



Lodz University
of Technology

Study programme

Faculty:	Faculty of Technical Physics, Information Technology and Applied Mathematics
Major:	Applied Mathematics
Level of study:	first-cycle programme (licencjat)
Form of study:	full-time studies
Academic year:	2026/27

Table of contents

Basic information	3
Learning outcomes (in relation to the PQF)	4
Matrix of course modules in relation to learning outcomes and curriculum content	5
ECTS - subjects	13
ECTS indicators	17
Methods of verifying and assessing learning outcomes	18
Professional internships	19
Characteristics of the course	20
Education program	22

Basic information

Name of the field of study:	Applied Mathematics
Level of study:	first-cycle programme (licencjat)
Study profile:	general academic
Form of studies:	full-time studies
Duration of studies (number of semesters):	6
The number of ECTS points required to complete studies:	180
Total number of hours of classes:	2270
The number of ECTS points a student obtains as part of classes conducted with the direct participation of academic teachers or other persons conducting classes:	91
Professional title awarded to graduates:	licencjat
ISCED code:	0541
Language of study:	polish

Assigning the course to the disciplines to which the learning outcomes relate

Discipline	Percentage share
Maths	100%

Learning outcomes (in relation to the PQF)

No.	Learning outcome code	Learning Outcome Content	Reference to the universal characteristics of the first level of PRK	Reference to the second-level characteristics of the PRK, taking into account the second-level characteristics enabling the acquisition of engineering competences
1	1MAS1	Possesses advanced knowledge of the foundations of mathematics, mathematical analysis and algebraic structures, taking into account their development and connections with other fields of science, and understands their applications in solving complex theoretical and practical problems.	P6U_W, P6U_U	P6S_WG, P6S_UU
2	1MAS2	Possesses advanced mathematical knowledge used to model phenomena described by various fields of science. Knows the basic legal requirements for using this knowledge responsibly, and understands related issues in entrepreneurship and project management.	P6U_W	P6S_WG, P6S_WK
3	1MAS3	Knows the basics of data collection, storage, processing and analysis, and knows how to select IT tools to meet specific requirements, including applications relevant to the discipline of mathematics.	P6U_W	P6S_WG
4	1MAS4	Is able to perform statistical analysis and inference based on data and interpret the obtained results.	P6U_U	P6S_UW, P6S_UK, P6S_UU
5	1MAS5	Uses a modern programming language and mathematical computational packages to solve problems.	P6U_U	P6S_UW
6	1MAS6	Is able to use mathematical knowledge to describe, analyze and formulate conclusions in the field of theoretical and applied issues.	P6U_U, P6U_K	P6S_UW, P6S_UK, P6S_UU, P6S_KK
7	1MAS7	Is able to systematize, develop and present issues in the field of higher mathematics or its applications, also based on teamwork, assuming various roles in it; is able to participate in a debate.	P6U_U	P6S_UW, P6S_UK, P6S_UO
8	1MAS8	Can communicate in speech and in writing in a foreign language at the B2 level of the Common European Framework of Reference for Languages, including specialist terminology, typical of the discipline of mathematics.	P6U_U	P6S_UW, P6S_UK
9	1MAS9	Is ready to critically assess the knowledge possessed, including through contact and discussion with experts or by means of public consultations.	P6U_K	P6S_KK, P6S_KO
10	1MAS10	Is ready to act in an entrepreneurial manner and is aware of the ethical dilemmas and social challenges arising from the contemporary practice of mathematics and professional work in the context of the development of technology and computer science.	P6U_K	P6S_KK, P6S_KO, P6S_KR

Matrix of course modules in relation to learning outcomes and curriculum content

No.	Course name	Program content	1MAS1	1MAS2	1MAS3	1MAS4	1MAS5	1MAS6	1MAS7	1MAS8	1MAS9	1MAS10
1	Linear Algebra with Elements of Analytic Geometry	Elementary concepts of linear algebra, focusing on real vector spaces and linear mappings of Cartesian spaces, provide a foundation for learning and exploring more advanced topics in higher mathematics. Elements of analytic geometry in Euclidean space.	x	x				x				
2	Mathematical Analysis I	Axioms and basic properties of the set $\mathbb{R}$ of real numbers; supremum and infimum of subsets of the set $\mathbb{R}$. Sequences of real numbers, convergent and divergent sequences and their properties, upper and lower limits of sequences. Elementary functions. Limit and continuity of real functions of a real variable. Differential calculus of one real variable functions with some applications. Antiderivatives.	x	x				x				
3	Computer Mathematical Calculations	A presentation of selected tools for numerical or symbolic mathematical computations (programming languages and CAS packages). Elements of the Python language: syntax, control statements, user functions, etc. Packages and libraries that extend computational capabilities. Selected mathematical algorithms. Drawing function graphs.					x	x	x			
4	Introduction to Discrete Mathematics and Probability Theory	Elements of combinatorics (inclusion-exclusion principle, pigeonhole principle, basic concepts of combinatorics: permutations, combinations, variations). Elements of discrete probability (properties, Bayes' theorem, expected value, variance, discrete probability distributions).	x	x				x				
5	Introduction to Logic and Set Theory	In area of mathematical logic: logical evaluation of propositions and operations on propositions, tautologies, quantifiers and their properties, the principle of mathematical induction. In the foundations of set theory: operations on sets, relations and functions, partial orders, equivalence relations, images and inverse images of functions. Equinumerous sets and cardinality of a set.	x					x				
6	Elements of Engineer Graphics	Selected topics related to creating and editing technical drawings in a CAD environment. Sheet formats, computer graphics storage methods, and the basics of AutoCAD, including precision drawing, basic geometric structures, working with layers and blocks. Presentation of rules consistent with technical standards, creation and editing of dimension styles, and the use of technical script. A technical drawing of a device in 2D projection form, and preparing files for printing.			x		x					
7	Algorithms and Basics of Programming	Algorithm – concept and properties. Basic structuring of algorithms: loops, recursion, conditioning, stopping condition – in reference to Python syntax. Data types available in the numpy and pandas packages. Outline of the general classification of types: simple and complex, statically and dynamically allocated. Selected data structures: list, set, queue, dictionary (map), stack – implementation in Python. Recursion vs. iterative approach – comparison. Graphs as data-storing structures and their representation in computer memory – adjacency matrices, adjacency lists, and others. Selected graph algorithms (DFS, BFS, Dijkstra). Comparison of the effectiveness of ready-made algorithms with custom implementations. Greedy algorithms – selected examples. Nature-inspired algorithms – examples and applications.			x		x		x			
8	Algebra	Basic concepts and theorems of abstract algebra, providing an introduction to the study of algebraic structures such as groups, rings, and fields. A presentation of selected properties and examples of such structures.	x	x				x				

No.	Course name	Program content	IMAS1	IMAS2	IMAS3	IMAS4	IMAS5	IMAS6	IMAS7	IMAS8	IMAS9	IMAS10
9	Professional Ethics and Intellectual Property Protection	Research areas and key ethical issues. Professional codes and ethical standards. The concept of social responsibility. The importance of intellectual property protection in international, European, and national law. Selected issues in the field of industrial property protection. Ethical aspects of compliance with occupational health and safety rules, the role of occupational health and safety regulations and procedures in organizational culture, professional responsibility for one's own and co-workers safety.		x								x
10	Basics of Economics and Entrepreneurship	Basic concepts in economics. Market, demand, and supply. Elements of the theory of the firm: production function, firm behavior in a competitive market, monopoly and oligopoly, cost-profit functions. Legal forms of conducting business in Poland. Elements of market equilibrium theory. Main trends in economics, specificity of macroeconomics. Basic macroeconomic concepts and categories: aggregation, national income, consumption, investment, exports, imports. Inflation and unemployment. Basic principles of the labor market. The role of the state in the economy. Economic growth. Commentary on current events affecting the Polish and global economies. Commercialization of research results and technology transfer.		x								x
11	English B2 module I	The first part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
12	English B2+ module I	The first part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
13	English C1 module I	The first part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
14	German B2 module I	The first part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
15	Basics of Probability and Measure Theory	Basic concepts of probability theory: probability space, event field and sigma-field, measure and probability measure, and the Lebesgue measure. Basic properties of probability, random variables and their numerical characteristics, generating functions; selected topics of the Lebesgue and Lebesgue-Stieltjes integrals, independence of sigma-fields of events and random variables, and conditional distributions, Bayes' theorem; Borel-Cantelli lemmas, various types of convergence for sequences of random variables, probability inequalities, Kolmogorov's inequality, strong and weak laws of large numbers, central limit theorems.	x			x						

No.	Course name	Program content	1MAS1	1MAS2	1MAS3	1MAS4	1MAS5	1MAS6	1MAS7	1MAS8	1MAS9	1MAS10
16	Mathematical Analysis II	Deepen the understanding of integral, its properties, an applications, with particular emphasis on the relations to differentiation, geometric interpretation and practical methods of integration. Ddevelopment of the ability to analyze of the convergence of numerical and functional series, recognition and description of functions through series expansion. Introduction to topology of Euclidean space, fostering geometric intuition and understanding of concepts related to limits, continuity, and the spatial structure of sets.	x	x				x				
17	English B2 module II	The second part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
18	English B2+ module II	The second part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
19	English C1 module II	The second part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
20	German B2 module II	The second part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
21	Mathematical Foundations of Data Analysis	A mathematical description of the main problems and methods of data analysis, including basic machine learning models. A statistical approach to the analysis of univariate data (identifying the sample distribution) and multivariate data (modeling the relationships between sample coordinates, depending on their type - i.e., regression, classification, AnoVa; and clustering by similarity).	x				x	x	x			
22	Mathematical Analysis III	Elements of topology of metric space. Calculus of functions of several variables along with its applications in finding extrema and conditional extrema. Selected topics in the integral calculus of functions of several variables.	x	x				x				
23	Basics of Statistics	Introduction to methods and models of statistical inference, including parametric estimation (maximum likelihood estimation, Bayesian estimation), confidence intervals, as well as the testing of statistical hypotheses.	x			x	x	x				
24	Introduction to Financial and Insurance Mathematics	The time value of money. Simple and compound interest. Equivalent interest rates. Certain (fixed) annuities. Credit analysis. Financial investment analysis. Bonds and their valuation. Macaulay duration. Basic life annuities.	x	x				x	x	x		
25	Discrete Mathematics	Recursions and selected methods for solving them. Generating functions. Methods for summing finite sequences. Non-elementary methods of combinatorics. Special sequences and special numbers. Elements of number theory.	x	x				x				

No.	Course name	Program content	1MAS1	1MAS2	1MAS3	1MAS4	1MAS5	1MAS6	1MAS7	1MAS8	1MAS9	1MAS10
26	English B2 module III	The third part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
27	English B2+ module III	The third part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
28	English C1 module III	The third part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
29	German B2 module III	The third part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
30	Database Systems	Databases - basic concepts. Data models. Relational database model. SQL query schemas. Normal forms of the database schema. Architecture of the database management system. Basics of the SQL language. Triggers, functions and procedures.			x		x		x			
31	Life Insurance Mathematics	Survival theory, life tables. Single net premium for standard life insurance policies. Life annuities. Periodic premiums.	x	x				x				
32	Estimation and Time Series	Nonparametric estimators of the density distribution, regression curve, damage intensity, ruin probability, etc., constructed using the Nadaraya-Watson method, k-nearest neighbors, orthogonal expansions, spline functions, etc. Optimal convergence rates for estimators in various metrics and the selection of the smoothing parameter based on a preliminary sample will be discussed; self-learning algorithms for some estimators, as well as correction algorithms for estimators that are not well-defined, will be discussed. Basic time series models, stationarity in the narrow and broad sense, properties of Markov chains, autoregressive models, and parameter estimation in these models.	x	x		x	x	x				
33	Fundamentals of Functional Analysis	Introduction to the theory of Banach and Hilbert spaces, and the theory of linear bounded operators defined on such spaces.	x					x				
34	Mathematical Analysis IV	Introducing to problems of complex analysis, Taylor and Laurent series and the Cauchy integral formulas. Development of Fourier analysis methods, the Fourier and Laplace transforms enabling understanding of periodic phenomena. Understanding of line and surface integrals and mastering the classical theorems from vector analysis (Green, Gauss and Stokes theorems) along with their applications.	x	x				x				
35	Modeling and Valuation of Financial Instruments	Principles of financial market operation. Analysis and selected methods of valuation financial instruments.		x				x	x			

No.	Course name	Program content	1MAS1	1MAS2	1MAS3	1MAS4	1MAS5	1MAS6	1MAS7	1MAS8	1MAS9	1MAS10
36	Programming in Data Analysis	Overview of selected Python packages and libraries used in data analysis (NumPy and pandas). Data as arrays (ndarrays) or complex collections of arrays — a review of useful Python data types. Accessing the current state of variables in interactive mode; assessing memory requirements for planned analyses. Python-specific computational methods — data preprocessing; binary saving and loading of results from completed analyses. Visualization of analysis results using the matplotlib package; capabilities for incremental, step-by-step presentation; saving graphical files. Example solutions to elementary data analysis and classification problems using custom procedures and functions. Evaluating the efficiency (including runtime) of implemented algorithms depending on data size; elements of functional programming in data analysis projects. Selected components of the scikit-learn package — comparison of the capabilities and performance of library functions with custom implementations.			x		x	x	x			
37	Algorithms of Linear Algebra	Selected topics in algebra and their applications to computational methods, including algorithms for solving systems of linear equations and finding particular matrix decompositions (e.g., SVD). Practical tasks involving the implementation of selected algorithms in a given programming language.	x				x		x			
38	Introduction to Numerical Analysis	Algorithms for finding function roots: the bisection method, the Newton-Raphson method. Numerical methods for solving differential equations: the Euler method and the Runge-Kutta method. Numerical integration: the rectangle method, the trapezoidal method, Simpson's method, Gaussian quadrature. Optimization methods: the gradient descent method, Lagrange multipliers.	x				x		x			
39	Selected Issues of Measure and Category	Presentation and comparative analysis of selected facts involving the Lebesgue and Baire sigma-algebras and functions measurable with respect to those and others sigma-algebras.	x					x				
40	Fundamentals of Cryptography and Information Theory	Introduce to the fundamental ideas and mathematical tools of modern cryptography and information theory. Analysis of connections between number theory, algebra, probability theory, and information security, as well as the mathematical foundations of coding and error detection.	x	x				x				
41	Introduction to Differential Equations	Selected topics related to ordinary differential equations (for example: the existence and uniqueness theorem, selected first-order equations, systems of equations) and partial differential equations (for example: heat, wave and Laplace-Poisson equations) with applications.	x	x				x				
42	Statistical Hypothesis Testing	Selected topics in the field of statistical hypothesis testing, including the concepts of parametric and nonparametric tests, type I and type II errors, and test power, as well as an overview of basic statistical tests.				x	x	x				
43	English B2 module IV	The fourth part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		

No.	Course name	Program content	1MAS1	1MAS2	1MAS3	1MAS4	1MAS5	1MAS6	1MAS7	1MAS8	1MAS9	1MAS10
44	English B2+ module IV	The fourth part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
45	English C1 module IV	The fourth part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
46	German B2 module IV	The fourth part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
47	Introduction to Machine Learning and Artificial Intelligence	Machine learning models and variants of the learning process. Artificial intelligence algorithms inspired by nature, stochastic optimization techniques. Clustering algorithms (DBSCAN, hierarchical methods, K-Means). Techniques for evaluating clustering models. Ensemble learning algorithms, theory of decision trees and random forests. Selected regression and classification techniques. Assessment of predictive model quality. Introduction to neural networks. Prompt engineering and the use of artificial intelligence models based on large language models (LLM).		x	x		x	x	x			
48	Life Insurance - Premium Calculation	Survival theory, life tables. Single net premium for standard life insurance. Life annuities. Periodic premium for an insurance package. Net reserves.		x		x		x	x			
49	Fuzzy Analysis	Introduction to the theory of fuzzy sets. Applications of fuzzy set theory in testing of statistical hypotheses, quality control, and financial mathematics.	x	x				x				
50	Elements of Linear Programming and Operational Research	Linear programming problems and the existence of their solutions. The simplex algorithm as a general tool for solving linear optimization problems. Selected linear and discrete optimization problems (transportation problems, minimum flow problems, optimal task allocation problems) and algorithms for solving them. CPM and PERT methods for constructing optimal project schedules. Using selected programming tools for solving optimization problems.	x	x			x	x				
51	Introduction to Nonlinear Optimization with Applications	Selected problems in conditional optimization with various types of constraints, including those involving convexity. Applications of the discussed optimization problems.	x	x				x				
52	Multivariate Data Analysis	Supervised Learning Models for Regression and Classification Problems. Unsupervised Learning Models for Clustering, Outlier Detection, and Dimension Reduction Problems.				x	x		x			
53	Risk Modeling in Bank and Insurance Activity	Selected issues related to modeling the risks associated with bank and insurer operations (including credit risk and insurer insolvency risk). Practical issues related to the operation of financial and insurance institutions and the basic products they offer, including security when using them - the role of the Bank Guarantee Fund.		x				x	x		x	

No.	Course name	Program content	1MAS1	1MAS2	1MAS3	1MAS4	1MAS5	1MAS6	1MAS7	1MAS8	1MAS9	1MAS10
54	Summative Module	Revision, consolidation, and expansion of the most important theoretical and applied components of mathematics, with possible inclusion of specialized topics in actuarial mathematics or data analysis. Selected topics in project management, device, product, or process lifecycle analysis, and basic cybersecurity principles.		x	x			x	x		x	
55	Diploma Seminar	Improving the substantive content related to the prepared thesis and key learning outcomes. Developing public speaking skills through the presentation of selected excerpts from the thesis. Familiarizing students with the research conducted at the Institute of Mathematics. Selected topics in preparation for the competency exam.		x				x	x	x	x	
56	History and Philosophy of Mathematical Discoveries	Chronological discussion of selected facts about the history of mathematics, along with the historical character of the discovery and its significance for the development of modern civilization. Selected aspects of the philosophy of mathematics.	x									
57	Internship	Using applied mathematics and computational tools to solve practical analytical problems in industry. Participation in team projects involving the use of applied mathematics in business or technological settings.						x	x		x	x
58	Non-Life Insurance Mathematics	Individual and joint risk models, discrete and continuous models of company solvency, probability of ruin over finite and infinite horizons. The bonus-malus system for determining insurance premiums, trust theory, the Bichsel model, the heterogeneous model. The chain ladder method and other methods for estimating IBNR-type reserves.		x				x	x			
59	Final Project	Independent development of mathematical competences under the guidance of a supervisor, including the development of deductive reasoning skills and the implementation of mathematical models in practical or theoretical problems, possibly using IT tools and methods. Students conduct a literature review, formulate thesis objectives, identify specific tasks, and select appropriate methods and tools for their implementation. The final stage of the thesis preparation involves developing a coherent text presenting the obtained results or reasoning.	x					x	x		x	
60	Heuristic Methods in Optimization Problems	P, NP, and NP-hard problems, computational complexity of algorithms, the Turing machine. Examples of NP-hard problems: TSP, QAP, SAT, VRP, vertex cover, graph coloring. Selected heuristic methods: greedy methods, genetic algorithm, simulated annealing, multi-start search, tabu search, particle swarm optimization, ant colony algorithm, and others.			x		x	x	x			
61	Selected Issues of Mathematical Statistics	A review of selected topics in mathematical statistics, focusing on estimation methods, including maximum likelihood estimation, and on the testing of statistical hypotheses.				x			x			
62	Selected Issues of Measure and Integral	A review of selected topics in measure and integration theory, with particular emphasis on a deeper understanding of the concept of a generated by a family of sets sigma-algebra, measure regularity, and limit theorems.	x									
63	Fundamentals of Programming in VBA	Entering formulas, using built-in functions, checking data validity, and organizing and importing various data formats with the ability to sort and filter them. Cell addressing methods, using special copy operations, and recording macros. Syntax, functions, subroutines, variables, control statements, and using user interface controls.			x		x					

No.	Course name	Program content	IMAS1	IMAS2	IMAS3	IMAS4	IMAS5	IMAS6	IMAS7	IMAS8	IMAS9	IMAS10
64	Applied Linear Algebra	Presentation of selected linear algebra tools in numerical analysis, theory of differential equations, data analysis and theory of random processes: Jordan form, Dunford-Jordan form, singular value decomposition (SVD), Perron-Frobenius theorem, properties of positive matrices and M-matrices, as well as applications of linear transformations in dynamic and statistical modeling.	x	x				x				
65	Computational Aspects of Functional Inequalities	Numerical verification and visualization of functional inequalities using computational and simulation methods, including the use of Monte Carlo methods to empirically test the validity of selected functional inequalities, such as subadditivity and submultiplicity. Analysis of the concepts of convexity and concavity from the perspective of the minimax theorem. Introduction to stochastic game theory involving functional inequalities, game simulation, and the identification and evaluation of optimal strategies.	x				x	x				

ECTS - subjects

No.	Course name	ECTS	Subjects in the field of humanities and social sciences	Elective subjects	Profile items	Classes in a foreign language
1	Linear Algebra with Elements of Analytic Geometry	7			7	
2	Mathematical Analysis I	11			11	
3	Computer Mathematical Calculations	2				
4	Introduction to Discrete Mathematics and Probability Theory	3			3	
5	Introduction to Logic and Set Theory	7			7	
6	Elements of Engineer Graphics	3		3		
7	Algorithms and Basics of Programming	5				
8	Algebra	5			5	
9	Professional Ethics and Intellectual Property Protection	2	2			
10	Basics of Economics and Entrepreneurship	2	2			
11	English B2 module I	2		2		
12	English B2+ module I	2		2		
13	English C1 module I	2		2		
14	German B2 module I	2		2		
15	Basics of Probability and Measure Theory	6			6	
16	Mathematical Analysis II	5			5	
17	English B2 module II	2		2		
18	English B2+ module II	2		2		
19	English C1 module II	2		2		
20	German B2 module II	2		2		

No.	Course name	ECTS	Subjects in the field of humanities and social sciences	Elective subjects	Profile items	Classes in a foreign language
21	Mathematical Foundations of Data Analysis	6				
22	Mathematical Analysis III	6		6	6	
23	Basics of Statistics	6			6	
24	Introduction to Financial and Insurance Mathematics	5			5	5
25	Discrete Mathematics	5			5	
26	English B2 module III	2		2		
27	English B2+ module III	2		2		
28	English C1 module III	2		2		
29	German B2 module III	2		2		
30	Database Systems	3				
31	Life Insurance Mathematics	4				
32	Estimation and Time Series	6			6	
33	Fundamentals of Functional Analysis	3			3	
34	Mathematical Analysis IV	4			4	
35	Modeling and Valuation of Financial Instruments	3		3		
36	Programming in Data Analysis	5		5		
37	Algorithms of Linear Algebra	3		3		
38	Introduction to Numerical Analysis	5		5		
39	Selected Issues of Measure and Category	3		3		
40	Fundamentals of Cryptography and Information Theory	5		5		
41	Introduction to Differential Equations	4			4	

No.	Course name	ECTS	Subjects in the field of humanities and social sciences	Elective subjects	Profile items	Classes in a foreign language
42	Statistical Hypothesis Testing	4			4	
43	English B2 module IV	3		3		
44	English B2+ module IV	3		3		
45	English C1 module IV	3		3		
46	German B2 module IV	3		3		
47	Introduction to Machine Learning and Artificial Intelligence	4				
48	Life Insurance - Premium Calculation	3		3		
49	Fuzzy Analysis	3		3		
50	Elements of Linear Programming and Operational Research	3		3		
51	Introduction to Nonlinear Optimization with Applications	3		3		
52	Multivariate Data Analysis	3		3		
53	Risk Modeling in Bank and Insurance Activity	4		4	4	
54	Summative Module	8		8		
55	Diploma Seminar	3			3	
56	History and Philosophy of Mathematical Discoveries	2	2			
57	Internship	6				
58	Non-Life Insurance Mathematics	6			6	
59	Final Project	10		10		
60	Heuristic Methods in Optimization Problems	3		3		
61	Selected Issues of Mathematical Statistics	3		3		
62	Selected Issues of Measure and integral	3		3		

No.	Course name	ECTS	Subjects in the field of humanities and social sciences	Elective subjects	Profile items	Classes in a foreign language
63	Fundamentals of Programming in VBA	3		3		
64	Applied Linear Algebra	3		3		
65	Computational Aspects of Functional Inequalities	3		3		

ECTS indicators

Name	Value
The total number of ECTS credits that a student must obtain through elective courses (amounting to no less than 30% of the total ECTS credits required to obtain the qualification corresponding to the given level of study)	54/180 (30%)
The total number of ECTS credits to be earned by a student through courses in the fields of humanities or social sciences	6
The total number of ECTS credits that a student must obtain from courses related to research conducted at the university, amounting to more than 50% of the total ECTS credits required to graduate from a given level of study	100/180 (55.56%)

Methods of verifying and assessing learning outcomes

Verification of the achieved learning outcomes requires the application of diverse forms of student assessment, appropriate to the categories of knowledge, skills, and social competences to which these outcomes relate. The selection of appropriate tools depends on the specifics of the course and the form of instruction, and is specified in the syllabi of individual courses. The achievement of the required learning outcomes is verified through:

1. written assignments (exams, quizzes, reports, essays, projects, posters, thesis, etc.);
2. oral responses (oral knowledge tests, public speaking assignments such as delivering a paper, presentation, etc.);
3. practical and/or project-based tasks (team-based or individual);
4. observation and assessment of student activity during classes;
5. self-assessment and peer assessment (especially in the case of group projects);
6. a competency exam and a diploma examination.

Verification may be formative (conducted partially and repeatedly during the course) and/or summative (final assessment). The final result of the verification is expressed using the currently applicable grading scale.

The course coordinator or instructor is obliged, during the first class, to discuss the course syllabus and to define and formally communicate to students the methods of verification and the conditions under which learning outcomes will be assessed.

Professional internships

The professional internship in the field of applied mathematics lasts 6 weeks. The principles and forms of professional internship are regulated by the relevant Order of the Rector of Lodz University of Technology (currently Order No. 66/2021 of October 29, 2021). Students receive 6 ECTS credits for completing the professional internship.

Characteristics of the course

Graduate profile

Graduates of Applied Mathematics possess advanced mathematical knowledge and analytical skills necessary to solve complex theoretical and practical problems, including those utilizing modern IT tools. They possess a solid foundation in mathematical logic, set theory, discrete mathematics, mathematical analysis, algebra, probability theory, statistics, and elements of computer science and computational techniques, enabling them to pursue graduate studies in mathematics, computer science (including data science), economics, and interdisciplinary fields. Graduates also possess skills in the following areas: • Financial and insurance mathematics – the graduate can analyze selected financial and insurance processes, calculate insurance premiums and reserves, and assess credit risk; • Data analysis and mining – the graduate understands statistical algorithms and methods for extracting knowledge from data and can use database systems and analytical tools. Graduates will also possess initial competencies in artificial intelligence applications, potentially involving these techniques in financial data analysis, insurance risk assessment, and decision-making modeling. They will be able to apply machine learning methods to analyze large data sets and support predictive and optimization processes. Graduates are prepared to work both individually and in teams, including in multidisciplinary environments, including international ones, requiring precision and logical reasoning.

The relationship between the field of study and the university's strategy

The education of students in the applied mathematics program fully aligns with the mission and strategy adopted by Lodz University of Technology, aligning with both its educational goals and the development of cooperation with the economic community. The curriculum was developed taking into account the current needs of the national and regional economies and the actual labor market demand, as confirmed by data obtained from businesses collaborating with the program. Graduates of the applied mathematics program are and will remain in demand in the long-term, further emphasizing the practical dimension of the education implemented within the university's strategy. The Institute of Mathematics creates appropriate conditions for students to comprehensively develop their intellectual abilities, enabling them to acquire the knowledge and skills necessary to undertake interesting and future-oriented careers based on competencies in the application of mathematics. The Institute actively collaborates with the economic community, implementing joint projects and monitoring changing trends and labor market needs, which is consistent with one of Lodz University of Technology's key strategic areas – impact on the socio-economic environment. The main educational concept is based on the outstanding scientific and teaching potential of the Institute of Mathematics and the Faculty of Technical Physics, Computer Science, and Applied Mathematics, of which the Institute is a part. In 2022, Lodz University of Technology once again achieved scientific category A in the discipline of mathematics, which perfectly aligns with the university's mission and promotes the highest level of student education, in line with its strategic assumptions regarding science, innovation, and teaching excellence. The program was designed to place a solid classical mathematical education at the heart of the curriculum, supplemented by two key areas of application: financial and insurance mathematics and mathematical methods of data analysis. The program incorporates active learning methods supported by information technology, enabling students to acquire knowledge and skills in advanced areas of mathematics applications, collaborate with the economic environment, and exchange experiences with other fields of study in Poland and abroad. The Institute of Mathematics has set as one of its strategic goals cooperation in consulting and research and development projects, which also provides ongoing feedback on the current state of the applied mathematics curriculum and job market expectations. All of these activities are fully aligned with the long-term strategy of Lodz University of Technology.

Educational objectives and employment and continuing education opportunities

The most important educational goals in the applied mathematics program are: • Development of advanced mathematical competencies – providing students with a solid theoretical foundation in logic, set theory, mathematical analysis, algebra, probability theory, statistics, and discrete mathematics, necessary for solving complex theoretical and practical problems and for continuing education in second-cycle studies. • Development of analytical and computational skills – preparing students to independently model phenomena, analyze complex processes, and critically evaluate results using modern IT techniques and tools. • Preparation for the application of mathematics in finance, insurance, and data analysis – developing competencies in financial and insurance mathematics, risk analysis, data mining, statistical modeling, and working with databases and analytical tools. • Introduction to artificial intelligence and machine learning methods – equipping students with the theoretical and practical foundations necessary for applying AI techniques in the analysis of large data sets, modeling decision-making processes, forecasting, and optimization. • Development of professional and social competencies – developing individual and teamwork skills, including in interdisciplinary environments, as well as improving the precise and logical formulation of statements, critical thinking, and responsibility for the quality of tasks performed. • Preparation for the practical use of mathematics in a modern technological environment – education in the effective use of IT tools in the application of

selected mathematical methods, including the use of computational software, database systems and programming environments in solving real-world scientific and business problems. Example employment areas: • financial institutions (banks, investment funds, insurance companies), • analytical departments of enterprises and organizations, • consulting firms, • IT sector: data analytics, data engineering. Example job positions: data analyst, financial analyst, insurance specialist, financial advisor, mathematician, statistician, model and analysis specialist, etc. Graduates in Applied Mathematics, thanks to their broad theoretical and practical competencies, are very well prepared to continue their second-cycle studies in mathematics, computer science (including data science), economics, and interdisciplinary fields. The acquired skills in financial and insurance process modeling, risk analysis, data mining, and machine learning applications open the door to specialized second-cycle studies in areas such as actuarial mathematics, econometrics, business analytics, applied statistics, and financial engineering. Thanks to computational skills and experience working with analytical tools, graduates can also pursue fields combining mathematics and computer science.

Description of the process and outcome of consultations on the proposed study program with the socio-economic environment

The Institute of Mathematics has been cooperating for many years with the socio-economic environment, in particular with representatives of the financial, insurance, and data analysis sectors. This cooperation includes periodic consultations and reviews of study programs implemented in the Applied Mathematics degree program.

The first analysis concerning planned modifications to the study program was conducted in November 2024. At that time, the relevance and adequacy of the learning outcomes to labor market needs were confirmed, while also indicating the need to further strengthen students' practical competencies, particularly in the areas of risk modeling and the use of data analysis tools and artificial intelligence. In connection with the implementation of applicable regulations concerning the design and improvement of study programs, further consultations with representatives of the socio-economic environment, representing the financial and data analytics sectors, were carried out in November 2025.

Representatives of the business environment emphasized the high quality of graduates' mathematical preparation and their competency profile, combining elements of applied mathematics, actuarial science, and data analysis. It was indicated that such a profile is particularly valued on the labor market. At the same time, attention was drawn to the need to further strengthen practical competencies by expanding content related to credit risk modeling, statistical methods, and programming using commonly used industry tools (Python, R, SQL). The introduction of content in the field of basic artificial intelligence was also highlighted as justified. In the opinion of stakeholders, it is also important to further increase the practical and business components of the study program, including the development of topics related to the functioning of financial institutions, financial instruments, and risk management processes. Attention was drawn to the importance of the practical application of statistical methods in data analysis and in the construction of decision-making models.

Recommended directions for further program improvement include:

increasing the number of student projects covering the full analytical workflow (from problem identification, through data analysis and model development, to interpretation of results and presentation of conclusions), which strengthens practical competencies and prepares students for project-based work,

expanding the use of real-world case studies illustrating practical applications of the discussed models and tools, in cooperation with the socio-economic environment,

maintaining a balance between actuarial content and data analysis topics, ensuring flexibility of students' professional development paths.

In conclusion, representatives of the socio-economic environment assessed the study program as modern and well aligned with labor market needs, enabling the development of competencies in applied mathematics, data analysis, and risk modeling. The program received a positive evaluation.

Description of competencies expected from a candidate applying for admission to studies

According to the current Recruitment Resolution at the Lodz University of Technology

The unit organizing education

Faculty of Technical Physics, Information Technology and Applied Mathematics

Education program

Semester 1

Course	Number of hours	ECTS points	Form of verification	Obligatory
Linear Algebra with Elements of Analytic Geometry	Tutorials: 30 Lecture: 30	7	Exam	Obligatory
Mathematical Analysis I	Tutorials: 60 Lecture: 60	11	Exam	Obligatory
Computer Mathematical Calculations	Laboratory classes: 30	2	Graded assignment	Obligatory
Introduction to Discrete Mathematics and Probability Theory	Tutorials: 30 Lecture: 15	3	Graded assignment	Obligatory
Introduction to Logic and Set Theory	Tutorials: 30 Lecture: 30	7	Exam	Obligatory
Sum	315	30		

Semester 2

Course	Number of hours	ECTS points	Form of verification	Obligatory
Elements of Engineer Graphics	Project work: 30	3	Graded assignment	Obligatory subjects to choose from
Algorithms and Basics of Programming	Laboratory classes: 30 Lecture: 30	5	Graded assignment	Obligatory
Algebra	Tutorials: 30 Lecture: 30	5	Exam	Obligatory
Professional Ethics and Intellectual Property Protection	Lecture: 30	2	Graded assignment	Obligatory
Basics of Economics and Entrepreneurship	Lecture: 30	2	Graded assignment	Obligatory

Course	Number of hours	ECTS points	Form of verification	Obligatory
Foreign Language Module 1		2	Graded assignment	Obligatory group
The student chooses one module from the group.				
English B2 module I	Tutorials: 30	2	Graded assignment	Optional
English B2+ module I	Tutorials: 30	2	Graded assignment	Optional
English C1 module I	Tutorials: 30	2	Graded assignment	Optional
German B2 module I	Tutorials: 30	2	Graded assignment	Optional
Basics of Probability and Measure Theory	Tutorials: 45 Lecture: 45	6	Exam	Obligatory
Mathematical Analysis II	Tutorials: 30 Lecture: 30	5	Exam	Obligatory
Physical Education 1	Tutorials: 30	0	Pass	Obligatory
Sum	420	30		

Semester 3

Course	Number of hours	ECTS points	Form of verification	Obligatory
Foreign Language Module 2		2	Graded assignment	Obligatory group
The student chooses one module from the group.				
English B2 module II	Tutorials: 30	2	Graded assignment	Optional
English B2+ module II	Tutorials: 30	2	Graded assignment	Optional
English C1 module II	Tutorials: 30	2	Graded assignment	Optional
German B2 module II	Tutorials: 30	2	Graded assignment	Optional
Mathematical Foundations of Data Analysis	Project work: 60	6	Graded assignment	Obligatory

Course	Number of hours	ECTS points	Form of verification	Obligatory
Mathematical Analysis III	Tutorials: 30 Lecture: 45	6	Exam	Obligatory subjects to choose from
Basics of Statistics	Tutorials: 30 Laboratory classes: 15 Lecture: 30	6	Exam	Obligatory
Introduction to Financial and Insurance Mathematics	Tutorials: 30 Lecture: 30	5	Graded assignment	Obligatory
Discrete Mathematics	Tutorials: 30 Lecture: 30	5	Graded assignment	Obligatory
Physical Education 2	Tutorials: 30	0	Pass	Obligatory
Sum	390	30		

Semester 4

Course	Number of hours	ECTS points	Form of verification	Obligatory
Foreign Language Module 3		2	Graded assignment	Obligatory group
The student chooses one module from the group.				
English B2 module III	Tutorials: 30	2	Graded assignment	Optional
English B2+ module III	Tutorials: 30	2	Graded assignment	Optional
English C1 module III	Tutorials: 30	2	Graded assignment	Optional
German B2 module III	Tutorials: 30	2	Graded assignment	Optional
Database Systems	Laboratory classes: 30 Lecture: 15	3	Graded assignment	Obligatory
Life Insurance Mathematics	Tutorials: 30 Lecture: 30	4	Graded assignment	Obligatory

Course	Number of hours	ECTS points	Form of verification	Obligatory
Estimation and Time Series	Tutorials: 30 Laboratory classes: 15 Lecture: 60	6	Graded assignment	Obligatory
Fundamentals of Functional Analysis	Tutorials: 15 Lecture: 30	3	Exam	Obligatory
Mathematical Analysis IV	Tutorials: 30 Lecture: 30	4	Exam	Obligatory
Elective Block 1		8	Graded assignment	Obligatory group
The student chooses 2 courses from the group.				
Modeling and Valuation of Financial Instruments	Tutorials: 15 Lecture: 30	3	Graded assignment	Optional
Programming in Data Analysis	Laboratory classes: 30 Lecture: 30	5	Graded assignment	Optional
Algorithms of Linear Algebra	Project work: 30 Lecture: 15	3	Graded assignment	Optional
Introduction to Numerical Analysis	Project work: 45 Lecture: 15	5	Graded assignment	Optional
Selected Issues of Measure and Category	Tutorials: 15 Lecture: 30	3	Graded assignment	Optional
Fundamentals of Cryptography and Information Theory	Tutorials: 30 Lecture: 30	5	Graded assignment	Optional
Sum	450	30		

Semester 5

Course	Number of hours	ECTS points	Form of verification	Obligatory
Introduction to Differential Equations	Tutorials: 30 Lecture: 30	4	Exam	Obligatory

Course	Number of hours	ECTS points	Form of verification	Obligatory
Statistical Hypothesis Testing	Laboratory classes: 30 Lecture: 15	4	Graded assignment	Obligatory
Foreign Language Module 4		3	Exam	Obligatory group
The student chooses one module from the group.				
English B2 module IV	Tutorials: 30	3	Exam	Optional
English B2+ module IV	Tutorials: 30	3	Exam	Optional
English C1 module IV	Tutorials: 30	3	Exam	Optional
German B2 module IV	Tutorials: 30	3	Exam	Optional
Introduction to Machine Learning and Artificial Intelligence	Laboratory classes: 30 Lecture: 30	4	Graded assignment	Obligatory
Physical Education 3	Tutorials: 30	0	Pass	Obligatory
Elective Block 2		3	Graded assignment	Obligatory group
The student chooses 1 course from the group.				
Life Insurance - Premium Calculation	Project work: 45 Lecture: 15	3	Graded assignment	Optional
Fuzzy Analysis	Tutorials: 30 Lecture: 30	3	Graded assignment	Optional
Elements of Linear Programming and Operational Research	Laboratory classes: 30 Lecture: 30	3	Graded assignment	Optional
Introduction to Nonlinear Optimization with Applications	Tutorials: 30 Lecture: 30	3	Graded assignment	Optional
Multivariate Data Analysis	Laboratory classes: 30 Lecture: 30	3	Graded assignment	Optional
Risk Modeling in Bank and Insurance Activity	Project work: 60	4	Graded assignment	Obligatory subjects to choose from

Course	Number of hours	ECTS points	Form of verification	Obligatory
Summative Module	Project work: 90	8	Graded assignment	Obligatory subjects to choose from
Sum	435	30		

Semester 6

Course	Number of hours	ECTS points	Form of verification	Obligatory
Diploma Seminar	Seminar: 60	3	Graded assignment + exam	Obligatory
History and Philosophy of Mathematical Discoveries	Lecture: 30	2	Graded assignment	Obligatory
Internship	Internship: 0	6	Pass	Obligatory
Non-Life Insurance Mathematics	Tutorials: 45 Lecture: 45	6	Exam	Obligatory
Final Project	Diploma Thesis: 0	10	Pass	Obligatory subjects to choose from
Elective Block 3		3	Graded assignment	Obligatory group
The student chooses 1 course from the group.				
Heuristic Methods in Optimization Problems	Laboratory classes: 30 Lecture: 30	3	Graded assignment	Optional
Selected Issues of Mathematical Statistics	Project work: 45 Lecture: 15	3	Graded assignment	Optional
Selected Issues of Measure and integral	Project work: 45 Lecture: 15	3	Graded assignment	Optional
Fundamentals of Programming in VBA	Laboratory classes: 45 Lecture: 15	3	Graded assignment	Optional
Applied Linear Algebra	Tutorials: 30 Lecture: 30	3	Graded assignment	Optional

Course	Number of hours	ECTS points	Form of verification	Obligatory
Computational Aspects of Functional Inequalities	Laboratory classes: 45 Lecture: 15	3	Graded assignment	Optional
Sum	240	30		