

## Subject card

|                                             |                                                                                                                                                                                                                                              |                                                          |                                                                                                                                                                                                                                                                                             |                                     |                                                |            |     |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|------------------------------------------------|------------|-----|
| Subject name and code                       | Mathematical Applications in Economics and Management, PG_00169726                                                                                                                                                                           |                                                          |                                                                                                                                                                                                                                                                                             |                                     |                                                |            |     |
| Field of study                              | Economics                                                                                                                                                                                                                                    |                                                          |                                                                                                                                                                                                                                                                                             |                                     |                                                |            |     |
| Date of commencement of studies             | October 2025                                                                                                                                                                                                                                 |                                                          | Academic year of realisation of subject                                                                                                                                                                                                                                                     |                                     | 2025/2026                                      |            |     |
| Education level                             | Bachelor's studies                                                                                                                                                                                                                           |                                                          | Subject group                                                                                                                                                                                                                                                                               |                                     | Obligatory subject group in the field of study |            |     |
| Mode of study                               | part-time studies                                                                                                                                                                                                                            |                                                          | Mode of delivery                                                                                                                                                                                                                                                                            |                                     | at the university                              |            |     |
| Year of study                               | 1                                                                                                                                                                                                                                            |                                                          | Language of instruction                                                                                                                                                                                                                                                                     |                                     | Polish                                         |            |     |
| Semester of study                           | 1                                                                                                                                                                                                                                            |                                                          | ECTS credits                                                                                                                                                                                                                                                                                |                                     | 5.0                                            |            |     |
| Learning profile                            | academic                                                                                                                                                                                                                                     |                                                          | Assessment form                                                                                                                                                                                                                                                                             |                                     |                                                |            |     |
| Conducting unit                             | Department of Microeconomics -> Faculty of Economics -> Rector                                                                                                                                                                               |                                                          |                                                                                                                                                                                                                                                                                             |                                     |                                                |            |     |
| Name and surname of lecturer (lecturers)    | Subject supervisor                                                                                                                                                                                                                           |                                                          | dr hab. Leszek Czerwonka                                                                                                                                                                                                                                                                    |                                     |                                                |            |     |
|                                             | Teachers                                                                                                                                                                                                                                     |                                                          |                                                                                                                                                                                                                                                                                             |                                     |                                                |            |     |
| Lesson types                                | Lesson type                                                                                                                                                                                                                                  | Lecture                                                  | Tutorial                                                                                                                                                                                                                                                                                    | Laboratory                          | Project                                        | Seminar    | SUM |
|                                             | Number of study hours                                                                                                                                                                                                                        | 20.0                                                     | 0.0                                                                                                                                                                                                                                                                                         | 0.0                                 | 0.0                                            | 0.0        | 20  |
|                                             | E-learning hours included: 0.0                                                                                                                                                                                                               |                                                          |                                                                                                                                                                                                                                                                                             |                                     |                                                |            |     |
| Learning activity and number of study hours | Learning activity                                                                                                                                                                                                                            | Participation in didactic classes included in study plan |                                                                                                                                                                                                                                                                                             | Participation in consultation hours |                                                | Self-study | SUM |
|                                             | Number of study hours                                                                                                                                                                                                                        | 20                                                       |                                                                                                                                                                                                                                                                                             | 7.0                                 |                                                | 98.0       | 125 |
| Subject objectives                          | Introducing students to the fundamentals of higher mathematics and its applications in economics and management.                                                                                                                             |                                                          |                                                                                                                                                                                                                                                                                             |                                     |                                                |            |     |
| Learning outcomes                           | Course outcome                                                                                                                                                                                                                               |                                                          | Subject outcome                                                                                                                                                                                                                                                                             |                                     | Method of verification                         |            |     |
|                                             | [EKONL3_K05] correctly identifies, diagnoses and resolves professional dilemmas and different options for solutions                                                                                                                          |                                                          | The student correctly identifies, diagnoses and resolves dilemmas and different options for solutions, related to the profession, using mathematical methods.                                                                                                                               |                                     | [SK4] test/exam - oral or written              |            |     |
|                                             | [EKONL3_U04] can predict and forecast the course of economic and social processes and phenomena                                                                                                                                              |                                                          | The student is able to predict the course of economic and social processes and phenomena and forecast these phenomena, using mathematical methods.                                                                                                                                          |                                     | [SU4] test/exam - oral or written              |            |     |
|                                             | [EKONL3_U02] is able to use the knowledge of theory and data to analyse concrete economic and social processes and phenomena and to analyse these phenomena using methods developed in economics, finance and management sciences            |                                                          | The student is able to use his/her theoretical knowledge and acquire data to analyse particular economic and social processes and phenomena, and to analyse these phenomena using methods developed in economics, finance and management sciences in conjunction with mathematical methods. |                                     | [SU4] test/exam - oral or written              |            |     |
|                                             | [EKONL3_W06] have an advanced knowledge of selected methods and tools, including statistical and econometric techniques, for describing economic agents and structures as well as social institutions and the processes taking place in them |                                                          | The student is acquainted, to an advanced degree, with selected methods and mathematical tools enabling him/her to describe economic entities and organisations as well as public institutions and the processes occurring in them.                                                         |                                     | [SW4] test/exam - oral or written              |            |     |

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| Subject contents                                                                                             | 1. Matrix algebra                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |
|                                                                                                              | Matrix operations, basic properties of determinants, finding the inverse matrix, Cramer's formula, application to market and national income models (matrix notation and model solution)                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |
|                                                                                                              | 2. Sequences and series                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |
|                                                                                                              | Concept of a numerical sequence, arithmetic and geometric sequences, convergence of a sequence, operations on the limits of sequences, concept of a numerical series, sum of a series, application to the calculation of the present value of cash flows (elements of financial mathematics)                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |
|                                                                                                              | 3. Functions of one and many variables                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |
|                                                                                                              | Basic elementary functions, graph of a function, inverse representation, monotonicity, limit of a function, continuity of a function, convexity and concavity of a function                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |
|                                                                                                              | 4. Elements of differential calculus                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |
|                                                                                                              | Rules of differentiation for functions of one variable, local extrema of functions of one variable, elasticity of functions, marginal calculus, maximisation of economic result, rules of differentiation for functions of many variables, optimisation of functions of many variables, conditional extremum, minimisation of costs by Lagrange multipliers method |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |
| Prerequisites and co-requisites                                                                              | 5. Integral calculus                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |
|                                                                                                              | Concept of primary function, definite and indefinite integral, method of integration by parts, method of integration by substitution, applications in marginal calculus and financial mathematics                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |
|                                                                                                              | 6. Difference and differential equations                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |
|                                                                                                              | First order difference equations, cobweb model, differential equations, application of differential equations in economic growth models.                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |
| In order to develop the concepts discussed during the lectures, students can take advantage of consultations |                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |
| Knowledge and skills in secondary school mathematics.                                                        |                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |
| Assessment methods and criteria                                                                              | Subject passing criteria                                                                                                                                                                                                                                                                                                                                           | Passing threshold                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Percentage of the final grade |
|                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                    | 51.0%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 100.0%                        |
| Recommended reading                                                                                          | Basic literature                                                                                                                                                                                                                                                                                                                                                   | 1. Babula E., Czerwonka L. (red.), Zastosowanie matematyki w ekonomii i zarządzaniu, Wydawnictwo Uniwersytetu Gdańskiego, Gdańsk 2015.<br>2. Blajer-Golebiewska A., Czerwonka L., Pankau E., Zielenkiewicz M., Ekonomia matematyczna w zadaniach, red. T. Kamińska, Wyd. UG, Gdańsk 2010.                                                                                                                                                                                                                                                                                                                                                                                                                      |                               |
|                                                                                                              | Supplementary literature                                                                                                                                                                                                                                                                                                                                           | 1. Czerwonka L., Matematyczne modele połączeń przedsiębiorstw uwzględniające czynniki menedżerskie, "Pieniądze i Więź. Kwartalnik Naukowy", 2009, nr 3, s. 81-88.<br>2. Czerwonka L., Zastosowanie matematycznych modeli fuzji egzogenicznych, "Pieniądze i Więź. Kwartalnik Naukowy", 2008, nr 1, s. 133-140.<br>3. Chiang A.C., Podstawy ekonomii matematycznej, PWE, Warszawa 1994.<br>4. Małłoka M., Matematyka dla ekonomistów, Wyd. AE w Poznaniu, Poznań 2008.<br>5. Ostoja-Ostaszewski A., Matematyka w ekonomii. Modele i metody t. 1 i 2, Wydawnictwo Naukowe PWN, Warszawa 2006.<br>6. Piszczala J., Matematyka i jej zastosowanie w naukach ekonomicznych, Wydawnictwo AE w Poznaniu, Poznań 2008. |                               |
|                                                                                                              | eResources addresses                                                                                                                                                                                                                                                                                                                                               | Adresy na platformie eNauczanie:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                               |
| Example issues/<br>example questions/<br>tasks being completed                                               | The determinant of matrix of order $(n-1)$ obtained by deleting row $i$ and column $j$ of matrix $A$ of order $n$ is called ...                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |

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| Work placement | Not applicable |
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