

## Subject card

|                                             |                                                                                                                                                                                                                                                                                                                           |                                                          |                                                                                                                                                                                                                                                                               |                                     |                                                                                                                      |            |     |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|----------------------------------------------------------------------------------------------------------------------|------------|-----|
| Subject name and code                       | Linear Algebra I, PG_00189364                                                                                                                                                                                                                                                                                             |                                                          |                                                                                                                                                                                                                                                                               |                                     |                                                                                                                      |            |     |
| Field of study                              | Mathematical Modeling and Data Analysis                                                                                                                                                                                                                                                                                   |                                                          |                                                                                                                                                                                                                                                                               |                                     |                                                                                                                      |            |     |
| Date of commencement of studies             | October 2026                                                                                                                                                                                                                                                                                                              |                                                          | Academic year of realisation of subject                                                                                                                                                                                                                                       |                                     | 2026/2027                                                                                                            |            |     |
| Education level                             | Bachelor's studies                                                                                                                                                                                                                                                                                                        |                                                          | Subject group                                                                                                                                                                                                                                                                 |                                     | Obligatory subject group in the field of study<br>Subject group related to scientific research in the field of study |            |     |
| Mode of study                               | full-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                                                                                                                                                                                                                                                               |                                     | exam                                                                                                                 |            |     |
| Conducting unit                             |                                                                                                                                                                                                                                                                                                                           |                                                          |                                                                                                                                                                                                                                                                               |                                     |                                                                                                                      |            |     |
| Name and surname of lecturer (lecturers)    | Subject supervisor                                                                                                                                                                                                                                                                                                        |                                                          | dr hab. Michał Stukow                                                                                                                                                                                                                                                         |                                     |                                                                                                                      |            |     |
|                                             | Teachers                                                                                                                                                                                                                                                                                                                  |                                                          | dr hab. Michał Stukow                                                                                                                                                                                                                                                         |                                     |                                                                                                                      |            |     |
| Lesson types                                | Lesson type                                                                                                                                                                                                                                                                                                               | Lecture                                                  | Tutorial                                                                                                                                                                                                                                                                      | Laboratory                          | Project                                                                                                              | Seminar    | SUM |
|                                             | Number of study hours                                                                                                                                                                                                                                                                                                     | 30.0                                                     | 30.0                                                                                                                                                                                                                                                                          | 0.0                                 | 0.0                                                                                                                  | 0.0        | 60  |
|                                             | 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                                                                                                                                                                                                                                                                                                     | 60                                                       |                                                                                                                                                                                                                                                                               | 3.0                                 |                                                                                                                      | 62.0       | 125 |
| Subject objectives                          | The aim of the course is to familiarize students with the methods and theorems of linear algebra and with selected concepts of general algebra.                                                                                                                                                                           |                                                          |                                                                                                                                                                                                                                                                               |                                     |                                                                                                                      |            |     |
| Learning outcomes                           | Course outcome                                                                                                                                                                                                                                                                                                            |                                                          | Subject outcome                                                                                                                                                                                                                                                               |                                     | Method of verification                                                                                               |            |     |
|                                             | [MMiADL3_W06] knows and understands the role and importance of proof in mathematics, as well as the concept of the importance of assumptions                                                                                                                                                                              |                                                          | The student is able to formulate and verify theorems in the area of linear algebra and selected topics of general algebra, carrying out correct and logically consistent proofs and consciously analyzing the significance and necessity of the assumptions made.             |                                     | [SW4] test/exam - oral or written                                                                                    |            |     |
|                                             | [MMiADL3_W03] knows and understands selected concepts, methods and theorems of linear algebra and analytic geometry, as well as basic examples both illustrating specific concepts in this field and allowing to refute false hypotheses or invalid reasoning; knows and understands selected concepts of general algebra |                                                          | The student knows and understands the concepts, methods and theorems within the scope of the program content presented during the lecture, and is able to use examples and counterexamples to illustrate these concepts and verify the correctness of mathematical reasoning. |                                     | [SW4] test/exam - oral or written                                                                                    |            |     |
|                                             | [MMiADL3_U03] is able to correctly use the concepts of linear algebra and analytic geometry, is able to apply the theorems and methods of these fields and is able to interpret the obtained results; correctly uses the learned concepts of general algebra                                                              |                                                          | The student is able to use concepts from the curriculum content to solve computational and proof tasks, as well as draw correct conclusions from the obtained results in a mathematical context.                                                                              |                                     | [SU4] test/exam - oral or written<br>[SU6] demonstration of practical skills                                         |            |     |

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|----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| Subject contents                                               | 1. Field of complex numbers, geometric interpretation and trigonometric form of complex numbers, roots of complex numbers.2. Cartesian product of sets and the construction of Euclidean spaces $\mathbb{R}^n$ . Elements of analytical geometry, operations on vectors, equations of lines and planes, basic properties of the dot product. 3. Systems of linear equations and methods of solving them - Gauss-Jordan elimination method.4. Matrices and operations on them. Inverse matrix and algorithm for determining the inverse matrix. Matrix equations and their relationship with systems of linear equations.5. The concept of abstract linear space over a field. Linear independence of vectors, linear subspaces generated by vector systems, basis and dimension of a linear space. Rank of a system of vectors, rank of a matrix. Rank calculation methods and applications.6. Matrix determinant. Properties and methods of calculating determinants. Applications of determinants. |                                                                                                                                                                                                                                                                                                                        |                               |
| Prerequisites and co-requisites                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                        |                               |
| Assessment methods and criteria                                | Subject passing criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Passing threshold                                                                                                                                                                                                                                                                                                      | Percentage of the final grade |
|                                                                | quizzes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 51.0%                                                                                                                                                                                                                                                                                                                  | 30.0%                         |
|                                                                | egzam                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 51.0%                                                                                                                                                                                                                                                                                                                  | 40.0%                         |
|                                                                | observation of the student's attitude                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 51.0%                                                                                                                                                                                                                                                                                                                  | 0.0%                          |
|                                                                | test                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 51.0%                                                                                                                                                                                                                                                                                                                  | 30.0%                         |
| Recommended reading                                            | Basic literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <ul style="list-style-type: none"><li>J. Topp, Algebra liniowa, Wyd. PG, Gdańsk 2005.</li><li>J. Rutkowski, Algebra liniowa w zadaniach, PWN , 2008.</li></ul>                                                                                                                                                         |                               |
|                                                                | Supplementary literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <ul style="list-style-type: none"><li>A. Białynicki-Birula, Algebra liniowa z geometrią, PWN W-wa, 1976</li><li>G. Banaszak, W. Gajda, Elementy algebry liniowej (cz. I i II) Wyd. Naukowo-Techniczne, Warszawa, 2002</li><li>Zbiór zadań z algebry, praca zbiorowa pod red. A.I. Kostrikin, PWN W-wa, 1995.</li></ul> |                               |
|                                                                | eResources addresses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                        |                               |
| Example issues/<br>example questions/<br>tasks being completed | Not applicable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                        |                               |
| Work placement                                                 | Not applicable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                        |                               |

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