

COURSE SHEET

1. Information on the study programme

1.1 Higher education institution	West University of Timisoara
1.2 Faculty / Department	Faculty of Physics and Mathematics
1.3 Department	Physics
1.4 Domain of study	Physics
1.5 Study cycle	Master
1.6 Study programme / Qualification	Astrophysics, elementary particles and computational physics / according to COR: Physicist (211101); Research assistant in physics (248102); Teacher (232201); Education reviewer (235204)

2. Information on the course

2.1 Title of the course	Symmetries in Physics ARMP1105						
2.2 Lecture instructor	Nistor Nicolaevici						
2.3 Seminar instructor	Nistor Nicolaevici						
2.4 Year of study	I	2.5 Semester	I	2.6 Evaluation form	E ¹	2.7 Regimul disciplinei	DOP

3. Estimated study time (number of hours per semester)

3.1 Attendance hours per week	3	out of which: 3.2 lectures	2	3.3 seminars	1
3.4 Attendance hours per semester	42	out of which: 3.5 lectures	28	3.6 seminars	14
Distribution of the allocated time:					hours
Study of literature, course handbook and personal notes					20
Supplementary documentation at library or using electronic repositories					20
Preparing for seminars and homeworks					18
Tutoring					
Exams					
Other activities					-
3.7 Total number of hours for individual study	58				
3.8 Total number of hours per semester	100				
3.9 Number of credits	4				

4. Prerequisites

curriculum	Analytical mechanics; Electrodynamics; Quantum mechanics
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¹ Conform articolului 37, alineatul (1) din Legea învățământului superior nr. 199/2023, cu modificările și completările ulterioare, „succesul academic al unui student pe parcursul unui program de studii este determinat prin **verificarea dobândirii rezultatelor așteptate ale învățării prin evaluări de tip examen și prin evaluarea pe parcurs**”.

5. Conditions:

5.1 for sustaining the course	• blackboard, projector
5.2 for sustaining the seminar	• idem

6. Course objectives

• to provide the basic notions of group theory with applications in physics • to enable the student to solve problems in various areas of physics using group theoretical methods • to offer a unified view on physical theories using symmetry principles
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7. Content

6.1. Lectures	Teaching methods	Observations
1. Basic notions of group theory	PP presentations blackboard calculations	course materials available on classroom.google
2. Group representations		
3. Physical applications involving discrete groups		
4. Basics of Lie groups		
5. The rotation group and the group SU(2)		
6. Translations and rotations in quantum mechanics		
7. The Lorentz and Poincare groups		
8. Unitary representations of the Poincare group		
9. Discrete symmetries. Representations of the full Poincare group		
10. Symmetries and conserved quantities		
11. The group SU(3). Young diagrams. Roots and weight vectors		

12. Quarks and the eight-fold way		
13. Gauge theories of elementary particles		
14. Instantons and monopoles		

6.2. Seminar	Teaching methods	Observations
1. Problems involving some simple groups	blackboard calculations	problem sets and solutions available on classroom.google
2. Decompositions of products of representations		
3. Splitting of energy levels and selection rules		
4. Representations of $SU(2)$		
5. The hidden $SO(4)$ symmetry of the hydrogen atom		
6. Thomas precession and the spin-orbit coupling		
7. Representations of the Lorentz group and fundamental fields		
9. Conserved operators in relativistic field theories		
10. Decomposition of representations of the group $SU(3)$		
11. Mass formulas and relations between scattering amplitudes		
12. Gauge models		
13. Aharonov-Bohm effect; The Dirac monopole		
14. $SU(2)$ instantons and monopole solutions		

8. Recommended literature

Wu-Ki Tung, *Group theory in physics* (World Scientific, 1985)

H. Jones, *Groups, representations and physics* (Adam Hilger, 1990)

A. Zee, *Group theory in a nutshell for physicists* (Princeton University Press, 2016)

R. Gilmore, *Lie group, physics and geometry* (Cambridge, 2008)

K. Huang, *Quarks, leptons and gauge fields* (World Scientific, 1992)

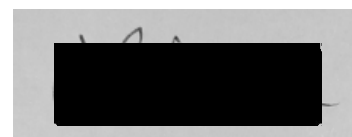
9. Evaluation

Activity	Weight in the final mark
Lectures (regular attendance)	20%
Homework	30%
End paper	50%
Minimum mark for passing	6

Date of completion

17.09.2025

Lecturer and seminar instructor
Nistor Nicolaevici



Approval date

Department director
Nicoleta Stefu