and solutions, enabling students to develop critical thinking skills and the ability to solve complex problems.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Classes	30
Project	30
Preparaton for classes	10
Preparation of a project	10
Preparation for an exam/credit	10
Self-study of class topics	5
Student workload	**Hours** 125

Wrocław University of Science and Technology

Large Language Models

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters	**Examination**	**Number of ECTS points**
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Laboratory: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Lists the mechanisms of tokenization and the construction/calculation of word embeddings used for large language models.	K2_AMA_W02, K2_AMA_W03
PEU_W02	Explains the driving mechanism and architecture of large language models.	K2_AMA_W03
PEU_W03	Presents the process of preparation, implementation, and maintenance of large language models.	K2_AMA_W03
In terms of skills		

PEU_U01	Implements a program for preparing input data for training large language models.	K2_AMA_U02, K2_AMA_U03
PEU_U02	Reproduces the operation of the self-attention mechanism.	K2_AMA_U03
PEU_U03	Designs and implements the basic structure of GPT-type models.	K2_AMA_U03
PEU_U04	Designs and implements a program for building foundation models and further fine-tuning them.	K2_AMA_U03
PEU_U05	Collaborates in a group to design, test, and finally implement a project related to applications of large language models.	K2_AMA_U05
In terms of social competences		
PEU_K01	Is open to learning new technologies.	K2_AMA_K02
PEU_K02	Identifies problems and challenges associated with the practical use of large language models.	K2_AMA_K02

Program content ensuring learning outcomes

The curriculum includes basic knowledge in the field of large language models, their training and optimization, and typical application areas. Strong emphasis will be placed on implementing language models from scratch, in particular addressing topics related to the preparation of training data, model architecture, and training and fine-tuning of large language models.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Laboratory	30
Project	30
Self-development of practical skills	15
Preparation of a report/summary/presentation/paper	15
Preparaton for classes	5
Student workload	**Hours** 125

Wrocław University of Science and Technology

Reinforcement Learning in Multi-Agent Systems

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters	**Examination**	**Number of ECTS points**
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Laboratory: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Selects an agent model appropriate for the problem	K2_AMA_W02, K2_AMA_W03
PEU_W02	Lists reinforcement learning algorithms and their practical applications in the context of multi-agent systems.	K2_AMA_W02
In terms of skills		
PEU_U01	Examines the behavior of complex systems using agent models	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05

PEU_U02	Uses reinforcement learning tools	K2_AMA_U02, K2_AMA_U03, K2_AMA_U05
In terms of social competences		
PEU_K01	Can independently search for necessary content in literature, including in foreign languages.	K2_AMA_K02

Program content ensuring learning outcomes

The course develops skills in implementing agent-based models, conducting simulations, and analyzing results. Students will learn how to design and develop multi-agent systems that use reinforcement learning to achieve goals in dynamic environments. This includes both the theoretical foundations of reinforcement learning and its practical applications in the context of multi-agent systems.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Laboratory	30
Project	30
Preparaton for classes	35
Student workload	**Hours** 125

Wrocław University of Science and Technology

Biomathematics

Educational subject description sheet

Basic information

Field of study
Applied Mathematics

Speciality
-

Organizational unit
Faculty of Pure and Applied Mathematics

Study level
second degree 3 semesters

Study form
full-time studies

Education profile
general academic profile

Education cycle
2025/2026

Subject code

Group of classes
Yes

Lecture languages
English

Mandatoriness
Elective

Block
Specialty subjects

Subject related to scientific research
Yes

Semesters	Examination	Number of ECTS points
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Classes: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Describes main mathematical models used in in biology and biochemisty.	K2_AMA_W02, K2_AMA_W03, K2_AMA_W04
PEU_W02	Explains the application of deterministic and stochastic differential equations to describe microscopic and macroscopic phenomena in cell biology and tissue formation.	K2_AMA_W02
In terms of skills		
PEU_U01	Uses computational methods of deterministic and stochastic differential equations and solves models used in biology.	K2_AMA_U02, K2_AMA_U03

PEU_U02	Combines mathematical and numerical methods in order to analyse biomathematical models in group projects.	K2_AMA_U03, K2_AMA_U05
In terms of social competences		
PEU_K01	Takes up the challenge to learn from biomathematical literature and use this knowledge in a group project.	K2_AMA_K02

Program content ensuring learning outcomes

The course teaches methods and mathematical models used in biology. It concentrates on models based on deterministic and stochastic differential equations which describe microscopic and macroscopic phenomena observed in cell biology and tissue formation. This advanced area is still actively developing and has crucial significance for biophysics, biochemistry and medicine.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Classes	30
Project	30
Preparation of a report/summary/presentation/paper	10
Self-development of practical skills	10
Preparaton for classes	15
Student workload	**Hours** 125

Wrocław University of Science and Technology

Stochastic Processes in Natural Sciences

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Elective **Block** Specialty subjects **Subject related to scientific research** Yes

Semesters	**Examination**	**Number of ECTS points**
Semester 1, Semester 2, Semester 3	Graded credit **Activities and hours** Lecture: 30 Classes: 30 Project: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Defines stochastic processes and explains real phenomena using advanced mathematical methods.	K2_AMA_W01, K2_AMA_W02, K2_AMA_W04
PEU_W02	Presents the theory in a way that can be understood by representatives of other disciplines.	K2_AMA_W01, K2_AMA_W02, K2_AMA_W04
In terms of skills		

PEU_U01	Appropriately selects stochastic methods to describe real phenomena.	K2_AMA_U02, K2_AMA_U04, K2_AMA_U05
PEU_U02	Develops new stochastic methods to describe complex real phenomena.	K2_AMA_U02, K2_AMA_U04, K2_AMA_U05
In terms of social competences		
PEU_K01	Is capable of independently addressing the challenges of modeling real-world phenomena using advanced stochastic methods.	K2_AMA_K02

Program content ensuring learning outcomes

Nowadays the area of applications of stochastic processes is expanding drastically. Novel classes of stochastic phenomena have recently been observed in a wide variety of complex systems such as amorphous semiconductors, glassy and nano-materials, fusion plasma, biological cells, epidemic spreading, neuromorphic and quantum computing. The coherent description of such and many other phenomena poses a fundamental challenge to a modern statistical physics of non-equilibrium state and requires going beyond the “traditional” university courses on the theory of probability, stochastic processes and kinetic theory. This lecture series aims to provide an introductory overview of some basic modern concepts in the theory of stochastic processes and random walk phenomena. The presentation will be given at a “physical” level of accuracy, with the use of exercises and particular examples from different areas of science. Additional seminars aim first, to make a historical overview, and second, to highlight more specific, yet interesting problems.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	30
Classes	30
Project	30
Preparaton for classes	10
Preparation of a project	20
Preparation for an exam/credit	5
Student workload	**Hours** 125

Wrocław University of Science and Technology

The Protection of Industrial Property and Copy Rights

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Lecture languages** English **Mandatoriness** Elective **Block** Subjects from the fields of humanities or social sciences **Subject related to scientific research** Yes

Semester	Activities, hours, ECTS and examination
Semester 1	• Seminar: 30 h, 3 ECTS, Graded credit

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Knows interpretation methods of legal regulations connected with copyrights and industrial property rights.	K2_AMA_W05, K2_AMA_W06
PEU_W02	Describes the most important aspects of copyright law, patent law, and invention protection procedures, including creators' rights, registration processes, and strategies for securing intellectual property.	K2_AMA_W05
In terms of skills		
PEU_U01	Argues and applies legal provisions in the appropriate context.	K2_AMA_U06
PEU_U02	Identifies and interprets Polish sources of law and types of licenses in the context of intellectual property.	K2_AMA_U06
In terms of social competences		

PEU_K01	Understands the need and knows the possibilities of constant training in terms of legal aspects of engineering work to increase professional competencies, personal and social ones.	K2_AMA_K04
PEU_K02	Is aware of the importance of observing and developing professional ethics in the context of industrial property rights and copyright.	K2_AMA_K04

Program content ensuring learning outcomes

A course dedicated to legal regulations protecting industrial property, including copyright and patent law. The program covers the fundamental aspects of copyright law, patent rights, and procedures for protecting inventions. Students will learn about creators' rights, registration processes, and strategies for safeguarding intellectual property in a professional context. The goal of the course is to equip participants with the knowledge needed to understand and apply intellectual property law in both creative and technical fields.

Calculation of ECTS points

Activity form	**Activity hours**
Seminar	30
Preparaton for classes	25
Preparation of a project	20
Student workload	**Hours** 75

Wrocław University of Science and Technology

Self-Presentation and Public Speaking

Educational subject description sheet

Basic information

Field of study
Applied Mathematics

Speciality
-

Organizational unit
Faculty of Pure and Applied Mathematics

Study level
second degree 3 semesters

Study form
full-time studies

Education profile
general academic profile

Education cycle
2025/2026

Subject code

Lecture languages
English

Mandatoriness
Elective

Block
Subjects from the fields of humanities or social sciences

Subject related to scientific research
Yes

Semester	Activities, hours, ECTS and examination
Semester 1	• Seminar: 30 h, 3 ECTS, Graded credit

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Identifies individual and group competences in the field of effective communication and self-presentation.	K2_AMA_W06
PEU_W02	Identifies the value of a commercial and personal brand and has tools to protect them.	K2_AMA_W05
In terms of skills		
PEU_U01	Manages his own public image and shape the personal brand.	K2_AMA_U06
PEU_U02	Designs a communicational space for the organization of the group, taking the role of the leader in it.	K2_AMA_U06
In terms of social competences		
PEU_K01	Is sensitive to the psychosocial competences of his/her environment.	K2_AMA_K03

Program content ensuring learning outcomes

Content from the field of social psychology providing the acquisition of knowledge on self-presentation and impression management. Practical content providing understanding and acquiring skills in presenting oneself, one's views and one's achievements. Content from the field of social psychology providing the development and consolidation of social competences, including the competence to work in a group (playing different roles and adopting different perspectives), effective conversation and argumentation in favor of one's own position.

Calculation of ECTS points

Activity form	**Activity hours**
Seminar	30
Preparaton for classes	10
Preparation of a project	20
Conducting literature research	10
Self-development of practical skills	5
Student workload	**Hours** 75

Wrocław University of Science and Technology

Foreign Language 2.1

Educational subject description sheet

Basic information

Field of study
lektoraty

Speciality
-

Organizational unit
Wrocław University of Science and Technology

Study level
second degree

Study form
full-time studies

Education profile
general academic profile

Education cycle
2025/2026

Subject code
SJO000-25SM02684C

Lecture languages
English

Mandatoriness
Elective

Block
Foreign languages

Semesters	Activities, hours, ECTS and examination
Semester 1, Semester 2, Semester 3	• Classes: 30 h, 2 ECTS, Graded credit

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of skills		
PEU_U01	Student has knowledge, skills and competences consistent with the requirements specified for the minimum B2 level according to the Common European Framework of Reference for Languages; knows, understands and uses linguistic means (grammatical, lexical and stylistic) from academic, specialist and technical languages used in the field of study and in the academic and professional environment; communicates in an intercultural and professional environment; understands and has the ability to analyze foreign-language specialist texts; improves their skills in the area of specialized and academic languages.	SJO_S2_U01

Program content ensuring learning outcomes

B2 plus English, French, Spanish, GermanC1 plus English languageGeneral educational content

Formation and deepening of communicative competence in academic and professional settings.
Interaction appropriate to the appropriate level of linguistic competence, such as the student's own profile for academic and professional purposes. Deepening creative, receptive and interactive competence in a team.
Language in communication in specialized and professional fields in the modern world. Verbal and non-verbal communication - functioning freely in an intercultural environment, conducting discourse, polemics, analysis of specialized texts.

Calculation of ECTS points

Activity form	**Activity hours**
Classes	30
Preparaton for classes	30
Student workload	**Hours** 60

Wrocław University of Science and Technology

Optimization Theory

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Obligatory **Block** Subjects of basic education - mathematics

Semester	**Examination**	**Number of ECTS points**
Semester 2	Exam **Activities and hours** Lecture: 45 Classes: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Distinguishes between the formulations of different optimization problems.	K2_AMA_W01
PEU_W02	Identifies the applications and importance of mathematical programming methods.	K2_AMA_W04
PEU_W03	Recognizes the situations when optimization tools are necessary to solve real-life problems.	K2_AMA_W04
PEU_W04	Understands the limitations of analytical methods and the possibility of numerical solutions of optimization problems.	K2_AMA_W01
In terms of skills		

PEU_U01	Formulates the optimization problem in a form convenient for the analysis.	K2_AMA_U01
PEU_U02	Chooses the appropriate algorithm to solve the mathematical programming task.	K2_AMA_U01
PEU_U03	Applies optimization methods, either analytical methods or numerical analysis, in order to solve practical problems.	K2_AMA_U01
In terms of social competences		
PEU_K01	Uses the scientific literature to independently acquire knowledge.	K2_AMA_K01
PEU_K02	Cooperates with scientists in other fields in order to solve their problems using mathematical tools.	K2_AMA_K01

Program content ensuring learning outcomes

The course is supposed to introduce the student to the standard methodology of solving optimization problems of different types. Necessary and sufficient condintions for the existence of an unconstrained optimium will be presented together with Lagrange multipliers theory for the constrained case, including Karush-Kuhn-Tucker conditions for the inequality constrained problems. Standard numerical methods of solving optimization problems of different types will also be presented. Those will include gradient methods for unconstrained optimization, Simplex method for linear programming and Branch and Bound method for integer programming. Several most commonly used methods for general nonlinear optimization will also be presented.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	45
Classes	30
Preparation of a project	20
Self-development of practical skills	16
Preparation for an exam/credit	10
Credit/Exam	4
Student workload	**Hours** 125

Wrocław University of Science and Technology

Applied Functional Analysis

Educational subject description sheet

Basic information

Field of study Applied Mathematics **Speciality** - **Organizational unit** Faculty of Pure and Applied Mathematics **Study level** second degree 3 semesters **Study form** full-time studies **Education profile** general academic profile	**Education cycle** 2025/2026 **Subject code** **Group of classes** Yes **Lecture languages** English **Mandatoriness** Obligatory **Block** Subjects of basic education - mathematics **Subject related to scientific research** Yes

Semester	**Examination**	**Number of ECTS points**
Semester 2	Exam **Activities and hours** Lecture: 45 Classes: 30	5.0

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Distinguishes linear spaces, presents their examples and lists their properties.	K2_AMA_W01
PEU_W02	Formulates the most important theorems of functional analysis.	K2_AMA_W01, K2_AMA_W04
PEU_W03	Lists the applications of the theory of functional analysis in other areas of mathematics.	K2_AMA_W01, K2_AMA_W04
In terms of skills		
PEU_U01	Constructs linear spaces.	K2_AMA_U01

PEU_U02	Uses the theory of functional analysis in other areas of mathematics and in solving real-world problems.	K2_AMA_U01, K2_AMA_U04
In terms of social competences		
PEU_K01	Searches, without assistance, for necessary information in the literature.	K2_AMA_K01
PEU_K02	Understands the need for systematic work on course material.	K2_AMA_K01

Program content ensuring learning outcomes

The aim of this subject is to present students with fundamental concepts of functional analysis, focusing on its application to other fields of mathematics such as differential equations, integral equations, variational methods, and numerical analysis.

Calculation of ECTS points

Activity form	**Activity hours**
Lecture	45
Classes	30
Preparaton for classes	30
Preparation for an exam/credit	10
Credit/Exam	4
Self-study of class topics	6
Student workload	**Hours** 125

Wrocław University of Science and Technology

Ethics of the New Technologies

Educational subject description sheet

Basic information

Field of study
Applied Mathematics

Speciality
-

Organizational unit
Faculty of Pure and Applied Mathematics

Study level
second degree 3 semesters

Study form
full-time studies

Education profile
general academic profile

Education cycle
2025/2026

Subject code

Lecture languages
English

Mandatoriness
Elective

Block
Subjects from the fields of humanities or social sciences

Subject related to scientific research
Yes

Semester	Activities, hours, ECTS and examination
Semester 2	• Seminar: 30 h, 2 ECTS, Graded credit

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Correctly characterizes ethical rules of conducting surveys and the rules of authorhsip.	K2_AMA_W05
PEU_W02	Identifies and applies ethical theories while explaining the problems from the field of new technologies.	K2_AMA_W06
In terms of skills		
PEU_U01	Based on the searched relevant ethical literature and regulations is able to evaluate the opinions and contents presented by other seminar participants.	K2_AMA_U06
In terms of social competences		
PEU_K01	Appreciates the importance of professional ethics and is ready to follow its rules.	K2_AMA_K04

Program content ensuring learning outcomes

The subject explains the main ethical concepts and theories, identifying the distinction between ethical and legal regulations. The programme content includes: presentation of technology assessment as a theoretical field and a multidisciplinary practice, principles of performing technology assessment and communicating its results, ethical and social consequences of technical activities. The subject develops the ability to apply regulations and rules to the analyzed problems. By completing the assignments, students also acquire the competence to formulate opinions on the basis of searched sources, to formulate opinions in thematic discussions, to evaluate the results of the work of others, and to present the results of the completed task to a wider audience.

Calculation of ECTS points

Activity form	**Activity hours**
Seminar	30
Preparaton for classes	5
Preparation of a report/summary/presentation/paper	5
Conducting literature research	5
Self-study of class topics	5
Student workload	**Hours** 50

Wrocław University of Science and Technology

Philosophy of Information

Educational subject description sheet

Basic information

Field of study
Applied Mathematics

Speciality
-

Organizational unit
Faculty of Pure and Applied Mathematics

Study level
second degree 3 semesters

Study form
full-time studies

Education profile
general academic profile

Education cycle
2025/2026

Subject code

Lecture languages
English

Mandatoriness
Elective

Block
Subjects from the fields of humanities or social sciences

Subject related to scientific research
Yes

Semester	Activities, hours, ECTS and examination
Semester 2	• Seminar: 30 h, 2 ECTS, Graded credit

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Distinguishes between technical and non-technical (philosophical and ethical) information issues	K2_AMA_W05, K2_AMA_W06
PEU_W02	Identifies and characterises issues related to the concept of information, also in the context of new technologies	K2_AMA_W05, K2_AMA_W06
PEU_W03	Presents and explains issues related to the complexity of the concept of information and its processing	K2_AMA_W05, K2_AMA_W06
In terms of skills		
PEU_U01	Analyses, demonstrates and critically evaluates information and its processing.	K2_AMA_U06
PEU_U02	Prepares and leads a discussion on the concept of information, the complexity of this topic and its importance	K2_AMA_U06
In terms of social competences		

PEU_K01	Identifies problems related to information and its processing in a critical way, appreciates the role of in-depth philosophical and ethical analysis of the concept of information and its processing	K2_AMA_K01
PEU_K02	Takes the initiative in discussions about the consequences of understanding information, also in the context of the social matters	K2_AMA_K01

Program content ensuring learning outcomes

The course is conducted in the form of a seminar and will allow participants to:

1. develop skills in identifying problems in the field of information processing, the complexity of which, apart from the technical layer, reaches beyond situations typical of the work of an engineer;
2. get students acquainted with the contemporary state of research related to key problems related to the concept of information, the philosophy of information and computer science;
3. introduction to the broader context of ethical issues related to information processing, including the use of AI systems.

Calculation of ECTS points

Activity form	**Activity hours**
Seminar	30
Self-study of class topics	15
Preparation of a report/summary/presentation/paper	5
Student workload	**Hours** 50

Wrocław University of Science and Technology

Foreign Language 2.2

Educational subject description sheet

Basic information

Field of study lektoraty	**Education cycle** 2025/2026
Speciality -	**Subject code** SJO000-25SM02690C
Organizational unit Wrocław University of Science and Technology	**Lecture languages** English
Study level second degree	**Mandatoriness** Elective
Study form full-time studies	**Block** Foreign languages
Education profile general academic profile	

Semesters	**Activities, hours, ECTS and examination**
Semester 1, Semester 2, Semester 3	• Classes: 60 h, 3 ECTS, Graded credit

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of skills		
PEU_U01	Student has knowledge, skills and competences consistent with the requirements specified for the appropriate language level; knows, understands and uses linguistic means (grammatical, lexical and stylistic) defined at a certain level from everyday life with selected elements of academic, specialist and technical language used in the field of study and in the academic and professional environment; communicates in a family, social and intercultural environment, practicing communication skills; appreciates the need to improve their skills in effective communication, develops competences in the area of communication language, basics of specialist and academic language	SJO_S2_U01

Program content ensuring learning outcomes

A1; A2; B1 French, Spanish, Japanese, German, Polish as a foreign language, Russian
General educational content
Formation and deepening of communicative competence in a family, social and intercultural environment and for a specific level for academic and professional needs.
Interaction appropriate to the appropriate level of language competence, e.g., the student's own profile and interests; presenting oneself, one's interests and ideas in environmental, academic and professional contexts. Developing creative, receptive and interactive competence in a group.
Language in communication in the modern world. Verbal and non-verbal communication - sensitivity to cultural differences, starting a conversation, joining in a discussion, moving on to the next points, summarizing statements, using characteristic phrases and expressions for a certain language level; taking part in various forms of interaction.

Calculation of ECTS points

Activity form	**Activity hours**
Classes	60
Preparaton for classes	30
Student workload	**Hours** 90

Wrocław University of Science and Technology

Diploma Seminar

Educational subject description sheet

Basic information

Field of study
Applied Mathematics

Speciality
-

Organizational unit
Faculty of Pure and Applied Mathematics

Study level
second degree 3 semesters

Study form
full-time studies

Education profile
general academic profile

Education cycle
2025/2026

Subject code

Lecture languages
English

Mandatoriness
Obligatory

Block
Major-specific subjects

Subject related to scientific research
Yes

Semester	Activities, hours, ECTS and examination
Semester 3	• Seminar: 30 h, 2 ECTS, Graded credit

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Selects and applies appropriate methods and models used in various applications of mathematics	K2_AMA_W05
PEU_W02	Has in-depth knowledge of a chosen specialty, enabling independent research work.	K2_AMA_W05
In terms of skills		
PEU_U01	Constructs mathematical models used in various fields	K2_AMA_U06
PEU_U02	Presents own results and discusses them, developing the ability to critically evaluate one's own and others' achievements.	K2_AMA_U06
In terms of social competences		
PEU_K01	Uses scientific literature (including in foreign languages), arrives at source materials and reviews them	K2_AMA_K01, K2_AMA_K03

Program content ensuring learning outcomes

The seminar aims to prepare students for independent research work and the development of their master’s thesis, as well as to enhance their skills in presenting research findings. As part of the seminar, students present the results obtained during the preparation of their theses and engage in discussions about them. This approach allows for in-depth analysis of research problems and helps develop the ability to critically evaluate both their own work and that of others.

Calculation of ECTS points

Activity form	**Activity hours**
Seminar	30
Preparation of a report/summary/presentation/paper	20
Student workload	**Hours** 50

Wrocław University of Science and Technology

Diploma Thesis

Educational subject description sheet

Basic information

Field of study
Applied Mathematics

Speciality
-

Organizational unit
Faculty of Pure and Applied Mathematics

Study level
second degree 3 semesters

Study form
full-time studies

Education profile
general academic profile

Education cycle
2025/2026

Subject code

Lecture languages
English

Mandatoriness
Obligatory elective

Block
Major-specific subjects

Semester	Activities, hours, ECTS and examination
Semester 3	• Diploma thesis: 45 h, 23 ECTS, Graded credit

Subject's learning outcomes

Subject's outcome	Content	Learning outcome
In terms of knowledge		
PEU_W01	Selects techniques and mathematical methods for the problem being studied in the master's thesis.	K2_AMA_W05
PEU_W02	Identifies the tools and methods needed to solve the defined problem.	K2_AMA_W05
PEU_W03	Presents the discussed real-world problem correctly and formulates it in a mathematical language.	K2_AMA_W05
In terms of skills		
PEU_U01	Analyzes the discussed problem and selects mathematical tools for its analysis.	K2_AMA_U06
PEU_U02	Interprets the obtained results and draws valid conclusions.	K2_AMA_U06
In terms of social competences		

PEU_K01	Defines the mathematical problem related to the topic of the master's thesis.	K2_AMA_K01, K2_AMA_K02, K2_AMA_K04
PEU_K02	Solves real-world problems using advanced mathematical tools.	K2_AMA_K01, K2_AMA_K02, K2_AMA_K04

Program content ensuring learning outcomes

As part of the course, students will present the progress of their research and master's theses. Learning outcomes will be achieved through the presentation of the final result of the work, which will serve as preparation for the defense of the master's thesis. During the classes, issues arising during the research for the master's thesis will be discussed.

Calculation of ECTS points

Activity form	**Activity hours**
Diploma thesis	45
Preparation of a project	200
Preparation of the thesis	100
Conducting empirical studies	100
Conducting literature research	50
Self-study of class topics	50
Self-development of practical skills	30
Student workload	**Hours** 575