COURSE SYLLABUS

1.	Course: Selected Tools of Modern Theoretical Physics 1A	
2.	Scientific discipline: physical sciences	
3.	Teaching language: English	
4.	University department: Faculty of Physics and Astronomy	
5.	Course/module type – mandatory (compulsory) or elective (optional): mandatory	
6.	University subject (programme/major): Physics, specialty Master's Study of Theoretical Physics	
7.	Study level (I or II): II	
8.	Year: 1	
9.	Semester (autumn/spring) autumn	
10.	Form of tuition and number of hours: lectures – 15, computer laboratory - 15	
11.	Initial requirements (knowledge, skills, social competences) regarding the course/module: Linear algebra, elements of probability theory, basics of Python	
12.	Learning objectives for the subject: • Developing skills in using modern mathematical and computer tools applicable in theoretical physics.	
13.	Course content: Introduction to programming in Python. Solving the linear and non-linear algebraic equations. Singular value decomposition. Random numbers. Monte Carlo simulations and their applications in statistical physics. Simulations of density matrix renormalization group and applications in solid state physics. Matrix product states method – simulations of quantum correlations in many-body systems	
14.	Learning outcomes: • Knows advanced mathematical methods and information technologies to the extent and scope enabling modeling of physical phenomena. • Knows data analysis methods and computer simulations used in physics, knows and understands their theoretical basis, possibilities and limitations. • Is able to use advanced mathematical and numerical methods to analyze and model physical phenomena. • Is able to prepare the results of calculations or measurements, analyze them correctly, critically evaluate them and properly interpret them. • Has the ability to transfer his knowledge and learn from others. • He is aware of the limitations of his competences and understands the need to constantly expand his	Learning outcomes for the course: F2_W02, F2_W03, F2_U01, F2_U03, F2_U10, F2_K01, F2_K03

<table>
<tr><td></td><td colspan="2">knowledge and improve his skills.
• Represents and promotes a scientific approach to solving cognitive and practical problems.</td><td></td></tr>
<tr><td>15.</td><td colspan="3">Obligatory literature:
• John Steward “Python for Scientist”, CUP 2017
• Mark Lutz “Programming Python”, O'Reilly Media (2011)

Recommended literature:
• Ian P McCulloch “From density-matrix renormalization group to matrix product states”, J. Stat. Mech. (2007) P10014</td></tr>
<tr><td>16.</td><td colspan="3">Methods for verifying the assumed learning outcomes:
- written semester work (individual)
- preparation and implementation of a project (individual)</td></tr>
<tr><td>17.</td><td colspan="3">Conditions and form of passing individual components of the subject:
- constant monitoring of attendance and progress in the scope of classes
- control work (final)
- written semester work (individual)
- preparation and implementation of a project (individual)</td></tr>
<tr><td rowspan="6">18.</td><td colspan="3">Student’s workload</td></tr>
<tr><td>The form of carrying out classes by the student (leave appropriate)</td><td>Number of hours allocated to carry out a given type of classes</td></tr>
<tr><td>classes (according to the study plan) with the instructor:
- lecture:
- lab:</td><td>

15
15</td></tr>
<tr><td>student's own work (including participation in group work):
- preparation for classes:
- reading the indicated literature:
- preparation of works/speeches/projects:
- preparation for tests and exams:</td><td>

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15
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<tr><td>Total number of hours</td><td>75</td></tr>
<tr><td>Number of ECTS</td><td>3</td></tr>
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