Silesian University of Technology
Faculty of Applied Mathematics

Courses

for

Mathematics

Programme: **Applied Mathematics**

First-cycle, intramural studies
Profile of studies: general academic

Gliwice 2018

Approved by the Council of the Faculty of Applied Mathematics on 12 September 2018

Table of context

1. General characteristic of studies and graduate's profile

a) Major of studies: **Mathematics.**

b) Educational level: **1st cycle**.

c) Educational profile: **general-academic.**

d) Programme of studies: **Applied Mathematics.**

e) Professional degree obtained by the graduate : **bachelor degree** (licencjat).

f) Academic areas: main: **Science,** additional: **Technical science.**

g) Educational effects, assumed for the studies, refer to the following academic areas:

Mathematical science, discipline – **Mathematics** (main),

Technical science, discipline – **Computer Science, Mechanics.**

h) Pre-requisite qualifications (candidate's expected competences):

Candidates must have a secondary school-leaving examination certificate (or an equivalent certificate/diploma) with a sufficiently good examination result in Mathematics. They should also demonstrate the predisposition to the field of the studies and science.

i) Graduate's profile:

The knowledge and experience gained during the studies enable the graduate of Mathematics course for teaching and explanation of mathematical content encountered during the work in the case of different professions and on various positions. The most important skill is the ability for independent, logical reasoning eliminating irrelevant factors and focusing on the essence of the problem. Moreover, the alumni are prepared for independent deepening and broadening of their knowledge.

The graduate has the basic knowledge needed to conduct its own business and after gaining additional teaching certificates has also qualifications and permission to work as a teacher of mathematics and other subjects in the scope of applications of mathematics at all levels of education.

Particularly, after the completion of studies in mathematics the graduate:

- has a broad knowledge of mathematics, including mathematical analysis, algebra, logic and set theory, probability, statistics;
- has the skills of precise formulation of practical problems in the language of mathematics, constructing mathematical models and the skills of constructing algorithms used for solving mathematical problems;
- has the skills of using software tools (especially MATHEMATICA and STATISTICA) in practice;
- has the skills of independent broadening of its knowledge using different sources (e.g. scientific literature, a critical view at Internet resources) and through the collaboration with others, is able to present its own opinions on basic mathematical issues and its applications.

Moreover, students have a significant knowledge and skills in fundamentals of computer programming and databases. Alumnus of Mathematics is very well prepared to

join the work market in fast changing environment, thanks to creativity, openness to new ideas, skills in team-work. Proficiency in English and the knowledge of English scientific and professional terminology allows him to be employed in international companies and in different countries.

2. Educational effects

a) Assumed educational effects:

The educational effects have been elaborated in accordance with the Minister of Science and Higher Education Regulation of 26 September 2016, taking into account the characteristics of the first and second degree for the qualifications on the sixth level of the Polish Qualifications Framework determined in the Act of 22 December 2015 on the Integrated System of Qualifications (Journal of Laws of 2016, No 64, with later amendments).

Key to the symbols:

K1A	–	major educational effects for studies in the 1st cycle of higher education
W	–	knowledge category
U	–	skills category
K	–	social competences category
01, 02 and further	–	number of the educational effect

Major of studies: **Mathematics** Programme: **Applied Mathematics** Educational level: **1st cycle** Educational profile: **general-academic**		
Symbol	Assumed major educational effects	Reference to learning outcomes for area
KNOWLEDGE The student knows and understands		
K1A_W01	well the role and the meaning of proof in mathematics, as well as the significance of assumptions; can use mathematical formalism for constructing and analysis of simple mathematical models in other areas of science.	X1A_W02 X1A_W03
K1A_W02	fundamental theorems of the known branches of mathematics, knows basic examples and counterexamples illustrating definite mathematical notions.	X1A_W01 X1A_W03
K1A_W03	selected notions and methods of mathematical logic, set theory and discrete mathematics that appear in the foundations of other fields of mathematics.	X1A_W01
K1A_W04	foundations of differential and integral calculus of one and many variables, and also other branches of mathematics used in it, with particular attention paid to linear algebra and topology.	X1A_W01

K1A_W05	basic computational techniques and foundations of programming supporting the mathematician's work and understands their limitations, knows at least one software package used for symbolic computations on the basic level.	X1A_W04 X1A_W05
K1A_W06	at least one foreign language on the intermediate level (B2).	X1A_U10 T1A_U06
K1A_W07	the basic rules of industrial safety regulations; has basic knowledge about legal and ethical factors connected with scientific and teaching activities; knows and understands basic notions and rules of protection of industrial property and copyright; can use resources of the patent information; knows general rules of formation and development forms of individual enterprise using the mathematical knowledge.	X1A_W06 X1A_W07 X1A_W08 X1A_W09
K1A_W08	the general laws of physics, physical quantities and fundamental interactions, and rules of conducting and working out the results of physical measurements.	X1A_W02 X1A_W03
K1A_W09	selected applications of mathematics in technology.	T1A_W01 T1A_W03 T1A_W04
K1A_W10	basic methods, techniques and tools used when solving technical problems.	T1A_W07
SKILLS The student can		
K1A_U01	depict in an intelligible way, in speech and writing, the mathematical argumentation, and can formulate theorems and definitions.	X1A_U01 X1A_U06 T1A_U04
K1A_U02	use the sentential calculus and quantifiers; can use correctly quantifiers, also in colloquial language.	X1A_U01
K1A_U03	make easy and average proofs using mathematical induction; can define recurrent functions and relations.	X1A_U01
K1A_U04	apply the classical logic system for formalizing mathematical theories.	X1A_U01
K1A_U05	create new objects using the method of quotient spaces or Cartesian products.	X1A_U01
K1A_U06	apply the language of the set theory when interpreting concepts of various areas of mathematics.	X1A_U01
K1A_U07	operate on the concept of a real number; knows examples of irrational and transcendental numbers.	X1A_U01
K1A_U08	use the notion of convergence and limit in various contexts; can evaluate limits of sequences and functions of basic and average level; can investigate the absolute and the conditional convergence.	X1A_U01 X1A_U02
K1A_U09	interpret and explain relations between the functions, which are expressed in a form of formulae, tables, plots, schemes, and apply them in practical problems.	X1A_U01 X1A_U02 X1A_U03

K1A_U10	use theorems and methods of differential calculus of one and more variable in problems connected with optimization, looking for local and global extreme values, the function complete analysis, and gives precise and accurate justifications of the reasoning.	X1A_U01 X1A_U02 X1A_U03
K1A_U11	evaluate the Riemann integrals of functions of one and many variables; can apply the Fubini theorem; can apply integrals to solve geometric and physical problems.	X1A_U01 X1A_U02 X1A_U03
K1A_U12	integrate functions of one and several variables by parts and by substitution.	X1A_U01 X1A_U02 X1A_U03
K1A_U13	use the definition of an integral of one and many real variables; can explain the analytic and geometric sense of this notion.	X1A_U01 X1A_U02 X1A_U03
K1A_U14	use tools and numerical methods to solve selected problems of differential and integral calculus, also based on applications.	X1A_U02 X1A_U04
K1A_U15	notice the presence of algebraic structures (group, ring, field, linear space) in various mathematical problems, not necessarily directly connected with algebra.	X1A_U01
K1A_U16	evaluate determinants and knows their properties; can give the geometric interpretation of a determinant and understands its connection with mathematical analysis.	X1A_U01
K1A_U17	solve systems of linear equations with constant coefficients; can operate on geometric interpretation of solutions.	X1A_U01
K1A_U18	find the matrices of linear maps in various bases; evaluates eigenvalues and eigenvectors of a matrix; can explain the geometric sense of these notions.	X1A_U01
K1A_U19	reduce the matrices to the canonical form; can apply this skill for solving differential equations with constant coefficients.	X1A_U01
K1A_U20	interpret a system of ordinary differential equations in a geometric language using the notion of a vector field and a phase space.	X1A_U01
K1A_U21	recognize and determine the most important topological properties of subsets of the Euclidean space and metric spaces.	X1A_U01
K1A_U22	recognize the problems, in particular technical ones, that can be solved in an algorithmic way; can construct and analyze an algorithm and implement it in some programming language; can establish its effectiveness.	X1A_U04
K1A_U23	compile, start and test the program written by oneself.	X1A_U04
K1A_U24	use computer programs for data analysis.	X1A_U04
K1A_U25	model and solve discrete problems.	X1A_U01
K1A_U26	operate on the notion of probabilistic space; can use law of total probability and the Bayes theorem; can build and analyze a mathematical model of a random experiment.	X1A_U01
K1A_U27	give various examples of discrete and continuous probability distributions and discuss the chosen random experiments and	X1A_U01

	mathematical models in which these distributions appear; knows practical applications of the basic distributions.	
K1A_U28	determine parameters of discrete and continuous distribution of a random variable; can apply the limit theorems and the large numbers laws to estimate probabilities.	X1A_U01
K1A_U29	use statistical characteristics of a population and their sampling equivalents.	X1A_U02
K1A_U30	make simple statistical inferences, also using computer tools.	X1A_U01 X1A_U04
K1A_U31	tell about mathematical issues in an intelligible, colloquial language.	X1A_U06 X1A_U09
K1A_U32	prepare a paper depicting a specific mathematical problem and ways of solving it, can learn by oneself.	X1A_U05 X1A_U07 X1A_U08 T1A_U05
K1A_U33	analyze and solve simple physical problems on the basis of the known laws and methods of physics and conduct simple physical measurements, and also work out and present in a clear way the results of these measurements.	X1A_U01 X1A_U03
K1A_U34	plan and conduct experiments and computer simulations, interpret the results of these, formulate conclusions and use them for solving various issues, in particular technical ones, especially mechanics.	T1A_U07 T1A_U08 T1A_U09
K1A_U35	prepare an analysis of the problems concerning applications of mathematics.	T1A_U03 T1A_U04
K1A_U36	be able to formulate algorithms and programming them with usage of at least one of popular tools.	T1A_U09 T1A_U14 T1A_U15
K1A_U37	design a simple system or process using appropriate methods, techniques and tools.	T1A_u16
K1A_U38	apply methods and mathematical models for analysis of technical issues and interpret the obtained results.	T1A_U16
K1A_U39	be able to build simple databases, using at least one of the most popular systems managing databases.	T1A_U09 T1A_U16
SOCIAL COMPETENCE The student is prepared to		
K1A_K01	being aware of limitations of one's own knowledge and understanding the need of a further education.	X1A_K01 X1A_K07
K1A_K02	formulating precisely the questions to be used for deepening one's own understanding of a given subject or finding gaps in the reasoning.	X1A_K01 X1A_K02 X1A_U09
K1A_K03	work in a team; understanding the necessity of a systematic work on all projects of a long-term character.	X1A_K02 T1A_K03
K1A_K04	understanding and appreciating the meaning of the intellectual honesty of one's own and other's operations; acting ethically.	X1A_K03 X1A_K04

K1A_K05	understanding the need of a popular presenting the chosen achievements of the modern mathematics to laymen.	X1A_K05 X1A_U08
K1A_K06	searching by oneself for information in the literature, also in foreign languages.	X1A_K01 T1A_U01 T1A_U05
K1A_K07	formulating opinions on the basic mathematical issues.	X1A_K06

3. Study program

Description of the study program was prepared based on the document: Uchwała nr VII/64/16/17 Senatu Politechniki Śląskiej z dnia 27 marca 2017 (document in Polish).

- form of study: **full-time studies**
- number of semesters: **6;** number of ECTS points required to obtain qualify (bachelor degree): **180**
- in the case of a study program for a course assigned to more than one area of study — percentage share of ECTS points for each of these areas in the total number of ECTS credits:

  science area – 70.7%

  technical science area – 29.3%

  The percentage share of ECTS credits was calculated on the basis of the total number of points in both areas of study, without consideration of humanities, economics and social courses as well as foreign languages.

- description of educational modules:

  The description of each module, in addition to its symbol and full name, contains two tables.

  In the table entitled "Subjects included in the module" there are basic information about each course. The meaning of labels for each column is as follows:

  - **code** – abbreviation of the course name (in Polish), used in the next table,
  - **course name** – name of the course according to the program of study,
  - **sem**– the semester number in which the course is pursued,
  - **exam/cred** –rule of the course completion, according to the program of study, where **Exam** means exam and **Cred** means credits,
  - **number of lecture hours** – number of hours of classes for a given course, including: **Σ** (total), **L** (lectures), **C** (classes), **Lab** (laboratories), **Sem** (seminar), **DSem** (diploma seminar), **La** (language classes),
  - **ECTS** points – number of ECTS credits, wherein:
    - **Σ** – total number of ECTS credits earned in the frame of a given course,
    - **K** – number of ECTS credits earned in didactic classes requiring the direct participation of an academic teacher (so called contact hours),
    - **S** – factor S (introduced by: A. Kraśniewski, „How to prepare degree programmes according to requirements following from National Qualification Framework for Higher Education?" (in Polish: „Jak przygotowywać programy kształcenia zgodnie z wymaganiami wynikającymi z Krajowych Ram Kwalifikacji dla Szkolnictwa Wyższego?") (p. 76). Factor S is the sum of the values of the corresponding indicators for all the education

modules that make up this learning program. The value of the factor determining what part of the educational program is implemented in the form of didactic classes requiring the direct participation of academic teachers is determined by dividing S by the number of ECTS assigned to the educational program under consideration,

- **P** - number of ECTS credits earned in practical classes (laboratories, projects),
- **M** – number of ECTS credits earned in the courses connected with the scientific research in the field of mathematical sciences in the discipline of **mathematics**,
- **T** – number of ECTS points assigned to the area of technical sciences in the field of technical sciences in disciplines of computer science, mechanics,
- **O** – number of ECTS credits from general university courses.

The last row of the table contains relevant summaries.

In the table entitled "Learning outcomes for courses and methods of their verification", all the learning outcomes of the module, broken down into the courses covered by this module, are presented, as well as the way the outcomes are verified. The number of pluses in the columns marked with courses codes shows how far the outcome is realized during the course. Learning outcomes which are realized during each course are contained in course descriptions, which are included as the appendix to this Education program. Moreover, Course descriptions are prepared each year and can be found at the website.

Evaluations rules are regulated by the procedure SZJK no. P-RMS-4. A necessary condition for passing a course is to evaluate all learning outcomes included in Course description and Education program. Generally, each learning outcome must be passed which means that the student must get at least 30 percent of points assigned *to* this outcome in the case of written methods of assessment.

It is recommended to use the following evaluation system: The grade is formed based on the points gained (out of a maximum of 100) during classes, tests and exams. The number of points assigned to each category of students' activity will be stated for the course instructor's decision and will be explained during first lecture. The final grade, under additional condition of evaluating all learning outcomes, is given with respect to the following rules:

Number of points	Grade	Grade in ECTS
91 – 100	(5,0)	A
81 – 90	(4,5)	B
71 – 80	(4,0)	C
56 – 70	(3,5)	D
41 – 55	(3,0)	E
0 – 40	(2,0)	F

After consultations with the Dean the course instructor can establish other grading criteria.

Courses and modules

Module: **AM**

Module name: **Mathematical Analysis**

Courses in the module:

Code	Course name	Sem	Exam/ Cred	Number of lecture hours			ECTS points						
				Σ	L	C	Σ	K	S	P	M	T	O
AM1	Mathematical analysis I	1	E	120	60	60	10	4	10	0	10	0	0
AM2	Mathematical analysis II	2	E	120	60	60	10	4	10	0	10	0	0
AM3	Mathematical analysis III	3	E	120	60	60	10	4	10	0	10	0	0
Total				360	180	180	30	12	30	0	30	0	0

Program content within the module:

Real numbers. Basic properties of functions. Elementary functions. Sequences: monotonicity, limit, convergence and divergence. Series: sum, series of nonnegative terms, series of positive and negative terms, convergence, convergence tests. Limit of function. Continuity. Basic properties of continuous functions. Derivatives and differentiable functions. Derivatives of higher orders. Rules of differentiation. Main theorems of differential calculus. Applications of differential calculus. Indefinite integral. Riemann integral and its relation to antiderivative. Applications of integral calculus. Improper integral. Function sequence and series, convergence, convergence tests. Topology of multidimensional Euclidean spaces. Differential calculus of several variables. Applications of differential calculus of several variables. Implicit functions. Lagrange multipliers. Multiple integral: double integral, Fubini's theorem, triple integral, geometrical and technical.

Educational effects and methods of verification:

Educational effect	AM1	AM2	AM3	Method of verification
The student knows and understands				
K1A_W01: well the role and the meaning of proof in mathematics, as well as the significance of assumptions; can use mathematical formalism for constructing and analysis of simple mathematical models in other areas of science.	+	+	+	exam
K1A_W02: fundamental theorems of the known branches of mathematics, knows basic examples and counterexamples illustrating definite mathematical notions.	+	+	+	exam

Educational effect	AM1	AM2	AM3	Method of verification
K1A_W04: foundations of differential and integral calculus of one and many variables, and also other branches of mathematics used in it, with particular attention paid to linear algebra and topology.	++	+++	+++	exam
The student can				
K1A_U01: depict in an intelligible way, in speech and writing, the mathematical argumentation, and can formulate theorems and definitions.		+	+	exam
K1A_U02: use the sentential calculus and quantifiers; can use correctly quantifiers, also in colloquial language.	+	+	+	exam
K1A_U07: operate on the concept of a real number; knows examples of irrational and transcendental numbers.	+++	+	+	exam
K1A_U08: use the notion of convergence and limit in various contexts; can evaluate limits of sequences and functions of basic and average level; can investigate the absolute and the conditional convergence.	++	++	+	exam
K1A_U09: interpret and explain relations between the functions, which are expressed in a form of formulae, tables, plots, schemes, and apply them in practical problems.	+	+		exam
K1A_U10: use theorems and methods of differential calculus of one and more variable in problems connected with optimization, looking for local and global extreme values, the function complete analysis, and gives precise and accurate justifications of the reasoning.	+++		++	exam
K1A_U11: evaluate the Riemann integrals of functions of one and many variables; can apply the Fubini theorem; can apply integrals to solve geometric and physical problems.		++	+++	exam
K1A_U12: integrate functions of one and several variables by parts and by substitution.		+++	+++	exam
K1A_U14: use tools and numerical methods to solve selected problems of differential and integral calculus, also based on applications.			+	exam

Educational effect	AM1	AM2	AM3	Method of verification
K1A_U16: evaluate determinants and knows their properties; can give the geometric interpretation of a determinant and understands its connection with mathematical analysis.			+	exam
K1A_U17: solve systems of linear equations with constant coefficients; can operate on geometric interpretation of solutions.			+	exam
K1A_U19: reduce the matrices to the canonical form; can apply this skill for solving differential equations with constant coefficients.			+	exam
K1A_U20: interpret a system of ordinary differential equations in a geometric language using the notion of a vector field and a phase space.			+++	exam
K1A_U21: recognize and determine the most important topological properties of subsets of the Euclidean space and metric spaces.		++		exam

Module: **AGL**

Module name: **Algebra, geometry and foundations of mathematics**

Courses in the module:

Code	Course name	Sem	Exam/ Cred	Number of lecture hours			ECTS points						
				Σ	L	C	Σ	K	S	P	M	T	O
AL	Linear algebra and analytical geometry	1	E	120	60	60	10	4	10	0	10	0	0
Log	Introduction to logic and set theory	1	C	60	30	30	4	2	4	0	4	0	0
Al1	Algebra I	2	E	60	30	30	5	2	5	0	5	0	0
Al2	Algebra II	3	E	60	30	30	6	2	6	0	6	0	0
Geo	Geometry	4	C	60	30	30	4	2	4	0	4	0	0
Total				360	180	180	29	12	29	0	29	0	0

Program content within the module:

Linear algebra and analytical geometry: Sets of numbers. Groups, fields – examples. Symmetric group. Finite fields. Complex Numbers - operations, geometric interpretation, roots of polynomials. Matrices and matrix operations. Elementary matrix transformations, Gauss elimination method. Determinants and ranks, inverse matrices. Systems of linear equations. Eigenvalues and eigenvectors of matrices. Analytical geometry in 3D space. Vector spaces and subspaces, linear dependency, bases and dimension. Linear transformations, matrix form of linear transformations. Transition matrices, Jordan canonical form.

Introduction to logic and set theory: Sentential and predicate logic. Sets. Relations. Functions. Natural numbers, induction principles. Equinumerosity of sets. Countable and uncountable sets. Ordered sets. Formal theories and rules of inference.

Algebra I: Basics of the number theory. Divisibility, the division algorithm. The Euclid algorithm. Solving Diophantine equations. Modular arithmetic. Solving linear equations in the rings of integers modulo n. Permutations. Cycle decomposition for permutations. Even and odd permutations. Permutation order. Conjugate permutations. Generators of permutation groups. Alternating and dihedral groups. Groups and subgroups. Abelian groups. Cyclic groups. Finite groups. The order of a group. The order of an element of a group. Homomorphisms and isomorphisms of groups. Image and kernel of groups. The Lagrange theorem. The Sylow theorem. Normal subgroups. Quotient subgroups. First isomorphism theorem for groups. Conjugacy in groups, centralizer and center. Theorem about the number of conjugates.

Algebra II: Definition of a ring. Subrings, ideals, quotient rings. Homomorphisms, isomorphisms of rings. Image and kernel of a homomorphism. First isomorphism theorem for rings. Ideals of rings. Matrix rings. Polynomial rings. Ideals of polynomial rings. Zeros of polynomials. Reducibility of polynomials over various rings. Polynomials of several variables. Theorem about symmetric polynomials. Fields. Characteristic of a field. Construction of a finite field. Number fields. Extensions of fields. Algebraic, normal, separable extensions of fields.

Geometry: Axioms of geometry. Selected topics of classical geometry. Non-Euclidean geometries. Ruler-and-compass constructions. Constructive numbers. Isometries of the plane. Rotations, translations, symmetries. Groups of isometries and similarities. Foundations of metric space theory. Topological spaces. Inner product spaces. Orthogonal transformations and matrices. The Gram–Schmidt process. Projection in inner product spaces. Inner product spaces as metric spaces. The method of least squares. Classification of conic sections. Quadric surfaces. Solids of revolution, ruled surfaces, conical surfaces, generalized cylinders. Selected topics of differential geometry of curves. Curvature and torsion of plane curves. The Frenet–Serret formulas.

Educational effects and methods of verification:

Educational effect	AL	Log	Al1	Al2	Geo	Method of verification
The student knows and understands						
K1A_W01: well the role and the meaning of proof in mathematics, as well as the significance of assumptions; can use mathematical formalism for constructing and analysis of simple mathematical models in other areas of science.		++	++	++	+	test, exam
K1A_W02: fundamental theorems of the known branches of mathematics, knows basic examples and counterexamples illustrating definite mathematical notions.	+	+	+	+	+	test, exam
K1A_W03: selected notions and methods of mathematical logic, set theory and discrete mathematics that appear in the foundations of other fields of mathematics.		+++				test
K1A_W04: foundations of differential and integral calculus of one and many variables, and also other branches of mathematics used in it, with particular attention paid to linear algebra and topology.					+	test
The student can						
K1A_U01: depict in an intelligible way, in speech and writing, the mathematical argumentation, and can formulate theorems and definitions.			+	+		exam
K1A_U02: use the sentential calculus and quantifiers; can use correctly quantifiers, also in colloquial language.		+++	+	+		test, exam

Educational effect	AL	Log	Al1	Al2	Geo	Method of verification
K1A_U03: make easy and average proofs using mathematical induction; can define recurrent functions and relations.		++				test
K1A_U04: apply the classical logic system for formalizing mathematical theories.		+	++	++		test, exam
K1A_U05: create new objects using the method of quotient spaces or Cartesian products.		++	+	+		test, exam
K1A_U06: apply the language of the set theory when interpreting concepts of various areas of mathematics.		++	+	+	+	test, exam
K1A_U14: use tools and numerical methods to solve selected problems of differential and integral calculus, also based on applications.	+++				+	test, exam
K1A_U15: notice the presence of algebraic structures (group, ring, field, linear space) in various mathematical problems, not necessarily directly connected with algebra.	+		+	+	++	test, exam
K1A_U16: evaluate determinants and knows their properties; can give the geometric interpretation of a determinant and understands its connection with mathematical analysis.	++					exam
K1A_U17: solve systems of linear equations with constant coefficients; can operate on geometric interpretation of solutions.	+++					exam
K1A_U18: find the matrices of linear maps in various bases; evaluates eigenvalues and eigenvectors of a matrix; can explain the geometric sense of these notions.	+++				+	test, exam
K1A_U19: reduce the matrices to the canonical form; can apply this skill for solving differential equations with constant coefficients.	++					exam
K1A_U21: recognize and determine the most important topological properties of subsets of the Euclidean space and metric spaces.					++	test

Module: **Inf**

Module name: **Computer Science courses**

Courses in the module:

Code	Course name	Sem	Exam/ Cred	Number of lecture hours			ECTS points						
				Σ	L	Lab	Σ	K	S	P	M	T	O
TInf	Information technology	1	C	60	30	30	4	2	4	2	0	4	0
Pr1	Programming I	2	C	60	30	30	4	2	4	2	0	4	0
Pr2	Programming II	3	E	60	30	30	5	2	5	2	0	5	0
Total				180	90	90	13	6	13	6	0	13	0

Program content within the module:

Information technology: Introduction to information technology. Computer essentials. Algorithms. Word processing. LaTeX. Spreadsheets. Computer programming. Networking. Databases. Information Security. IT project management. Management information systems. Other aspects.

Programming I: Syntax of C++. Types, operators, expressions. Arrays. Control blocks. The conditional statement, loops, labels. Functions. Namespaces, static variables, global variables. The header files. A preprocessor directive. Recursion and backtracking. Mathematical functions. Selected math problems in C++. Input-output operations. Error handling. Processing text files and binary. The streams. Memory management functions. Pointers, addresses, subtitles, multidimensional arrays, pointers to functions. Complicated declarations. Structure declarations, unions, bit fields. Dynamic data structures. singly linked list and doubly linked list. Tree structures. Implementation of selected algorithms based on dynamic data structures in C++.

Programming II: The elements of C++ and C++/CLI. Function overloading, function template. The STL library-data types, data operations, containers, iterators. Class and object. Inheritance and polymorphism. Friend functions and virtual function. Virtual inheritance and multiple inheritance. Operators, operator overloading. Constructors and destructors. Pointers to methods. Function objects. Class template. Exception handling. Smart pointers. Analysis of the solutions used in the standard library. Window-based applications.

Educational effects and methods of verification:

Educational effect	TInf	Pr1	Pr2	Method of verification
The student knows and understands				
K1A_W05: basic computational techniques and foundations of programming supporting the mathematician's work and understands their limitations, knows at least one software package used for symbolic computations on the basic level.	+	++	++	project, exam
K1A_W10: basic methods, techniques and tools used when solving technical problems.	+	+	+	project, exam
The student can				
K1A_U22: recognize the problems, in particular technical ones, that can be solved in an algorithmic way; can construct and analyze an algorithm and implement it in some programming language; can establish its effectiveness.	+	++	++	project, exam
K1A_U23: compile, start and test the program written by oneself.		++	++	project, exam
K1A_U24: use computer programs for data analysis.		+	+	project, exam
K1A_U25: model and solve discrete problems.		++	++	project, exam
K1A_U32: prepare a paper depicting a specific mathematical problem and ways of solving it, can learn by oneself.	+	+	+	project
K1A_U36: be able to formulate algorithms and programming them with usage of at least one of popular tools.	++	++	++	project
K1A_U37: design a simple system or process using appropriate methods, techniques and tools.		+	+	project
The student is prepared to				
K1A_K03: work in a team; understanding the necessity of a systematic work on all projects of a long-term character.	+	+	+	project

Module: **Tech**

Module name: **Technical Science subjects**

Courses in the module:

Code	Course name	Sem	Exam/ Cred	Number of lecture hours				ECTS points						
				Σ	L	C	Lab	Σ	K	S	P	M	T	O
ASD	Algorithms and data structures	3	C	60	30	0	30	5	2	5	2	0	5	0
MN	Numerical methods	4	C	60	30	0	30	4	2	4	2	2	2	0
SK	Computer simulations	5	C	60	30	0	30	4	2	4	2	1	3	0
Total				180	90	0	90	13	6	13	6	3	10	0

Program content within the module:

Algorithms and data structures: Basic data structures: list, stack, queue, collection, dictionary, graph, tree, implementation in selected languages. Basic algorithms for sorting, their properties and computational complexity, quick and heap sort. Basic search algorithms have computational complexity, hash. Selected graphing algorithms, including finding the shortest path. Selected geometric algorithms. Study of computational complexity of algorithms, NP-completeness.

Numerical methods: Floating-point arithmetic. Errors in calculations. Conditional assignment. Numerical correctness and stability of the algorithm. Iterative algorithms for nonlinear equations. Algorithms for solving systems of linear equations. Indicator of matrix condition. Interpolation: error, Chebyshev nodes, convergence of the interpolation process. Hermite's interpolation.

Computer simulations: Basic concepts of numerical methods: numerical task, algorithm. Error analysis: absolute and relative error, error propagation. Approach to solving nonlinear equations and their systems: bisecting method, falsi method, secant method, Newton method, simple iteration method. Solving systems of linear equations: Gaussian elimination, general form of iterative methods and its special cases, Jacoby's method and Gauss-Seidel method. Interpolation: formulation of the problem, interpolation using algebraic polynomials, Lagrange interpolation pattern, estimation of interpolation error and convergence of interpolation processes. Interpolation with glued functions (splines). Approximation: formulation of the problem, discrete and integral quadratic approximation. Numeric integration: simple and complex Newton-Cotes square. Methods for solving the initial problems for ordinary differential equations: Euler's method, second order method (Heun method, modified Euler method), Runge-Kutta type methods.

Educational effects and methods of verification:

Educational effect	ASD	MN	SK	Method of verification
The student knows and understands				
K1A_W05: basic computational techniques and foundations of programming supporting the mathematician's work and understands their limitations, knows at least one software package used for symbolic computations on the basic level.		++	++	test
K1A_W09: selected applications of mathematics in technology.		++	++	test, project
K1A_W10: basic methods, techniques and tools used when solving technical problems.	+	+	+	test, project
The student can				
K1A_U03: make easy and average proofs using mathematical induction; can define recurrent functions and relations.	+			test
K1A_U13: use the definition of an integral of one and many real variables; can explain the analytic and geometric sense of this notion.		++		test
K1A_U22: recognize the problems, in particular technical ones, that can be solved in an algorithmic way; can construct and analyze an algorithm and implement it in some programming language; can establish its effectiveness.	++			test
K1A_U24: use computer programs for data analysis.		+	++	test
K1A_U25: model and solve discrete problems.	++			test
K1A_U34: plan and conduct experiments and computer simulations, interpret the results of these, formulate conclusions and use them for solving various issues, in particular technical ones, especially mechanics.		+	++	test
K1A_U35: prepare an analysis of the problems concerning applications of mathematics.		+	++	test
K1A_U36: be able to formulate algorithms and programming them with usage of at least one of popular tools.	++	++		test
K1A_U37: design a simple system or process using appropriate methods, techniques and tools.	++		++	project, test
K1A_U38: apply methods and mathematical models for analysis technical issues and interpret the obtained results.		++	+	test

Module: **PS**

Module name: **Probability and Statistics**

Courses in the module:

Code	Course name	Sem	Exam/ Cred	Number of lecture hours				ECTS points						
				Σ	L	C	Lab	Σ	K	S	P	M	T	O
RP	Probability calculus	4	E	60	30	30		5	2	5	0	5	0	0
WS	Introduction to statistics	5	C	60	30		30	5	2	5	2	5	0	0
Total				120	60	30	30	9	4	10	2	10	0	0

Program content within the module:

Probability calculus: Random experiments. Axioms of probability theory. Conditional and total probability. Bayes' theorem. Discrete and continuous random variables. Cumulative distribution function and probability density function. Review of main probability distributions. Number characteristics of random variables. Mean and variance. Characteristic functions and probability generating functions of random variables. Convergence of random variables. Limits theorems and laws of large numbers. Central Limit Theorem. Introduction to Markov chains.

Introduction to statistics: Methods of sampling, types of data, their organisation, descriptive statistics. Distributions: chi-square, Studend's, Fisher's. Measures of center and variability – estimators, their properties, the Rao-Cramer inequality. Confidence intervals for mean, variance, proportion. Hypothesis testing, the Neyman-Pearson lemma, making decision, errors of type 1 and 2. Selected statistical tests. Correlation and regression line.

Educational effects and methods of verification:

Educational effect	RP	WS	Method of verification
The student knows and understands			
K1A_W01: well the role and the meaning of proof in mathematics, as well as the significance of assumptions; can use mathematical formalism for constructing and analysis of simple mathematical models in other areas of science.		+	project, test
K1A_W02: fundamental theorems of the known branches of mathematics, knows basic examples and counterexamples illustrating definite mathematical notions.	+	+	project, test, exam

Educational effect	RP	WS	Method of verification
The student can			
K1A_U09: interpret and explain relations between the functions, which are expressed in a form of formulae, tables, plots, schemes, and apply them in practical problems.	+	+	project, exam
K1A_U24: use computer programs for data analysis.		+++	project
K1A_U26: operate on the notion of probabilistic space; can use law of total probability and the Bayes theorem; can build and analyze a mathematical model of a random experiment.	+++	+	project, exam
K1A_U27: give various examples of discrete and continuous probability distributions and discuss the chosen random experiments and mathematical models in which these distributions appear; knows practical applications of the basic distributions.	+++	+	project, exam
K1A_U28: determine parameters of discrete and continuous distribution of a random variable; can apply the limit theorems and the large numbers laws to estimate probabilities.	++	+	project, exam
K1A_U29: use statistical characteristics of a population and their sampling equivalents.		+++	project
K1A_U30: make simple statistical inferences, also using computer tools.		+++	project
K1A_U35: prepare an analysis of the problems concerning applications of mathematics.		++	project

Module: **HES**

Module name: **Humanistic – economic – social subjects**

Courses in the module:

Code	Course name	Sem	Exam/ Cred	Number of lecture hours			ECTS points						
				Σ	L	C	Σ	K	S	P	M	T	O
Fil	Philosophy	2	C	60	30	30	5	2	5	0	0	0	5
Ek	Principles of economics	3	C	30	15	15	2	1	2	0	0	0	2
Szk	Training in areas of occupational health and safety, ethics and copyright	1-6	C	6			0	0	0	0	0	0	0
Total				96	45	45	7	3	7	0	0	0	7

Program content within the module:

Philosophy: Philosophy as a science: its concept, division and development. Philosophy and other sciences. Pre-Socratic philosophy. Classical period of philosophy: Socrates', Plato's, Aristotle's views and their significance for the further development of European culture and Philosophy. Christian philosophy. Basic movements of modern philosophy. Basic issues of the Philosophy of Mathematics. The place and importance of philosophical reflection in contemporary culture.

Principles of economics: Basic economics concepts. Scarcity, definitions of economics, economic systems. The Market Mechanizm in Economy. The Elements of Supply and Demend. Elasticities. Government Intervention. The Theory of Enterprises. The Basic Concept of Costs, Income and Profit. Perfect Competition, Monopoly, Monopolistics Competition, Oligopoly. The Financial Market and the Finances of Enterprises. Measurement of National Output and Income. The Circular Flow Model. The Economic Growth. Fiscal Policy, Deficits, and the Government Debt. The Impact on Economy and Enterprises. Money and Commericial Banking. Central Bank Monetary Policy. The Impact on Economy and Enterprises. Unemployment. Causes and Effects. Inflation: Definitions and Costs. International Economics. The European Union – the main problems. Exchange rates. The uses of Economics and Pitfalls in Economics Reasoning. How Markets solve the Basic Economic Problems. Analysis of Supply and Demand: Equilibrium, Effects of Shift in Supply and Demand Curves. Measuring of National Output. Analysis of statistic data on National Output. Solving problems. The Making of Fiscal Policy: Concepts and Trends in Economies today. Solving problems. Current Issues in Monetary Policy: Effectiveness and Targets. Labour. Market Issues. Research on Trends in World Economy Today.

Educational effects and methods of verification:

Educational effect	Fil	Ek	Szk	Method of verification
The student knows and understands				
K1A_W07: the basic rules of industrial safety regulations; has basic knowledge about legal and ethical factors connected with scientific and teaching activities; knows and understands basic notions and rules of protection of industrial property and copyright; can use resources of the patent information; knows general rules of formation and development forms of individual enterprise using the mathematical knowledge.		++	++	test, attendance
The student is prepared to				
K1A_K01: being aware of limitations of one's own knowledge and understanding the need of a further education.	+			Verified by the entity that holds the course
K1A_K02: formulating precisely the questions to be used for deepening one's own understanding of a given subject or finding gaps in the reasoning.	+			
K1A_K06: searching by oneself for information in the literature, also in foreign languages.	+			

Module: **OW**

Module name: **Subjects of the limited choice**

Courses in the module:

Code	Course name	Sem	Exam / Cred	Number of lecture hours			ECTS points						
				Σ	L	C/ Lab*	Σ	K	S	P**	M	T	O
WM1	Monographic lecture I	4	C	60	30	30	5	2	5	3	0	5	0
WM2	Monographic lecture II	4	C	60	30	30	5	2	5	3	0	5	0
WM3	Monographic lecture III	6	C	60	30	30	4	2	4	0-1	4	0	0
Total				180	90	90	14	6	14	6-7	4	10	0

* Total number of hours of labs and laboratories per semester

** depending on the planned hours of laboratories

Students have the right to choose subjects from the list of the subjects annually determined by the Dean of the Faculty. Due to the need to maintain the size limits of groups, the selection is done in the order resulting from the position on the ranking list based on the learning outcomes.

Program content within the specialization module:

Selected issues in contemporary mathematics and computer science. The choice of a specific lecture determines the detailed scope of the content of the course.

Educational effects and methods of verification:

Educational effect	WM1	WM2	WM3	Method of verification
The student knows and understands				
K1A_W01: well the role and the meaning of proof in mathematics, as well as the significance of assumptions; can use mathematical formalism for constructing and analysis of simple mathematical models in other areas of science.	+	+	+	test
K1A_W02: fundamental theorems of the known branches of mathematics, knows basic examples and counterexamples illustrating definite mathematical notions.			+	test
K1A_W09: selected applications of mathematics in technology.	++	++		test
K1A_W10: basic methods, techniques and tools used when solving technical problems.	+	+		test

Educational effect	WM1	WM2	WM3	Method of verification
The student can				
K1A_U01: depict in an intelligible way, in speech and writing, the mathematical argumentation, and can formulate theorems and definitions.			+	test

Module: **Spec**
Module name: **Specialization courses – Applied Mathematics**

Graduates from Applied Mathematics shall possess the knowledge of classical and modern mathematical methods and ways of their implementation in science and economy. They shall be able to use mathematical methods enabling interpretation and analysis of processes taking place in technology and economy, with a special emphasis on banking, insurance and industry. Apart from mathematical training, they shall acquire the knowledge of state-of-the-art IT methods and a wide range of mathematical applications.
Graduates from Applied Mathematics:

- shall be adequately trained to face the challenges related to work in banks, insurance companies and IT departments of any enterprises,
- shall have the chance to obtain national qualifications in professions such as actuarial practice, brokerage in insurance and tax consultancy,
- after obtaining relevant teaching qualifications, they may also work as teachers of mathematics and other mathematics-related subjects at all levels of education,
- they shall be well-prepared to take up post-graduate studies leading to the Master's degree.

Objects within the specialization:

Code	Course name	Sem	Exam/ Cred	Number of lecture hours			ECTS points						
				Σ	L	C/Lab	Σ	K	S	P	M	T	O
PS1	Optimization methods	5	E	60	30	30	5	2	5	0	4	1	0
PS2	Numerical analysis	5	E	60	30	30	5	2	5	1	4	1	0
PS3	Mathematical models in engineering	5	E	60	30	30	5	2	5	3	2	3	0
PS4	Data bases	6	E	60	30	30	5	2	5	3	0	5	0
Total				240	120	120	20	8	20	7	10	10	0

Program content within the specialization module:

Optimization methods : Definitions and concepts connected with mathematical, convex and linear optimization problems. The constraints regularity condition. The Kuhn-Tucker theorem. The Lagrange function for the mathematical programming problem. The dual problem for the convex and linear optimization problems. The duality theorem. Connection between the solutions of the primal and dual problems. Linear programming problem and the methods of its solution (the graphical method, the simplex algorithm). Transportation problem and the transportation algorithm. Selected optimization algorithms for one-variable and multi-variable functions. Selected methods for hyperbolic, integer, binary optimization problems. Selected optimization algorithms of artificial intelligence.

Numerical analysis: Floating-point arithmetic. Errors in calculations. Conditional assignment. Numerical correctness and stability of the algorithm. Iterative algorithms for nonlinear equations. Algorithms for solving systems of linear equations. Indicator of matrix con-

dition. Interpolation: error, Chebyshev nodes, convergence of the interpolation process. Hermite's interpolation.

Mathematical models in engineering: Examples of mathematical models in engineering. Basic concepts of solving ordinary differential equations. Laplace'a transformation. Systems of ordinary differential equations. Linearization. Stability. Chaotic models(logistic map, tent map, Henon map, Lorentz system). Bifurcations. Lyapunov exponent. Invariant density. Basic concepts of signal processing. Fourier series. Fourier transformation. Spectrum analysis.

Data bases: Databases and their construction, SQL (Structured Query Language), the concept of data warehouse and BI (Business Intelligence) tools, BI application in IT. Databases and their types, relational database model, designing relational databases, SQL (simple queries, aggregation functions, condition where, grouping, subqueries, join clause), basics of programing, database application design and implementation, designing simply data warehouse, application of BI (Business Intelligence) tools.

Educational effects and methods of verification:

Educational effect	PS1	PS2	PS3	PS4	Method of verification
The student knows and understands					
K1A_W01: well the role and the meaning of proof in mathematics, as well as the significance of assumptions; can use mathematical formalism for constructing and analysis of simple mathematical models in other areas of science.	+	+	+	+	exam
K1A_W02: fundamental theorems of the known branches of mathematics, knows basic examples and counterexamples illustrating definite mathematical notions.	++	++			exam
The student can					
K1A_U01: depict in an intelligible way, in speech and writing, the mathematical argumentation, and can formulate theorems and definitions.	+	+	+	+	exam
K1A_U38: apply methods and mathematical models for analysis technical issues and interpret the obtained results.			++		exam
K1A_U39: be able to build simple databases, using at least one of the most popular systems managing databases.				+++	exam

Educational effects for specialization module courses:

Educational effect	PS1	PS2	PS3	PS4
The student				
knows mathematical and nonlinear mathematical programming methods.	+++			
can solve the tasks of optimization with given constraints and create models of optimization of technical issues, taking into consideration the criteria.	+++			
knows the theoretical basis of selected numerical methods.		+++		
can construct the appropriate algorithm and implement it on the chosen computing platform.		+++		
knows the ways of modeling various technical issues.			++	
can find the solutions of the obtained equations describing the studied technical issues.			++	
has knowledge in the field of identifying the parameters of the adopted model of the discussed technical issue.			++	
has knowledge of the design and use of databases as a tool for supporting engineering works and technical processes.				+++
knows the basics and principles of database creation and management.				+++

Module: **SW**

Module name: **Subjects of free choice**

Courses in the module:

Code	Course name	Sem	Exam / Cred	Number of lecture hours		ECTS points						
				Σ	L/C/ Lab*	Σ	K	S	P**	M	T	O
PO1	Elective subject I	***	C	60	60	4	2	4	0-2	4	0	0
PO2	Elective subject II		C	60	60	4	2	4	0-2	4	0	0
PO3	Elective subject III		C	60	60	4	2	4	2	0	0	4
Total				180	180	12	6	12	2-6	8	0	4

* Total number of lecture hours, exercises and laboratories (no more than 30 hours of lecture)
** depending on the planned hours of laboratories and projects
*** two courses will be hold in the 5th semester and one in the 6th semester

Students have the right to choose any subject - both on the list of proposals prepared by the staff of the Institute of Mathematics and their own, agreed upon with the selected academic teacher. Due to the need to maintain the size limits of groups, the selection is done in the order resulting from the position on the ranking list based on the learning outcomes.

Program content within the module:

Selected issues in contemporary mathematics and computer science. The choice of a specific subject determines the detailed content of the content of the course.

Educational effects and methods of verification:

Educational effect	PO1	PO2	PO3	Method of verification
The student knows and understands				
K1A_W02: fundamental theorems of the known branches of mathematics, knows basic examples and counterexamples illustrating definite mathematical notions.	++	++		test
The student can				
K1A_U01: depict in an intelligible way, in speech and writing, the mathematical argumentation, and can formulate theorems and definitions.	+	+		test

Educational effect	PO1	PO2	PO3	Method of verification
The student is prepared to				
K1A_K01: being aware of limitations of one's own knowledge and understanding the need of a further education.	+	+	+	test
K1A_K02: formulating precisely the questions to be used for deepening one's own understanding of a given subject or finding gaps in the reasoning.	+	+	+	project, test, lecture (report)
K1A_K06: searching by oneself for information in the literature, also in foreign languages.	+	+	+	project, test, lecture (report)

Module: **PD**

Module name: **Diploma thesis**

Courses in the module:

Code	Course name	Sem	Exam / Cred	Number of lecture hours			ECTS points						
				Σ	Sem	DSem	Σ	K	S	P	M	T	O
Sem	Seminar	5	C	30	30		2	1	2	0	2	0	0
DSem	Diploma Seminar	6	C	45		45	4	2	4	0	4	0	0
PD	Diploma thesis	6	C				9	1	1	0	9	0	0
Total				75	30	45	15	4	7	0	15	0	0

Program content within the module:

In-depth knowledge of selected mathematics areas Ability to search for information in professional literature, subject to critical analysis. Presentation of mathematical and computer science content in a legible and communicative manner in English. Establishing the thesis and the structure of thesis, collecting relevant literature according to the needs - preparing translations of foreign literature, writing computer programs, developing examples.

Educational effects and methods of verification:

Educational effect	Sem	DSem	PD	Method of verification
The student can				
K1A_U31: tell about mathematical issues in an intelligible, colloquial language.	+	+++		lecture (report)
K1A_U32: prepare a paper depicting a specific mathematical problem and ways of solving it, can learn by oneself.	++	++	+++	lecture (report), diploma thesis
K1A_U35: prepare an analysis of the problems concerning applications of mathematics.	+	++	+++	lecture (report), diploma thesis
The student is prepared to				
K1A_K01: being aware of limitations of one's own knowledge and understanding the need of a further education.	++	++	++	lecture (report), diploma thesis

Educational effect	Sem	DSem	PD	Method of verification
K1A_K02: formulating precisely the questions to be used for deepening one's own understanding of a given subject or finding gaps in the reasoning.	++	++		lecture (report)
K1A_K03: work in a team; understanding the necessity of a systematic work on all projects of a long-term character.		+	++	lecture (report), diploma thesis
K1A_K04: understanding and appreciating the meaning of the intellectual honesty of one's own and other's operations; acting ethically.	+	+	++	lecture (report), diploma thesis
K1A_K05: understanding the need of a popular presenting the chosen achievements of the modern mathematics to laymen.	+	+	+	lecture (report), diploma thesis
K1A_K06: searching by oneself for information in the literature, also in foreign languages.	+	++	++	lecture (report), diploma thesis
K1A_K07: formulating opinions on the basic mathematical issues.	++	+++	+	lecture (report), diploma thesis

Module: **Prak**

Module name: **Professional practice**

Courses in the module:

Code	Course name	Sem	Exam/ Cred	Number of lecture hours	ECTS points						
					Σ	K	S	P	M	T	O
PZ	Professional practice	4	C	4 weeks	5	0	0	5	2	3	0

Program content within the module:

Work in a professional environment using modern organizational forms, communication tools, and teamwork tools

Educational effects and methods of verification:

Educational effect	PZ	Method of verification
The student is prepared to		
K1A_K01: being aware of limitations of one's own knowledge and understanding the need of a further education.	++	report
K1A_K02: formulating precisely the questions to be used for deepening one's own understanding of a given subject or finding gaps in the reasoning.	++	report
K1A_K03: work in a team; understanding the necessity of a systematic work on all projects of a long-term character.	++	report
K1A_K04: understanding and appreciating the meaning of the intellectual honesty of one's own and other's operations; acting ethically.	+	report

Module: **Fiz**

Module name: **Physics**

Courses in the module:

Code	Course name	Sem	Exam/ Cred	Number of lecture hours			ECTS points						
				Σ	L	C	Σ	K	S	P	M	T	O
Fiz	General physics	2	C	60	30	30	4	2	4	0	0	0	4

Program content within the module:

General physics: Physics as a science and the basis of technical sciences. Basic physical units and derivatives in the SI system. Kinematics and dynamics of a material point. Forces in nature. Principles and laws of behavior in mechanics. Force in non-commercial systems. Rigid body mechanics elements. Fundamentals of particular relativity. Dilation of time and shortening of Lorentz. Mass and energy of the relativistic particle. Vibrational movement. Harmonic oscillator simple and suppressed. Forced oscillation and resonance phenomenon. Wave motion. Diffraction and wave interference. Packets of waves. The concept of a field on the example of a gravitational field. Properties of electric and magnetic fields. Electromagnetic waves. Corpuscular properties of light. Wave and corpuscular structure of matter. Bohr atom model. Fundamentals of quantum mechanics. Construction and properties of the nuclear nucleus. Fundamentals of nuclear power. Elementary particles. Standard particle model, elementary structure of matter. The rise of the universe.

Educational effects and methods of verification:

Educational effect	Fiz	Method of verification
The student knows and understands		
K1A_W08: the general laws of physics, physical quantities and fundamental interactions, and rules of conducting and working out the results of physical measurements.	+++	Verified by the entity that holds the course (Institute of Physics - Centre for Science and Education)
The student can		
K1A_U33: analyze and solve simple physical problems on the basis of the known laws and methods of physics and conduct simple physical measurements, and also work out and present in a clear way the results of these measurements.	+++	Verified by the entity that holds the course (Institute of Physics - Centre for Science and Education)

Module: **JA**

Module name: **Foreign language**

Courses in the module:

Code	Course name	Sem	Exam / Cred	Number of lecture hours		ECTS points						
				Σ	La	Σ	K	S	P	M	T	O
JA1	Foreign language	1	C	30	30	2	1	2	0	0	0	2
JA2	Foreign language	2	C	30	30	2	1	2	0	0	0	2
JA3	Foreign language	3	C	30	30	2	1	2	0	0	0	2
JA4	Foreign language	4	E	30	30	2	1	2	0	0	0	2
Total				120	120	8	4	8	0	0	0	8

Program content within the module:

Content, vocabulary, communication functions and grammatical structures in accordance with the "European System for Language Education Description" at the level of language proficiency of at least B2 with elements of technical language and consistent with the level of the material.

Educational effects and methods of verification:

Educational effect	JA1	JA2	JA3	JA4	Method of verification
The student knows and understands					
K1A_W06: at least one foreign language on the intermediate level (B2).	+++	+++	+++	+++	Verified by the entity that holds the course (College of Social Sciences and Foreign Philologies), exam in the foregin language at the level B2 (or higher)

Module: **WF**

Module name: **Physical education**

Courses in the module:

Code	Course name	Sem	Exam / Cred	Number of lecture hours		ECTS points						
				Σ	C	Σ	K	S	P	M	T	O
WF1	Physical education	3	Z	30	30	0	0	0	0	0	0	0
WF2	Physical education	4	Z	30	30	0	0	0	0	0	0	0
Total				60	60	0	0	0	0	0	0	0

Program content within the module:

Shaping motivation, recreation, sport skills and physical fitness, while taking into account individual needs and interests supported by the development of human psychophysical skills.

Educational effects and methods of verification:

Educational effect	WF1	WF2	Method of verification
The student			
maintains and improves the good physical fitness.	+++	+++	Verified by the entity that holds the course (Sports Centre)

Matrix of the education effects

Expected effect (symbol)	module												
	AM	AGL	Inf	Tech	PS	HES	OW	Spec	SW	PD	Prak	Fiz	JA
K1A_W01	+	+ +			+		+	+					
K1A_W02	+	+			+		+	+ +	+ +				
K1A_W03		+ + +											
K1A_W04	+ + +	+											
K1A_W05			+ +	+ +									
K1A_W06													+ + +
K1A_W07						+ + +							
K1A_W08												+ + +	
K1A_W09				+ + +			+ +						
K1A_W10			+	+ +			+						
K1A_U01	+	+					+	+	+				
K1A_U02	+	+ + +											
K1A_U03		+ +		+									
K1A_U04		+ + +											
K1A_U05		+ + +											
K1A_U06		+ + +											
K1A_U07	+ + +												
K1A_U08	+ + +												
K1A_U09	+				+ +								
K1A_U10	+ + +												
K1A_U11	+ + +												
K1A_U12	+ + +												
K1A_U13				+ + +									
K1A_U14	+	+ + +											
K1A_U15		+ + +											
K1A_U16	+	+ +											
K1A_U17	+	+ + +											
K1A_U18		+ + +											
K1A_U19	+	+ +											
K1A_U20	+ + +												
K1A_U21	+ +	+ +											
K1A_U22			+ +	+ +									
K1A_U23			+ + +										
K1A_U24			+	+ +	+ + +								
K1A_U25			+ +	+ +									
K1A_U26					+ + +								

Expected effect (symbol)	module												
	AM	AGL	Inf	Tech	PS	HES	OW	Spec	SW	PD	Prak	Fiz	JA
K1A_U27					+ + +								
K1A_U28					+ + +								
K1A_U29					+ + +								
K1A_U30					+ + +								
K1A_U31										+ + +			
K1A_U32			+							+ + +			
K1A_U33												+ + +	
K1A_U34				+ + +									
K1A_U35				+ +	+ +					+ + +			
K1A_U36			+ +	+ +									
K1A_U37			+	+ +									
K1A_U38				+ +				+ +					
K1A_U39								+ + +					
K1A_K01						+			+	+ +	+ +		
K1A_K02						+			+	+ +	+ +		
K1A_K03			+							+ +	+ +		
K1A_K04										+ +	+		
K1A_K05										+ +			
K1A_K06						+			+	+ +			
K1A_K07										+ + +			

Description of the way of evaluation of the educational effects was included in the description of each individual module.

Plan of study cycle

In color are selected elective courses (the specialization courses are colored because studying in Polish the student has a choice between three programmes).

Year I, semester 1

No	Course name	Hours in the week					Hours	Course status				
		L	C/ La	Lab	Sem/ DSem	P		Exam / Cred	ECTS	M	T	O
1	Linear algebra and analytical geometry	4	4				120	E	10	10	0	0
2	Mathematical analysis I	4	4				120	E	10	10	0	0
3	Introduction to logic and set theory	2	2				60	C	4	4	0	0
4	Information technology	2		2			60	C	4	0	4	0
5	Foreign language		2				30	C	2	0	0	2
Total		12	12	2	0	0	390	E2/C3	30	24	4	2

Year I, semester 2

No	Course name	Hours in the week					Hours	Course status				
		L	C/ La	Lab	Sem/ DSem	P		Exam / Cred	ECTS	M	T	O
1	Mathematical analysis II	4	4				120	E	10	10	0	0
2	Algebra I	2	2				60	E	5	5	0	0
3	Programming I	2		2			60	C	4	0	4	0
4	General physics	2	2				60	C	4	0	0	4
5	Philosophy	2	2				60	C	5	0	0	5
6	Foreign language		2				30	C	2	0	0	2
Total		12	12	2	0	0	390	E2/C4	30	15	4	11

Year II, semester 3

No	Course name	Hours in the week					Hours	Course status				
		L	C/ La	Lab	Sem/ DSem	P		Exam / Cred	ECTS	M	T	O
1	Mathematical analysis III	4	4				120	E	10	10	0	0
2	Algebra II	2	2				60	E	6	6	0	0
3	Principles of economics	1	1				30	C	2	0	0	2
4	Algorithms and data structures	2		2			60	C	5	0	5	0
5	Programming II	2		2			60	E	5	0	5	0
6	Foreign language		2				30	C	2	0	0	2
7	Physical education		2				30	C	0	0	0	0
Total		11	11	4	0	0	390	E3/C4	30	16	10	4

Year II, semester 4

No	Course name	Hours in the week					Hours	Course status				
		L	C/ La	Lab	Sem/ DSem	P		Exam / Cred	ECTS	M	T	O
1	Probability calculus	2	2				60	E	5	5	0	0
2	Numerical methods	2		2			60	C	4	2	2	0
3	Geometry	2	2				60	C	4	4	0	0
4	Monographic lecture I	2	2				60	C	5	0	5	0
5	Monographic lecture II	2	2				60	C	5	0	5	0
6	Foreign language		2				30	E	2	0	0	2
7	Physical education		2				30	C	0	0	0	0
8	Professional practice	4 weeks						C	5	2	3	0
Total		11	14	1	0	0	390	E2/C6	30	13	15	2

Year III, semester 5

No	Course name	Hours in the week					Hours	Course status				
		L	C/ La	Lab	Sem/ DSem	P		Exam / Cred	ECTS	M	T	O
1	Introduction to statistics	2		2			60	C	5	5	0	0
2	Computer simulations	2		2			60	C	4	1	3	0
3	Specialization course I (Optimization methods)	2	2				60	E	5	5-3	0-2	0
4	Specialization course II (Numerical analysis)	2	2				60	E	5	5-3	0-2	0
5	Specialization course III (Mathematical models in engineering)	2	2				60	E	5	2-3	3-2	0
6	Elective course I	4					60	C	4	4	0	0
7	Seminar				2		30	C	2	2	0	0
Total		24			2	0	390	E3/C4	30	22	8	0

Year III, semester 6

No	Course name	Hours in the week					Hours	Course status				
		L	C/ La	Lab	Sem/ DSem	P		Exam / Cred	ECTS	M	T	O
1	Specialization course IV (Data bases)	2		2			60	E	5	0	5	0
2	Elective course II	4					60	C	4	4	0	0
3	Elective course III	4					60	C	4	0	0	4
4	Monographic lecture III	4					60	C	4	4	0	0
5	Diploma seminar				3		45	C	4	4	0	0
6	Diploma thesis								9	9	0	0
Total		16			3	0	275	E1/C4	30	21	5	4

Total in 6 semesters		2195	E13/Z25	180	111	46	23

Training in areas of occupational health and safety, ethics and copyright – 6 hours in a study cycle.

According to columns M and T describing the course status in the above tables, the number of ECTS credits connected with education within the field of science, in the discipline of mathematics, is equal to 111 and within the field of technical sciences, in the discipline of

informatics and mechanics, is equal to 46, which give 61.7 and 25.6, respectively, of the total number of ECTS credits. The Faculty of Applied Mathematics conducts the scientific research in the above mentioned disciplines.

The total number of ECTS credits, which the student must gain during courses from social and humanistic sciences: **5**

Measure, form and rules of the student internship with practical profile: **not applicable.**

Education program provides a student internship of length 4 weeks. After the internship each student is obligated to submit the report to the Faculty supervisor of student internships. In this case the student can gain 5 ECTS credits.

Principles of conducting the diploma process

Execution diploma thesis is a prerequisite for completing a first cycle degree.

The diploma process at the first cycle degree has the following form:

- No later than at the 5th semester of study, on the basis of proposals submitted by academic staff with at least a doctorate degree, the Faculty Council of Applied Mathematics approves the thematic scope of thesis. Students, according to the order of the places on the ranking list determined by the average grades, choose the supervisor. Detailed topics of thesis are determined before the end of the 5th semester.
- The diploma seminar, which is included in the 6th semester program of 3 hours per week, is aimed at the proper completion of the thesis.
- The diploma theses are prepared in LaTeX.
- After submitting the thesis, the student is obliged to present it to the supervisor and reviewer.
- The diploma exam, which verifies the selected learning outcomes gained by the student during the course of studies, has an oral form. The detailed scope of the material is determined by the Faculty committee and, after being approved by the Dean, is presented on the website.
- Documents which describes the rules of the diploma process are the following:
    - Studies Regulations at the Silesian University of Technology of 30th of March 2015;
    - Resolution of the Council of the Faculty of Applied Mathematics of 22nd of March 2017.

4. List of the academic teachers forming the minimum academic staff complement for the first cycle of higher education in Mathematics

List of the academic teachers forming the minimum academic staff complement for the first cycle of higher education in Mathematics must be determined till the 30 of June before the start of each academic year belonging to the study period.

5. Additional information

Documentation confirming that the degree programme enables a student to choose educational modules in total number not less than 30% ECTS points.

Degree programme of the first cycle of education in Mathematics enables choice of educational modules in total 33,9% ECTS points. Student decides on a choice of courses within 4 modules. These are: the major module, limited course module, free choice module and degree dissertation module.

Documentation confirming that at least a half of the degree programme is fulfiled as classes with direct contact with academic teachers.

Number of classes with direct contact with academic teachers was evaluated with the use of method from: A. Kraśniewski, „How to prepare degree programmes according to requirements following from National Qualification Framework for Higher Education?" (in polish: „Jak przygotowywać programy kształcenia zgodnie z wymaganiami wynikającymi z Krajowych Ram Kwalifikacji dla Szkolnictwa Wyższego?") (p. 76).

According to module cards the total coefficient S is equal to **167**. Thus **92,8%** of classes requires direct contact with academic teachers.

Analysis of agreement of assumed learning outcomes with the needs of labor market.

On the Faculty of Applied Mathematics meetings with representatives of employers are organized regularly. During these meetings the degree programmes and expectations of graduates applying for a job are analyzed. Employers have underlined repeatedly how important the following attributes of a graduate are: good team work skills, knowledge of various types of works, logical thinking skills. The assumed learning outcomes are aimed at development of these attributes of students major in Mathematics.

The description of a way of including conclusions of analysis of monitoring graudates' professional careers.

The authorities of the Faculty of Applied Mathematics attach a great importance to the cooperation with the Student Carrer Office of the Silesian University of Technology

that monitors graduates' professional lots and employers' needs. Various joint-ventures are organized, e.g. presentations of companies interested in employing graduates, participation in job fairs, meetings with graduates employed in various institutions, courses, trainings etc. Since many years the graduates in Mathematics are appreciated by employers, cooperation between employers' representatives and student self-management are constant inspiration to modernise the degree programme.

Cooperation with the external stakeholders

While preparing the program of studies, conducted at the Faculty of Applied Mathematics, a number of consultation meetings with the external stakeholders were organized. In years 2015-2017 the meetings with the representatives of the following companies took place: SkyTech Research sp. z o.o., BT Skyrise sp. z o.o., LOGOTECH AA S.C., Sap Polska sp. z o.o, MCCOM sp. z o.o., ING Services, BioStat, Kroll Ontrack, Wasko S.A.

During these meetings the program of studies was analyzed and the current trends in technology as well as the expectations and requirements for the graduates applying for job in the mentioned companies were presented. In particular, the following features of the graduates were emphasized as very important for the potential employees: ability of working in a team, familiarity with various working methods, ability of logical thinking.

In result of the consultations a number of agreements were signed, in the framework of which the following general directions for cooperation were formulated: consultation of employees hired in these companies playing the role of external stakeholders, the scope and subjects realized within the selected study modules, compatible with the modern, current standards.

Most of the suggestions and remarks reported by the representatives of the cooperating companies have been included in the study program.

Similar agreements were made also in the previous years with other firms and ventures, among others with ING Bank Śląski, IBM Polska sp. z o.o., FIS-SST sp. z o.o.

Additionally, in 2017 four consultation meetings with the external stakeholders were organized in the subject of necessity for the studies in English. The following companies took a part in these meetings: FIS-SST sp. z o.o., ALM Factory sp. z o.o., Geosolution sp. z o.o., Chanda Innovations sp. z o.o. During the meetings the given below advantages for studying mathematics in English were pointed out: in global world the fluent knowledge of English language is a standard requirement, study in English is a first step for international career, graduates of Applied Mathematics find very often the employment in the IT companies - the documentation in IT industry is in English and most of the IT companies cooperate with the companies from all over the world.