University of Gdańsk

Subject card

Subject name and code	Algebra II, PG_00155412						
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	4		ECTS credits	6.0			
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		10.0		80.0	150
Subject objectives	Learning the basic algebraic concepts (in this term primarily from field and ring theory) and theorems describing the properties of these concepts and the relationships between them						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[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 (rings and fields), 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 [SU6] demonstration of practical skills
[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	[SW4] test/exam - oral or written
[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
[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 algebraic 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_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_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_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 [SU6] demonstration of practical skills
[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 [SU6] demonstration of practical skills
[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

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 group is abelian, cyclic, whether a given mapping is a homomorphism, epimorphism, monomorphism or isomorphism, can decide whether two algebraic objects are isomorphic	[SU4] test/exam - oral or written [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_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_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_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
[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 (rings, fields) and allowing to refute erroneous hypotheses or unauthorized reasoning	[SW4] test/exam - oral or written

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<tr><td>Subject contents</td><td>

Ring theory

1. Subjects from the beginning of ring theory that could not be placed in the first term.
2. Further examples of rings (fields, skew fields, rings of polynomials of many variables matrix rings, group rings).
3. Zero divisors, reversible elements, Fermat's little theorems.
4. Subset-generated ideal, principal ideal, prime and maximal ideals and their characterization in terms of quotient rings.
5. Chinese Remainder Theorem.
6. Euler function and its properties
7. Irreducibility criteria for polynomials
8. Euclidean rings and their properties, Euclidean algorithm for finding GCD.
9. Priciplal ideal domains (PID)
10. Noetherian rings
11. Localization of rings and local rings.
12. Subdividing ring-elements into irreducible factors
13. Reversible, irreducible and prime elements, definition of a unique factorization domain (UFD).
14. Criteria for the irreducibility of polynomials.
15. Uniqueness of factorization in PIDs.
16. Uniqueness of factorization in polynomial rings with coeficients in UFDs

• **Field Theory**

1. Fields, subfields, simple fields, field characteristic
2. Extensions of fields, degree of extension and its multiplicativity, algebraicity of an element and its degree
3. Algebraic closure of a field and theorem about its existence; field of algebraic elements
4. Splitting field of a polynomial
5. Theorem on the existence and structure of finite fields
6. Cyclicity of the multiplicative group of a finite field.

• **If time should suffice:**

1. Moduls, and extending the theorem on the structure of finitely generated Abelian groups to moduls over PIDs.
2. Some information on the application of Algebra in Algebraic Geometry, Algebraic Topology and Gallois Theory.

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<tr><td>Prerequisites and co-requisites</td><td>elementary knowledge of Linear Algebra and Algebra I</td></tr>
<tr><td>Assessment methods and criteria</td><td>
<table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>tests</td><td>51.0%</td><td>50.0%</td></tr>
<tr><td>exam</td><td>51.0%</td><td>50.0%</td></tr>
<tr><td>Observation of the student's attitude</td><td>51.0%</td><td>0.0%</td></tr>
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<tr><td>Recommended reading</td><td>
<table>
<tr><td>Basic literature</td><td>1. A. Białynicki-Birula, Algebra, PWN (wiele wydań).
2. J. Rutkowski, Algebra Abstrakcyjna w Zadaniach, PWN</td></tr>
<tr><td>Supplementary literature</td><td>1. S. Lang, Algebra, PWN 1973.
2. M. Bryński, J. Jurkiewicz, Zbiór zadań z algebry, PWN 1985.
3. K. Szymiczek, Zbiór zadań z teorii grup.</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>Not applicable</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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