University of Gdańsk

Subject card

Subject name and code	Algebra II, PG_00188848						
Field of study	Algebra II						
Date of commencement of studies	October 2026		Academic year of realisation of subject		2027/2028		
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		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. Michał Stukow				
	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		3.0		62.0	125
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_W04] knows and understands at an advanced level selected concepts, methods and theorems of general algebra, as well as basic examples both illustrating specific concepts in this field and allowing to refute false hypotheses or invalid 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/egzamin - ustny lub pisemny
[MATL3_K01] is ready to acquire knowledge in order to solve cognitive and practical problems related to the field of mathematics and to use the opinions and assistance of experts	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] obserwacja samodzielnej lub zespołowej pracy studenta
[MATL3_U04] is able to correctly use the concepts of general algebra, is able to apply the 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, 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/egzamin - ustny lub pisemny [SU6] demonstracja umiejętności praktycznych
[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/egzamin - ustny lub pisemny
[MATL3_U08] can formulate definitions and theorems in an understandable manner, both orally and in writing, and present correct mathematical reasoning on the learned topics	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/egzamin - ustny lub pisemny [SU6] demonstracja umiejętności praktycznych

Subject contents

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.

Prerequisites and co-requisites

elementary knowledge of Linear Algebra and Algebra I

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
tests	51.0%	50.0%
exam	51.0%	50.0%
Observation of the student's attitude	51.0%	0.0%

Recommended reading

Basic literature	1. A. Białynicki-Birula, *Algebra*, PWN (wiele wydań). 2. J. Rutkowski, *Algebra Abstrakcyjna w Zadaniach*, PWN
Supplementary literature	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*.
eResources addresses	

Example issues/ example questions/ tasks being completed

Not applicable

Work placement

Not applicable

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