NAME OF THE COURSE	**Stochastic simulations in classical and quantum physics**					
Code	PMP271	Year of study	1			
Course teacher	Petar Stipanović, PhD, Assistant Professor	Credits (ECTS)	6,0			
Associate teachers	Petar Stipanović, PhD, Assistant Professor	Type of instruction (number of hours)	L	S	E	F
			30		30	
Status of the course	Compulsory / elective	Percentage of application of e-learning	10%			

COURSE DESCRIPTION

Course objectives	Deeper understanding of selected topics of classical and quantum physics. Understanding the advantages and limitations of Monte Carlo simulations. Testing and developing simpler simulations. The ability to visualise and critically evaluate obtained results.
Course enrolment requirements and entry competences required for the course	Basic knowledge of statistical and quantum physics, as well as programming.
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	After the exam the student should: 1. Know several Monte Carlo simulation methods. 2. Be able to independently develop and apply Metropolis algorithm for a given probability distribution. 3. Be able to evaluate the efficiency and validity of the results of a given Monte Carlo algorithm. 4. Understand the advantages and limitations of stochastic simulations of phase transitions. 5. Be able to apply the learned methods to selected problems of classical and quantum many-body physics and to interpret the obtained results.
Course content broken down in detail by weekly class schedule (syllabus)	Basic techniques of stochastic simulations are introduced and applied to different physical systems and models. The exercises follow the following content of the lectures according to the same schedule. DETERMINISTIC RANDOMNESS (1h) Pseudorandom number generators. (1h) Testing for randomness and uniformity. (2h) Simulating random variables. Random walk. (4h) Brownian dynamics. Diffusion and entropy. (2h) Distributions. Percolation. (2h) Radioactive decay. (1h) Distribution transformation methods and rejection methods. (1h) Multidimensional integration using Monte Carlo methods. (2h) Markov chains. Metropolis algorithm. (2h) Estimation of statistical errors. MONTE CARLO SIMULATIONS OF THERMAL SYSTEMS (2h) Ideal gas. Demon algorithm. (4x) Ising model. Periodic boundary conditions. (3h) Simulation of continuous systems. Classical fluids. QUANTUM MONTE CARLO METHODS (3h) Variational Monte Carlo. Diffusion Monte Carlo.
Format of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ on line in entirety ☐ partial e-learning ☐ field work ☒ independent assignments ☐ multimedia ☒ laboratory ☐ work with mentor ☒ homework assignments

<table>
<tr><td>Student responsibilities</td><td>Homework during semester.
Final project and presentation.</td></tr>
<tr><td>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>
<table>
<tr><th>Name</th><th>Ects</th><th>Name</th><th>Ects</th><th>Name</th><th>Ects</th></tr>
<tr><td>Class attendance</td><td>2</td><td>Research</td><td></td><td>Experimental work</td><td></td></tr>
<tr><td>Oral exam</td><td></td><td>Report</td><td></td><td>Homework assignments</td><td>1</td></tr>
<tr><td>Seminar essay</td><td></td><td>Essay</td><td></td><td></td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td>1</td><td></td><td></td></tr>
<tr><td>Written exam</td><td></td><td>Project</td><td>2</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Grading and evaluating student work in class and at the final exam</td><td>Homework and the final project, in which the student should independently develop the program using the appropriate Monte Carlo method, and presentation are evaluated.
For homework and project, the students should write a report in which they answer the questions asked and critically evaluate obtained results.</td></tr>
<tr><td>Required literature (available in the library and via other media)</td><td>
<table>
<tr><th>Title</th><th>Number of copies in the library</th><th>Availability via other media</th></tr>
<tr><td>[1] L. Vranješ Markić, P. Stipanović: "Stohastičke simulacije u klasičnoj i kvantnoj fizici", skripta, PMFST, Split, 2016.</td><td>0</td><td>yes</td></tr>
<tr><td>[2] Harvey Gould, Jan Tobochnik, and Wolfgang Christian: "An Introduction to Computer Simulation Methods", 3rd revised edition, 2016. URL: https://www.compadre.org</td><td>0</td><td>yes</td></tr>
</table>
</td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td>[1] R. H. Landau & M. J. Paez: "Computational Problems for Physics", CRC Press, Taylor & Francis, 2018.
[2] M. P. Allen & D. Tildesley: "Computer Simulation of Liquids", Clarendon Press, Oxford, 1987.
[3] Different web pages.</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td>Lecturers who teach subjects, which have correlated learning outcomes, collaborate and take care of teaching quality.
Discussion with students and analysing their progress in solving problem and project tasks.
Statistics of exam results and evaluation of efficacy in accordance with the learning outcomes.
Student evaluation by anonymous survey conducted according to the rules of the University of Split.</td></tr>
<tr><td>Other (as the proposer wishes to add)</td><td></td></tr>
</table>