

## Subject card

|                                             |                                                                                                                                                          |                                                          |                                         |                                     |                                                |            |     |
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| Subject name and code                       | Algebra I, PG_00155399                                                                                                                                   |                                                          |                                         |                                     |                                                |            |     |
| Field of study                              | Mathematics                                                                                                                                              |                                                          |                                         |                                     |                                                |            |     |
| Date of commencement of studies             | October 2025                                                                                                                                             |                                                          | Academic year of realisation of subject |                                     | 2026/2027                                      |            |     |
| Education level                             | Bachelor's studies                                                                                                                                       |                                                          | Subject group                           |                                     | Obligatory subject group in the field of study |            |     |
| Mode of study                               | full-time studies                                                                                                                                        |                                                          | Mode of delivery                        |                                     | at the university                              |            |     |
| Year of study                               | 2                                                                                                                                                        |                                                          | Language of instruction                 |                                     | Polish                                         |            |     |
| Semester of study                           | 3                                                                                                                                                        |                                                          | ECTS credits                            |                                     | 5.0                                            |            |     |
| Learning profile                            | academic                                                                                                                                                 |                                                          | Assessment form                         |                                     | exam                                           |            |     |
| Conducting unit                             | Institute of Mathematics -> Faculty of Mathematics, Physics and Informatics -> Rector                                                                    |                                                          |                                         |                                     |                                                |            |     |
| Name and surname of lecturer (lecturers)    | Subject supervisor                                                                                                                                       |                                                          | dr hab. Andreas Zastrow                 |                                     |                                                |            |     |
|                                             | Teachers                                                                                                                                                 |                                                          |                                         |                                     |                                                |            |     |
| 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                                                       |                                         | 5.0                                 |                                                | 60.0       | 125 |
| Subject objectives                          | Learning basic algebraic concepts: rings and ideals, as well as theorems describing the properties of these concepts and the relationships between them. |                                                          |                                         |                                     |                                                |            |     |

| Learning outcomes | Course outcome                                                                                                                                                                                                                                                                    | Subject outcome                                                                                                                                                                                                                                                                | Method of verification                                                       |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|
|                   | [MATL3_K01] is ready to accept the limitations of his/her own knowledge and understands the need for further education                                                                                                                                                            | is ready to acknowledge the limitations of one's own knowledge and understand the need for further education, is ready to independently expand algebraic knowledge based on existing textbooks devoted to more advanced content                                                | [SK8] observation of student's independent or team work                      |
|                   | [MATL3_W09] knows and understands the role and importance of proof in mathematics, as well as the concept of the importance of assumptions                                                                                                                                        | knows and understands the role and importance of proof in mathematics, as well as the concept of the importance of assumptions                                                                                                                                                 | [SW4] test/exam - oral or written                                            |
|                   | [MATL3_U01] is able to correctly use the known concepts of mathematical logic and set theory, is able - at a simple and medium level of difficulty - to apply the known theorems and methods of these fields and is able to interpret the obtained results                        | can correctly use the concepts of mathematical logic and set theory in an algebraic context: equivalence relations and their classes, Cartesian products, binary operations                                                                                                    | [SU4] test/exam - oral or written<br>[SU6] demonstration of practical skills |
|                   | [MATL3_K02] is ready to precisely formulate questions to deepen his/her own understanding of a given topic or to find missing elements of reasoning                                                                                                                               | is ready to precisely formulate questions to deepen his/her understanding of algebra, or finding the missing elements for some reasoning                                                                                                                                       | [SK1] oral statement/conversation/discussion                                 |
|                   | [MATL3_K09] is ready to critically evaluate arguments, find gaps in reasoning and constructively criticize other people's reasoning                                                                                                                                               | is ready to critically evaluate arguments, find gaps in algebraic reasoning and constructively criticize other people's reasoning                                                                                                                                              | [SK1] oral statement/conversation/discussion                                 |
|                   | [MATL3_U03] is able to correctly use the acquired concepts of linear algebra and geometry, is able - at a simple and medium level of difficulty - to apply the known theorems and methods in these fields and is able to interpret the obtained results                           | can correctly use the concepts of linear algebra and geometry in an algebraic context: algebraic structures related to vector spaces, algebraic structures related to geometric transformations)                                                                               | [SU4] test/exam - oral or written<br>[SU6] demonstration of practical skills |
|                   | [MATL3_W08] knows and understands the structure of mathematical theories, is able to use mathematical formalism to build and analyze simple mathematical models in other fields of science                                                                                        | knows and understands the structure of mathematical theories, is able to use mathematical formalism to build and analyze simple mathematical models in other fields of science                                                                                                 | [SW1] oral statement/conversation/discussion                                 |
|                   | [MATL3_U04] is able to correctly use the acquired concepts of general algebra, is able - at a simple and medium level of difficulty - to apply the known theorems and methods of these fields and is able to interpret the obtained results                                       | is able to correctly use the acquired concepts of general algebra (groups, homomorphisms, kernels), is able - at a simple and medium level of difficulty - to apply the known theorems and methods in these fields and is able to interpret the obtained results               | [SU4] test/exam - oral or written<br>[SU6] demonstration of practical skills |
|                   | [MATL3_U09] is able to plan how to solve a specific problem and prepare a correct record of this solution, providing strict and precise justification for the correctness of his reasoning                                                                                        | is able to plan a way to solve a specific problem and prepare a correct record of this solution, providing strict and precise justification for the correctness of his reasoning, is able to indicate or construct examples of algebraic objects that meet specific properties | [SU4] test/exam - oral or written                                            |
|                   | [MATL3_W03] knows and understands the basic concepts, methods and theorems of linear algebra and analytical geometry, as well as basic examples both illustrating specific concepts in these fields and enabling the refutation of erroneous hypotheses or unauthorized reasoning | knows and understands the concepts of linear algebra and geometry in the algebraic context: algebraic structures related to vector spaces, algebraic structures related to geometric transformations                                                                           | [SW1] oral statement/conversation/discussion                                 |
|                   | [MATL3_K04] is ready to understand and appreciate the importance of intellectual honesty in one's own and other people's actions; is willing to act ethically                                                                                                                     | is willing to understand and appreciate the importance of intellectual honesty in his own and other people's actions; ethical conduct                                                                                                                                          | [SK8] observation of student's independent or team work                      |

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|                                                                | Course outcome                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Subject outcome                                                                                                                                                                                                                                                                                                                                                                                                                                       | Method of verification                                                       |
|                                                                | [MATL3_U08] is able to formulate definitions and theorems in an understandable way, both orally and in writing, and present correct mathematical reasoning regarding the acquired issues                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | is able to formulate definitions and theorems in an understandable way, both verbally and in writing, and present correct mathematical reasoning regarding the acquired issues, is able to examine its properties for a given object, for example whether the ideal is principal, maximal or prime and whether a given mapping is a homomorphism or epimorphism, monomorphism or isomorphism, can decide whether two algebraic objects are isomorphic | [SU4] test/exam - oral or written<br>[SU6] demonstration of practical skills |
|                                                                | [MATL3_W01] knows and understands the basic concepts, methods and theorems of mathematical logic and set theory, as well as basic examples illustrating specific concepts in these fields and enabling the refutation erroneous hypotheses or unauthorized reasoning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | knows and understands the concepts of mathematical logic and set theory in an algebraic context: equivalence relations and their classes, Cartesian products, binary operations                                                                                                                                                                                                                                                                       | [SW4] test/exam - oral or written                                            |
|                                                                | [MATL3_W04] knows and understands the basic concepts, methods and theorems of general algebra as well as basic examples that both illustrate specific concepts from these fields and enabling the refutation erroneous hypotheses or unauthorized reasoning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | knows and understands the basic concepts, methods and theorems of general algebra as well as basic examples both illustrating specific concepts (groups, homomorphisms, kernels) and allowing to refute erroneous hypotheses or unauthorized reasoning                                                                                                                                                                                                | [SW4] test/exam - oral or written                                            |
|                                                                | [MATL3_K06] is ready to formulate opinions on basic mathematical issues                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | is ready to formulate opinions on learned algebraic theories and issues                                                                                                                                                                                                                                                                                                                                                                               | [SK1] oral statement/conversation/discussion                                 |
| Subject contents                                               | <ul style="list-style-type: none"><li>• <b>Group Theory</b><ol style="list-style-type: none"><li>1. Definition of groups, subgroups, examples, cosets, index, Lagrange's theorem.</li><li>2. Subgroups generated by subsets, the order of elements, cyclic groups.</li><li>3. Permutations, decomposition into disjoint cycles and transpositions, permutation sign of a permutation.</li><li>4. Homomorphisms of groups, kernel and its properties, normal subgroups, construction of a quotient group, isomorphism theorems for groups.</li><li>5. Cayley's theorem on subgroups of permutation groups.</li><li>6. Internal and external direct and semidirect sum for groups, relationships between these concepts.</li><li>7. Theorem on the structure of finitely generated Abelian groups.</li><li>8. Groups acting on sets, examples, Cauchy's theorem, Sylow theorems.</li></ol></li><li>• <b>The beginning of ring theory:</b> (If time in the first term should suffice)<ol style="list-style-type: none"><li>1. Definition of rings and ideals, quotient ring.</li><li>2. Ring homomorphisms, kernel, isomorphism theorem for rings.</li><li>3. Polynomial rings as examples.</li><li>4. Degree of a polynomial, division of polynomials, roots of a polynomial, Bezout's theorem and its consequences (otherwise this will be in the second term).</li></ol></li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                              |
| Prerequisites and co-requisites                                | elementary knowledge of Linear Algebra                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                              |
| Assessment methods and criteria                                | Subject passing criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Passing threshold                                                                                                                                                                                                                                                                                                                                                                                                                                     | Percentage of the final grade                                                |
|                                                                | tests                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 51.0%                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 50.0%                                                                        |
|                                                                | observation of the student's attitude                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 51.0%                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0.0%                                                                         |
|                                                                | exam                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 51.0%                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 50.0%                                                                        |
| Recommended reading                                            | Basic literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | A. Białynicki-Birula, Algebra, PWN (wiele wydań).<br>J. Rutkowski, Algebra Abstrakcyjna w Zadaniach, PWN.                                                                                                                                                                                                                                                                                                                                             |                                                                              |
|                                                                | Supplementary literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | S. Lang, Algebra, PWN 1973.<br>M. Bryński, J. Jurkiewicz, Zbiór zadań z algebry, PWN 1985.<br>K. Szymiczek, Zbiór zadań z teorii grup.                                                                                                                                                                                                                                                                                                                |                                                                              |
|                                                                | eResources addresses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                              |
| Example issues/<br>example questions/<br>tasks being completed | Not applicable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                              |
| Work placement                                                 | Not applicable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                              |

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