SYLLABUS

1. Information about the study programme

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

2. Information about the subject/discipline

2.1 Name			**Symmetries in Physics ARMP1105**				
2.2 Course coordinator			Lect. univ. dr. Nistor Nicolaevici				
2.3 Seminar coordinator			Lect. univ. dr. Nistor Nicolaevici				
2.4 Year of study	I	**2.5 Semester**	I	**2.6 Type of assessment**	E	**2.7 Type of discipline**	DOP

3. Total estimated time (hours of teaching per semester)

3.1 Number of hours per week	3	**3.2 course**	2	**3.3 seminar/laboratory**	1
3.4 Total hours in the curriculum	42	**3.5 course**	28	**3.6 seminar/laboratory**	14
Distribution of time:					**hours**
Study based on Instructions, course materials, bibliography and notes					50
Additional documentation library, specialized electronic platforms / field					50
Training seminars / laboratories, homework, essays, portfolios and essays					30
Tutoring					3
Examinations					3
Other activities					–

3.7 Total hours of individual study	133
3.8 Total hours per semester	175
3.9 Number of credits	7

4. Prerequisites (where applicable)

4.1 of curriculum	Analytical mechanics; Electrodynamics; Quantum mechanics
4.2 of skills	Ability to solve standard problems in mechanics, electrodynamics and quantum mechanics; basic linear algebra

5. Conditions (where applicable)

5.1 for the course	Blackboard, projector
5.2 for the seminar	Blackboard, projector

6. **Discipline objectives - expected learning outcomes which contribute to the completion and passing the discipline**

Knowledge	• describe the basic notions of group theory and representation theory used in physics; • explain how symmetry principles provide a unified description of physical theories; • identify the role of discrete groups, Lie groups, the Lorentz and Poincare groups, SU(2), SU(3), and gauge symmetries in physical applications.
Skills	• apply group-theoretical methods to solve problems in different areas of physics; • decompose products of representations and use symmetry arguments in problems involving energy-level splitting, selection rules and conserved quantities; • use group representations in quantum mechanics, relativistic field theory and particle physics.
Responsibility and autonomy	• select and apply appropriate symmetry and group-theoretical tools independently in unfamiliar physical problems; • critically assess the assumptions and limits of symmetry-based arguments and communicate the resulting analysis clearly.

7. **Contents**

The platform through which the course materials in electronic format and other learning/bibliographic resources can be accessed: Google Classroom

7.1 Course	**Teaching methods**	**Comments**
1. Intuitive notion of symmetry	PPT presentations blackboard calculations	course materials available on classroom.google
2. Representative applications of group theory in physics		
3. Basic group theory		
4. Elements of representation theory		
5. Orthogonality theorems		
6. The rotation group		
7. Basics of Lie groups		
8. Translations and rotations in quantum mechanics		
9. The Lorentz and Poincare groups		
10. Symmetries and conserved quantities		
11. Unitary representations of the Poincare group		
12. Discrete symmetries. Representations of the full Poincare group		
13. The group SU(3). Young diagrams and weight vectors		
14. Quarks and the eight-fold way		

Bibliography:

[1] Wu-Ki Tung, Group theory in physics (World Scientific, 1985)
[2] H. Jones, Groups, representations and physics (Adam Hilger, 1990)
[3] A. Zee, Group theory in a nutshell for physicists (Princeton University Press, 2016)
[4] R. Gilmore, Lie group, physics and gemetry (Cambridge, 2008)
[5] K. Huang, Quarks, leptons and gauge fields (World Scientific, 1992)

7.2. Seminar	Teaching methods	Comments
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 quantities in relativistic field theories		
10. Decomposition of representations of the group SU(3)		
11. Relations between scattering amplitudes		
12. The Wigner-Eckart theorem and applications		

Bibliography:

[1] Wu-Ki Tung, Group theory in physics (World Scientific, 1985)
[2] H. Jones, Groups, representations and physics (Adam Hilger, 1990)
[3] A. Zee, Group theory in a nutshell for physicists (Princeton University Press, 2016)
[4] R. Gilmore, Lie group, physics and gemetry (Cambridge, 2008)
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8. **Corroboration of the course contents with the epistemic expectations of the community representative, professional associations and representative employers of the programme itself**

The contents of the discipline cover standard graduate-level group-theoretical methods used in quantum mechanics, relativistic field theory and particle physics. The course connects abstract symmetry principles with concrete physical applications and supports competencies relevant to advanced study and research in theoretical and computational physics.

9. **Use of tools based on generative artificial intelligence**

Pentru realizarea sarcinilor definite la secțiunea de evaluare, atât la curs, cât și la seminar/laborator, este permisă utilizarea instrumentelor IAgen pentru generarea de idei/slogan/design/imagini/rescriere de text, editare/review etc. Utilizarea instrumentelor IAgen nu este permisă în cadrul examenului scris sau al altor evaluări desfășurate sub supraveghere.

10. **Evaluation**

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final mark
10.4 Course	Regular attendance and an end paper demonstrating understanding of the concepts and methods covered in the course.	Attendance record / end paper	70%

10.5 Seminar	Completion and correctness of homework assignments based on the seminar topics.	Homework	30%
10.6 Minimum performance standards			
Minimum mark for passing: 6			

Date of submission: 16.09.2026 **Titular of the course: Lect. univ. dr. Nistor Nicolaevici**

Signatur[redacted]

Date of approval in department: **Seminary titular: Lect. univ. dr. Nistor Nicolaevici**

Signature:[redacted]

HEAD OF THE DEPARTMENT:

Conf. univ. dr. Nicoleta Ștefu