The Faculty of Mathematics and Applied Physics

The Faculty of Mathematics and Applied Physics offers degree at the level of Master of Science (MSc), which requires two years of study including advanced courses and a Master's thesis. All credits cited are according to the European Community Course Credit Transfer System (ECTS).

Plan and programme

of 2nd cycle studies (Master's degree)
at

Applications of Mathematics in Economics

The Master's degree in *Mathematics* (in *Applications of Mathematics in Economics*) has a prescribed duration of two years of full-time study, corresponding to 120 ECTS credits.
The number of contact hours during the studies for a MSc degree is 1250.
A completed Master's degree programme provides graduates with the title Master of Science in Mathematics.
In order to obtain a MSc degree the students are obliged to: complete the subjects included in the programme (120 ECTS credits), prepare and defend a MSc thesis.

The study plan for MSc course at *Applications of Mathematics in Economics* is presented in tables enclosed below. Subjects are described by number of hours per semester (each 15 weeks long) and number of ECTS credits. The letter "Y" in the column "Exam" means that the examination is obligatory.
To grant the professional title of Master of Science it is necessary to complete the study program, to prepare and defend MSc thesis. During a defence of master's thesis the final oral examination is also carried out.

Admission requirements

The BSc or equivalent degree in Mathematics and good English language skills are required. The admission decision will be undertaken by the selection committee.

The study plan for MSc course at *Applications of Mathematics in Economics:*

Semester	Org.Unit	Module	Lecture	Class	Laboratory	Project/ Seminar	Sum of hours	ECTS	Exam
1	FM	Functional analysis I	30	30	0	0	60	5	N
1	FM	Complex Analysis	30	30	0	0	60	6	Y
1	FM	Real functions I	30	30	0	0	60	5	N
1	FM	Higher mathematics	0	30	0	0	30	2	N
1	FM	Securities account	30	30	20	0	80	6	N
1	FM	Topology II	30	30	0	0	60	6	Y
Sum for semester: 1			**150**	**180**	**20**	**0**	**350**	**30**	**2**
2	FM	Functional analysis II	30	30	0	0	60	5	Y
2	FM	Mathematical analysis	30	30	0	0	60	5	Y
2	ZE	Economics	30	30	0	0	60	5	Y
2	FM	Real functions II	30	30	0	0	60	5	Y
2	FM	Higher Mathematics	0	30	0	0	30	2	N
2	FM	Evaluation of effectiveness of investments	30	30	0	0	60	4	N
2	FM	Proseminar	0	30	0	0	30	2	N
2	FM	Monographic lecture I	30	0	0	0	30	2	N
Sum for semester: 2			**180**	**210**	**0**	**0**	**390**	**30**	**4**
3	FM	Differential geometry	30	30	0	0	60	5	Y
3	FM	Probabilistic aspects of financial and insurance mathematics	45	45	0	0	90	5	Y
3	FM	Topic of choice I	30	30	0	0	60	5	N
3	FM	Topic of choice II	30	30	0	0	60	5	N
3	FM	Differential Equations	30	30	0	0	60	5	Y
3	FM	Graduate Seminar	0	0	0	30	30	3	N
3	FM	Monographic lecture II	30	0	0	0	30	2	N
Sum for semester: 3			**195**	**165**	**0**	**30**	**390**	**30**	**3**
4	ZO	Financial	30	30	0	0	60	5	Y

		mathematical analysis							
4	FM	Master thesis	0	0	0	0	0	20	N
4	FM	Graduate Seminar	0	0	0	30	30	3	N
4	FM	Monographic lecture III	30	0	0	0	30	2	N
Sum for semester: 4			**60**	**30**	**0**	**30**	**120**	**30**	**1**
TOTAL FOR ALL SEMESTER:			**585**	**585**	**20**	**60**	**1250**	**120**	**10**

Framework programs
of 2nd cycle studiem (Master's degree)
at
Applications of Mathematics in Economics

Semester 1

1. **Functional analysis I**

   The aim of education is first of all delivery of the honest knowledge from functional analysis. During the classes of this subject, students are instructed to basic structures and methods of proving of theorems, which are applied in this area. Moreover, students to get to know fundamental tools of functional analysis, that are used in modern mathematics.

2. **Complex analysis**

   Get acquainted with the theory of complex functions, understanding some analogues and differences with the theory of real functions of one and two variable. Make the easy using the concepts of complex analysis. The scope of the material concerns the introduction of complex numbers and their interpretation and properties, the concept of the complex functions of a real variable, and their interpretation and application, complex functions of a complex variable, their limits, continuity and derivatives.

3. **Real functions I**

   To familiarize students with the fundamentals of measure theory with particular emphasis on Lebesgue measure.

4. **Higher Mathematics**

   Knowledge mathematical terminology (analysis, algebra).

5. **Securities account**

   To acquaint students with basic types of securities and methods of their valuation.on the Polish market. To familiarize students with short- and long-term securities occurring on the Polish market, such as bills of exchange, Treasury bills, deposit certificates, stocks or bonds,

and methods of their valuation. To talk over methods of portfolio construction based on the expected rate of return and the risk. Moreover, to characterize basic derivatives such as futures contracts, forward contracts, swaps and stock options.

6. **Topology II**

   Teaching students basic topological structures and their fundamental properties of the objects found in geometry and mathematical analysis. Topics discussed in the module: topological spaces, bases and subbases, continuity, homeomorphism, countability, separation axioms, compactness, connectedness, complete metric spaces, deformations, knots, homotopy, fundamental groups.

Semester 2

1. **Functional analysis II**

   Topics discussed in the module: Norms of functional, dual space. Hahn-Banach theorem. Dual spaces of classical sequence and function Banach spaces. Riesz theorem. The second dual space. Reflexivity. Adjoint, Hermitian, unitary operators. Eigenvalues, eigenvectors, spectrum, set of resolvent, resolvent of operator, von Neumann series. Integral operators, the Fredholm integral equations. The spectral theorem for compact operators. Locally convex spaces. Hyperplane separation theorem for convex sets. The Mazur, Alaoglu, Goldstine, Eberlein theorems. Theorems for reflexive spaces. The Banach and Schauder theorems. Examples of applications in theory of differential and integral equations.

2. **Mathematical analysis**

   The concept of double integral. Changing of double integral onto iterative integrals. Triple integral. Changing of triple integral onto iterative integrals. Applications of multiple integrals. Curve integral of a scalar field, its properties and applications. Curve integral of vector field and methods of its evaluating. Green theorem and its applications. The basis of the theory of field: a gradient, a potential, a divergence, a curl and a circulation of the vector field. The concept of the surface integral of a scalar field and of a vector field. Properties surface integrals. Applications of surface integral in the field theory. Gauss-Ostrogradski theorem and Stokes theorem. Differential forms.

3. **Real functions II**

   To familiarize students with the Lebesgue integral and its basic properties, and with profound theorems concerning differentiability almost everywhere and absolute continuity.

4. **Higher Mathematics II**

   Knowledge mathematical terminology of Graph Theory.

5. **Evaluation of effectiveness of investments**

   To familiarize the students with the notion of the financial and physical investment as well as with methods of evaluation of their effectiveness. Upon completion of this module the student should know the indicators and methods (static and dynamic) of evaluate of the effectiveness of the investments.

6. **Proseminar**
   The ability to understand a mathematical text written in German or Spanish.

7. **Monographic lecture I**
   Introduction of the chosen topics of the higher mathematics. The subject of lectures will be chosen by students.

8. **Economics**
   During the Economics course the student is to be familiarized with the basic terms in economics, types of economic systems, subjects, elements, the functioning of markets of goods and services, production factors, market structures and ways of measuring the scope of economic activity, fiscal and monetary politics as well as the phenomena of inflation, unemployment and economic development.

Semester 3

1. **Differential geometry**
   Getting knowledge about the notions and quantities characterizing curves and surfaces. Getting ability of classifying curves and surfaces and determining their geometric invariants such as curvatures**.** The module concerns a theory of spatial curves and surfaces. The theory of curves contains the arclength parameter, the Frenet frame, fundamental theorems and theorems involving invariants. The surface theory leads to determining various curvatures (Gauss, mean, normal curvature) and classifying points of a surface. The Riemanian metric and properties of curves contained in a surface are also studied.

9. **Probabilistic aspects of financial and insurance mathematics**
   Students should have the knowledge and skills of modeling some financial and insurance phenomena by using probabilistic methods.

10. **Topic of choice I**
    Students should choose a topic of general education (non-mathematical) from a list.

11. **Topic of choice II**
    Students should choose a topic of general education (non-mathematical) from a list.

12. **Differential Equations**
    Extension of knowledge about differential equations**.** Training of basic methods of solving systems of ordinary differential equations and research of stability of their solutions. To familiarize students with the fundamentals of theory linear partial differential equations first and second order.

13. **Graduate seminar**
    Preparing for the presentation of the thesis and the final exam.

14. **Monographic lecture II**
    Introduction of the chosen topics of the higher mathematics. The subject of lectures will be chosen by students.

Semester 4

1. **Master thesis**
   Student should write the thesis.

2. **Graduate seminar**
   Preparing for the presentation of the thesis and the final exam.

3. **Monographic lecture III**
   Introduction of the chosen topics of the higher mathematics. The subject of lectures will be chosen by students.

4. **Financial mathematical analysis**
   The subject of research and methods of economic analysis in the enterprise: the essence of the analysis and its role in decision-making. Analysis basic financial reporting documents. Analysis of the profitability of individual business areas and liquidity management in the enterprise.

Applications of Mathematics in Economics

International Program

Program title:	Applications of Mathematics in Economics
School, city:	Rzeszow University of Technology, Rzeszów, Poland
Faculty:	The Faculty of Mathematics and Applied Physics
ECTS points:	120
Duration:	4 semesters
Web page:	
Prerequisites:	BSc Degree in Mathematics
Contact person:	Dorota Jakubczyk, PhD, e-mail: djak@prz.edu.pl
Deadline of application:	20th July or 15th February each year
Fees:	4 x 1750 = 7 000 Euro