GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Mathematical approach to symetrical phenomenon , PG_00025535					
Field of study	Mathematics					
Date of commencement of studies	October 2024		Academic year of realisation of subject		2026/2027	
Education level	first-cycle studies		Subject group		Optional subject group 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	3		Language of instruction		Polish	
Semester of study	5		ECTS credits		5.0	
Learning profile	general academic profile		Assessment form		exam	
Conducting unit	Department of Nonlinear Analysis and Statistics -> Faculty of Applied Physics and Mathematics					
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. Marek Izydorek				
	Teachers					

Lesson types and methods of instruction							
	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						
	Adresy na platformie eNauczanie:						

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

The main goal of the course is to present one of the most natural way of looking to the group theory, namely by actions of groups on various structures. Simply saying we will look on groups as groups of symmetries of some objects. We will focus on the action of groups on vector spaces by linear automorphisms of those spaces.

Linear representations of finite groups are one of the main tools in the theory of crystallographic groups - the symmetry groups of crystal structures. We will present introduction to this theory.

Learning outcomes

Course outcome	Subject outcome	Method of verification
K6_K02	Student is able to formulate precisely basic definitions and theorems in representation theory. He (she) is also able to present clearly proofs of certain theorems.	[SK2] Assessment of progress of work
K6_W03	Student can find representations of certain standard groups, can find symmetry groups of regular polygons and simple solids. Understands Schur's lemma.	[SW2] Assessment of knowledge contained in presentation
K6_U08	Student understands notion of real and complex representation of a finite group. He is able to check if a representation is irreducible and to compute its character.	[SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information
K6_W01	Student is able to recognise symmetric fenomena in architecture, art and nature.	[SW2] Assessment of knowledge contained in presentation

Subject contents	1. Theory of groups. 2. Vector spaces and general linear groups. 3. Linear representations of finite groups and basic examples. 4. Direct sum of representations. Subrepresentations. 5. Irreducible and indecomposable representations. 6. Characters. Schur's Lemma. 7. Canonical decomposition of a representation. 8. Unitary representations. 9. Induced representations (existance and uniqueness). 10. Linear representations of given groups, such as dihedral and symmetric groups.
Prerequisites and co-requisites	• Linear algebra • Algebra I

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Written exam	50.0%	50.0%
Tests during a semester	50.0%	50.0%

Recommended reading

Basic literature	1. J.P. Serre, Linear representations of finite groups, Graduate Texts in Mathematics, Vol. 42. *Springer-Verlag, New York-Heidelberg,* 1977 2. A. Trautman, Grupy oraz ich reprezentacje, skrypt WF UW, Warszawa, 2000.
Supplementary literature	J. Browkin, Teoria reprezentacji grup skończonych, PWN, Warszawa, 2009.
eResources addresses	

Example issues/ example questions/ tasks being completed	1. Determine all, up to equivalence, complex, real and rational representations of the cyclic group of order n. 2. Present a relationship between eigenvalues of a matrix and irreducible subrepresentations of a representation of a finite cyclic group. 3. Let V be a complex representation of a finite group G. Show that there exists G-invariant scalar product on V. 4. Let a finite group G act on a finite set X. Show that the character of the permutation representation corresponding to the action calculates number of fixed points under the action of every element of G. 5. Find all irreducible representations of the quaternion group. 6. Determine the canonical decomposition of the regular representations of groupsS_6, D_8, Q_8, D_{10}. 7. Determine the fundamental domain of the action $\mathbf{Z}^2$ on $\mathbf{R}^2$
Work placement	Not applicable