University of Gdańsk

Subject card

Subject name and code	Applications of Group Theory in Physics, PG_00208826		
Field of study	Mathematics		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2026/2027
Education level	Master's studies	Subject group	Obligatory subject group in the field of study 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 hab. inż. Marek Krośnicki	
	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

Introduction to the formalism and structure of groups, along with the elements of representation theory. Introduction to point groups, space groups, and Lie groups. Familiarization of the student with the applications of the groups SU(2), SU(3), and O(3). Demonstrating to the student how the symmetry properties of a system (molecule, crystal) determine the nature of its internal energy structure and allow (partially) the prediction of the systems response to an external perturbation (e.g., light); training the student to apply group theory to the analysis of the properties of simple systems.

Learning outcomes

Course outcome	Subject outcome	Method of verification

Subject contents

1. Introduction and fundamentals of group theory
-Definition of a group, examples of finite and infinite groups, elements of notation.
-Subgroups, conjugate elements, classes, homomorphisms.

2. Structure of groups
-Abelian and non-Abelian groups.
-Permutation groups.
-Point groups in physics.
-Space groups.
-Particularly important examples: SU(2), SU(3), O(3).

3. Lie groups and their representations
-Definition and examples of Lie groups.
-Lie algebras and their role in physics.

4. Representation theory in quantum mechanics

5. Applications
-Selection rules and state degeneracies.
-Use of symmetry to simplify quantum-mechanical calculations of electronic states.
-Examples of applications in atomic physics, molecular physics, and solid-state physics.

<table>
<tr><td>Prerequisites and co-requisites</td><td colspan="3">Linear algebra and basic mathematical analysis

Basic quantum mechanics,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="3"><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Oral exam</td><td>51.0%</td><td>50.0%</td></tr>
<tr><td>“completion of 2 problem-solving tasks</td><td>51.0%</td><td>20.0%</td></tr>
<tr><td>2 written assignments completed during class</td><td>51.0%</td><td>30.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td colspan="2">J.F. Cornwell, Group Theory in Physics: An Introduction, Academic Press, 1997.

D.M. Bishop, Group Theory and Chemistry, Dover, 1993</td></tr>
<tr><td>Supplementary literature</td><td colspan="2">M.S. Dresselhaus,G. Dresselhaus,A. Jorio Group Theory Application to the Physics of Condensed Matter, Springer-Verlag, 2008</td></tr>
<tr><td>eResources addresses</td><td colspan="2"></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="3"></td></tr>
<tr><td>Work placement</td><td colspan="3">Not applicable</td></tr>
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