LEARNING OUTCOMES FOR *MATHEMATICS*

studies of first degree; education profile: general academic

<u>Placing the field of *mathematics* within other disciplines</u>
The field of *mathematics* offered by Faculty of Mathematics, Computer Science and Econometrics at the University of Zielona Góra, has been placed within the discipline of Formal Sciences.

Code	Upon successful completion of first degree studies in the field of *mathematics*, students:	Relation to discipline-specific learning outcomes
KNOWLEDGE		
K_W01	understand significance of mathematics and its applications to the development of modern civilization	X1A_W01
K_W02	understand the importance of proof and assumptions in mathematics	X1A_W03
K_W03	know methods of mathematical analysis, linear algebra, probability theory and mathematical statistics, enabling to build models of medium complexity in other branches of science	X1A_W02 X1A_W03
K_W04	know basic theorems of previously studied branches of mathematics	X1A_W01 X1A_W03
K_W05	know basic examples which present mathematical concepts and enable to refute wrong hypotheses or invalid reasoning	X1A_W03
K_W06	know selected concepts and methods of mathematical logic, set theory, discrete mathematics included in fundamentals of other branches of mathematics	X1A_W01
K_W07	know fundamentals of differential and integral calculus of functions of one and many variables; know other branches of mathematics used in the calculus, linear algebra and topology in particular	X1A_W01
K_W08	know fundamentals of computing techniques and programming which help mathematicians to carry out their tasks, and are aware of their limitations	X1A_W04 X1A_W05

K_W09	have basic knowledge of at least one software package used for symbolic calculations	X1A_W05
K_W10	have achieved English language proficiency equivalent to level B2 of European Framework of Reference for Languages and are familiar with specialist terminology from selected branches of mathematics	X1A_W01
K_W11	know principles of occupational health and safety	X1A_W06
K_W12	have basic knowledge of the law and ethics relating to scientific research activities and teaching, as well as to forms of individual entrepreneurship and copyright law	X2A_W07 X2A_W08 X2A_W09
SKILLS		
K_U01	are able to present in a clear manner, both in speech and writing, correct mathematical reasoning, and formulate theorems and definitions	X1A_U01 X1A_U06 X1A_U07
K_U02	demonstrate the ability to use propositional logic and quantifiers, can properly use quantifiers in colloquial language	X1A_U01
K_U03	demonstrate the ability to perform mathematical proofs by complete induction; can define functions and recurrence relations	X1A_U01
K_U04	are able to support mathematical reasoning using simple diagrams, such as Vienna or Hasse diagrams, or graphs	X1A_U01
K_U05	are able to create new objects by means of constructing quotient spaces or Cartesian products	X1A_U01
K_U06	use the language of multiplicity theory to interpret problems relating to different branches of mathematics	X1A_U01
K_U07	understand issues concerning different types of infinity and orders in sets	X1A_U01
K_U08	can use the concept of real number; can give examples of irrational numbers and leap numbers	X1A_U01
K_U09	are able to define functions, also using boundary crossings, and describe their properties	X1A_U01 X1A_U02
K_U10	can use in different contexts the concept of convergence and limit; are able to – on easy and medium difficulty levels – calculate limits of sequences and functions, determine absolute and conditional convergence of series	X1A_U01 X1A_U02
K_U11	can interpret and explain functional dependencies presented in the form of formulae, charts, graphs, schemes and apply them to practical problems	X1A_U01 X1A_U02 X1A_U03

K_U12	can apply theorems and methods of differential calculus of functions of one and many variables to problems relating to optimization, to finding local and global extrema, and to function investigation; can give precise justification of their reasoning	X1A_U01 X1A_U02 X1A_U03
K_U13	can use the definition of an integral of a function of one and many real variables; can explain analytical and geometric sense of the concept	X1A_U01 X1A_U02 X1A_U03
K_U14	can integrate functions of one and many variables by parts and substitution; can change order of integration; can present areas of plane surfaces and volumes in forms of integrals	X1A_U01 X1A_U02 X1A_U03
K_U15	can apply numeric tools and methods to solving selected problems of differential and integral calculus, including those basing on its applications	X1A_U02 X1A_U04
K_U16	use the concepts of linear space, vector, linear transformation, matrix	X1A_U01
K_U17	Notice algebraic structures (group, ring, body, linear space) in different mathematical issues, not necessarily associated directly with algebra	X1A_U01
K_U18	can compute determinants and know their properties; can give a geometric representation of a determinant and understand its relation to mathematical analysis	X1A_U01
K_U19	solve sets of linear equations with constant coefficients; can use geometric interpretation of solutions	X1A_U01
K_U20	find matrices of linear transformations with respect to different bases; computes eigenvalues and eigenvectors of matrices; can explain geometric sense of these concepts	X1A_U01
K_U21	reduce matrices to a canonical form; can use this skill to solve linear differential equations with constant coefficients	X1A_U01
K_U22	are able to interpret a system of ordinary differential equations in the language of geometry by means of vector field and phase space	X1A_U01
K_U23	recognize and determine most important topological properties of subsets of Euclidean space and metric spaces	X1A_U01
K_U24	apply topological properties of sets and functions to solving problems relating to quality	X1A_U01
K_U25	recognize problems, including practical issues, which can be solved using algorithms; can specify this type of problem	X1A_U04
K_U26	can construct and analyze an algorithm in accordance with a specification and write it in a selected programming language	X1A_U04

K_U27	are able to compile, start and test an independently written computer program	X1A_U04
K_U28	are able to use computer programs for data analysis	X1A_U04
K_U29	are able to model and solve discrete problems	X1A_U01
K_U30	use the concept of probabilistic space; are able to construct and analyze a mathematical model of a random experiment	X1A_U01
K_U31	can give various examples of discrete and continuous probability distributions and discuss selected random experiments and mathematical models in which these distributions occur; know practical applications of basic distributions	X1A_U01
K_U32	know how to use formula of total probability and Bayes formula	X1A_U01
K_U33	can identify parameters for the distribution of a discrete and continuous random variable; can apply boundary theorems and law of large numbers to probability evaluation	X1A_U01
K_U34	know how to use statistical characteristics of a population and the equivalent sample	X1A_U02
K_U35	are able to conduct simple statistical inference, also with the use of computer tools	X1A_U01 X1A_U04
K_U36	are able to present mathematical problems and issues in a simple colloquial language	X1A_U06 X1A_U09
K_U37	have acquired English language proficiency in the field of mathematics according to the requirements for level B2 of European Framework of Reference for Languages	X1A_U08 X1A_U09 X1A_U10
K_U38	can write a short paper and deliver an oral presentation, both in English and Polish, relating to previously studied problems; use relevant resources to fulfill the task	X1A_U08 X1A_U09
K_U39	can prepare a longer presentation discussing a selected problem in mathematics and its applications	X1A_U05
SOCIAL COMPETENCES		
K_K01	graduates understand the need for lifelong education	X1A_K01 X1A_K05
K_K02	demonstrate the ability to formulate precise questions to deepen their understanding of a given topic or to find missing elements of reasoning	X1A_K01 X1A_K02
K_K03	can interact and work in a team; understand the need of systematic work on long term projects	X1A_K02 X1A_K03

K_K04	understand the significance of intellectual honesty, both in their own and in other people's activities; demonstrate ethical behavior	X1A_K03 X1A_K04
K_K05	understand the need to popularize selected achievements in the field of higher mathematics	X1A_K05
K_K06	deepen their knowledge and abilities relating to the scope of their interests; are able to obtain information from specialist literature independently, also in foreign languages	X1A_K01 X1A_K07
K_K07	demonstrate the ability to formulate opinions concerning important mathematical issues	X1A_K06