University of Gdańsk

Subject card

Subject name and code	Computational Group Theory, PG_00174493						
Field of study	Mathematics						
Date of commencement of studies	October 2024		Academic year of realisation of subject	2025/2026			
Education level	Master's studies		Subject group	Optional subject group			
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							
Name and surname of lecturer (lecturers)	Subject supervisor		dr Rafał Lutowski				
	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	The purpose of the course is to familiarize students with the basic algorithms of computational group theory and the GAP program.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[MATMU2_K04] is ready to understand and appreciate the importance of intellectual honesty in one's own and other people's actions; ethical conduct	The student understands the importance of intellectual honesty in scientific and programming work, including the use of existing algorithms and sources, and can act in accordance with the principles of academic ethics.	[SK8] observation of student's independent or team work
[MATMU2_U03] can understand mathematical texts of various types from selected fields of mathematics	The student can comprehend mathematical texts related to computational group theory, both theoretical and algorithmic in nature, including documentation and scientific articles concerning the GAP system.	[SU8] observation of student's independent or team work
[MATMU2_U05] can perform proofs in a selected field and, if necessary, also use tools from other areas of mathematics	The student can construct proofs in the field of computational group theory, using tools from other areas of mathematics when necessary, such as linear algebra, number theory, or mathematical logic.	[SU4] test/exam - oral or written [SU5] implementation of a problem task
[MATMU2_U07] is able to define his/her interests and develop them; in particular, is able to establish contact with specialists in his/her field, e.g. understand their lectures intended for young mathematicians	The student is able to identify and develop their interests in computational group theory through independent study, participation in specialist lectures, and engagement with the academic community; using the GAP system, they are capable of constructing examples for more advanced problems in group theory and gaining deeper insight into the presented topics.	[SU5] implementation of a problem task [SU8] observation of student's independent or team work
[MATMU2_K01] is willing to acknowledge the limitations of his or her own knowledge and is willing to pursue further education	The student can recognize the limits of their knowledge in algorithmic methods of group theory and the use of the GAP system, and demonstrates readiness to independently deepen their competencies in this area.	[SK8] observation of student's independent or team work
[MATMU2_W01] knows and understands in-depth the theory of selected areas of mathematics	The student knows and understands the theoretical foundations of computational group theory.	[SW5] implementation of a problem task
[MATMU2_W02] knows and understands well the role and importance of the construction of mathematical reasoning	The student understands the importance of precise mathematical reasoning in computational group theory, can construct and analyze such reasoning, and recognizes its role in algorithm design and result verification, including through the use of the GAP system.	[SW4] test/exam - oral or written [SW5] implementation of a problem task
[MATMU2_W03] knows and understands in-depth a selected field of theoretical or applied mathematics and is able to understand the formulations of issues in this field that are still at the research stage and knows the connections of issues in this field with other areas of mathematics	The student has an understanding of computational group theory; the student can recognize connections between this field and other areas of mathematics such as algebra, logic, and theoretical computer science.	[SW5] implementation of a problem task
[MATMU2_U04] is able, at an advanced level and including modern mathematics, to apply and present, orally and in writing, methods of at least one selected branch of mathematics	The student can apply methods of computational group theory at an advanced level, including the use of the GAP system, and to present their application and results both orally and in writing.	[SU4] test/exam - oral or written
[MATMU2_U06] is able to apply methods and examples from a selected field of mathematics in related fields	The student can use the GAP system, to solve problems in related areas of mathematics, such as algebra, combinatorics.	[SU5] implementation of a problem task
[MATMU2_K02] is ready to precisely formulate questions to deepen his/her understanding of a given topic or find missing elements of reasoning	The student can formulate precise questions that support solving problems in group theory using the GAP system, particularly to deepen understanding of algorithm behavior and interpretation of results.	[SK5] implementation of a problem task [SK8] observation of student's independent or team work

	Course outcome	Subject outcome	Method of verification
	[MATMU2_K05] is ready to independently search for information in literature, also in foreign languages	The student can independently search for and analyze scientific literature, including in foreign languages, related to algorithmic problems in group theory and their applications.	[SK8] observation of student's independent or team work
	[MATMU2_K06] is ready to formulate opinions on basic mathematical issues	The student can critically evaluate and formulate an opinion on algorithmic aspects of group theory, particularly regarding decidability problems and computational complexity.	[SK8] observation of student's independent or team work
	[MATMU2_U01] can construct mathematical reasoning: prove theorems and refute hypotheses through construction and selection of counterexamples	The student can construct mathematical arguments in the field of computational group theory, including proving theorems and refuting hypotheses by building constructions and counterexamples, also using the GAP system.	[SU4] test/exam - oral or written [SU8] observation of student's independent or team work

Subject contents

1. Definition and selected properties of groups
2. Group actions: arbits and stabilizers
3. Permutation groups:
   - stabilizer chains
   - Schreiera-Sims algorithm
   - ,,backtrack" algorithms
   - natural actions and decompositions
   - primitive groups
   - composition series
4. GAP - groups, algorithms, programming
   - examples of theoretical concepts
   - GAP kernel - extending functionality

Prerequisites and co-requisites

Basic knowledge of group theory and related algebraic objects.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
observation of the student's attitude	51.0%	0.0%
test	51.0%	100.0%

Recommended reading

Basic literature	1. Alan F. Beardon, *Algebra and Geometry*, Cambridge University Press, 2005 2. Alexander Hulpke, *Notes on Computational Group Theory*, https://www.math.colostate.edu/~hulpke/CGT/cgtnotes.pdf 3. Various authors, documentations and tutorials for GAP, https://www.gap-system.org/Doc/doc.html
Supplementary literature	1. Holt, D. F., Eick, B., & O'Brien, E. A. (2005). *Handbook of Computational Group Theory*. Chapman & Hall/CRC
eResources addresses	

Example issues/ example questions/ tasks being completed

1. Determine the orbit of a group action.
2. Determine the stabilizer of a group action.
3. Determine stabilizer chain.

Work placement

Not applicable

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