NAME OF THE COURSE	Symmetry in Physics					
Code	PMP274	Year of study	DS-1			
Course teacher	prof.dr. sc. Ilja Doršner	Credits (ECTS)	5,0			
Associate teachers	doc.dr. sc. Toni Šćulac	Type of instruction (number of hours)	L	S	E	F
			30	15	15	
Status of the course	Compulsory	Percentage of application of e-learning	25%			

COURSE DESCRIPTION	
Course objectives	The course objective is to introduce students to the methods of group theory in order to describe and study symmetries of physical systems.
Course enrolment requirements and entry competences required for the course	None.
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Upon succesful completion of the course a student will be able to: 1. define basic concepts of group theory; 2. name the most common finite and continous groups; 3. implement the tools of group theory to decompose reducible representations of finite groups into irreducible ones; 4. find direct product of representations of Lie groups; 5. explain the connection between permutation groups and representations of unitary groups; 6. describe Lorentz group and its representations.
Course content broken down in detail by weekly class schedule (syllabus)	1. Symmetries of physical systems, laws of conservation, classification of states. Group theory basics. Group axioms, generators and defining relations, Cayley's tables, subgroups, Lagrange's theorem. 2. Normal subgroups, quotient-groups. Equivalence relations, conjugation classes. Group representations. Dihedral group. 3. Group morphisms. Direct sum and direct product, semidirect group product. Projection operators. Schur's lemma. Representation operations. 4. Characters of representations. Representations of direct group product. Permutation group - cycles, transpositions, and conjugation classes. Permutation group representations. 5. Permutation group algebra. Quantum mechanics examples: n-electron systems. Building up of antisymmetric wave functions out of the spacial and spin wave functions. 6. Young tableaux. 7. Continous groups and associated representations. Lie groups, continuity and analyticity of structure functions. 8. Examples of Lie groups in physics. Properties of Lie algebras - SO(n) and SU(n). 9. Lie group representations and Lie algebras, structure constants. Ireducibile representations of Lie algebra of group of rotations. Canonical basis. Casimir operator. 10. Direct product of representations of Lie group - operators, matrice, and generators. Decomposition of direct product into ireducibie representations for SU(2) group. Clebsch-Gordan coefficients. 11. Weight diagrams. (Selection rules. Ireducibile tensor operators, Wigner-Eckart theorem.) Unitary group in particle physics. Isospin, SU(2) group. Hypercharge, SU(3). 12. Representations of unitary groups, connection to permutation group, Young tableaux. 13. Lorentz group and its representations. Homogenous and inhomogenous Lorentz transformations. Properties and ireducibile representations of Lorentz and Poincaré groups. Connection to classical and quantum fields.

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<tr><td>Format of instruction</td><td colspan="3">☒ lectures
☐ seminars and workshops
☒ exercises
☐ on line in entirety
☐ partial e-learning
☐ field work</td><td colspan="3">☒ independent assignments
☐ multimedia
☐ laboratory
☐ work with mentor
☐ (other)</td></tr>
<tr><td>Student responsibilities</td><td colspan="6">Lecture attendance >70%; Excercises attendance >70%.</td></tr>
<tr><td rowspan="5">Screening student work (name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)</td><td>Class attendance</td><td>2</td><td>Research</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Report</td><td></td><td>(Other)</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td></td><td>(Other)</td><td></td></tr>
<tr><td>Tests</td><td>0,2</td><td>Oral exam</td><td>1</td><td>(Other)</td><td></td></tr>
<tr><td>Written exam</td><td>0,1</td><td>Project</td><td>1,7</td><td>(Other)</td><td></td></tr>
<tr><td>Grading and evaluating student work in class and at the final exam</td><td colspan="6">Two tests (midterm exams).
Final exam.</td></tr>
<tr><td rowspan="8">Required literature (available in the library and via other media)</td><td colspan="3">Title</td><td>Number of copies in the library</td><td colspan="2">Availability via other media</td></tr>
<tr><td colspan="3">I. Doršner, Simetrije u fizici, ISBN 978-9958-592-35-5, 2013.</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="3">A. Zee, Group Theory in a Nutshell for Physics, ISBN 978-0691162690, 2016.</td><td></td><td colspan="2"></td></tr>
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<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="6">[1] H. F. Jones, Groups, Representations and Physics, 2nd edition, IOP Publishing, 1998.
[2] J. F. Cornwell, Group Theory in Physics, An Introduction, Academic Press, 1997.</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="6">Evaluation of examination results and the course evaluation via anonymous student evaluation at the end of the course. Anonymous evaluation will be conducted following the rules of University of Split.</td></tr>
<tr><td>Other (as the proposer wishes to add)</td><td colspan="6"></td></tr>
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