HEP Research practice/ Scientific Research Internship

1. Study program

1.1. University	University of Bucharest, "Alexandru Ioan Cuza" University of Iași, "Babeș-Bolyai" University of Cluj-Napoca, West University of Timișoara
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Theoretical Physics, Mathematics, Optics, Plasma and Lasers
1.4. Field of study	Physics
1.5. Course of study	Master of Science
1.6. Study program	Theoretical and Computational Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course title	Research practice							
2.2. Teacher	Călin Alexa, Paul Grăvilă, Zsolt Lazăr, Daniel Radu, Roxana Zus							
2.3. Tutorials instructor(s)								
2.4. Practicals instructor(s)								
2.5. Year of study	1,2	2.6. Semester	2 - 4	2.7. Type of evaluation	V	2.8. Type of course unit	Content[1)]	**DS**
							Type[2)]	**DI**

[1)] fundamental (DF), specialized (DS); complementary (DC)
[2)] compulsory (DI), elective (DO), noncompulsory disciplines (DFC)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	**4**	distribution: Lecture		Practicals/Tutorials	
3.2. Total hours per semester	**56**	Lecture		Practicals/Tutorials	

Distribution of estimated time for study	**hours**
3.2.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	**2**
3.2.2. Research in library, study of electronic resources, field research	**2**
3.2.3. Preparation for practicals/tutorials/projects/reports/homeworks	**11**
3.2.4. Preparation for exam	**4**
3.2.5. Other activities	**0**

3.3. Total hours of individual study	**15**
3.4. Total hours per semester	**75**
3.5. ECTS	**3**

4. Prerequisites (if necessary)

4.1. curriculum	-
4.2. competences	-

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	-
5.2. for practicals/tutorials	Scientific computing laboratory

6. Specific competences acquired

Professional competences	Apply scientific methods, Manage research data Gather experimental data Analyse experimental laboratory data Demonstrate disciplinary expertise Prepare work reports Think abstractly Perform scientific research Promote open innovation in research Develop professional network with researchers and scientists
Transversal competences	Work in teams Apply knowledge of scientific, technological and engineering

7. Course objectives

7.1. General objective	Understanding theoretically and computationally the models which describe real physical systems
7.2. Specific objectives	Detailed study of some physical systems of utmost scientific interest Understanding how these systems are modelled Forming a creative and autonomous way of thinking

8. Contents

8.1. Lecture [chapters]	Teaching techniques	Observations/ hours
Bibliography:		
8.2. Tutorials [main themes]	Teaching and learning techniques	Observations/hours
Bibliography:		
8.3 Laboratory	Teaching and learning techniques	Observations
Bibliography:		
8.4 Project	Teaching and learning techniques	Observations
Depending on the laboratory/research center which she/he selects, the student will choose a research project from a sub-domain of high-energy physics or their applications. Examples of dedicated projects this semester: - Phenomenological analysis of theoretical models - Monte-Carlo methods for particle collisions simulations - Physics analysis problems - Particle detectors construction and performance studies - Detectors simulation - Particle reconstruction algorithms		

- Data acquisition methods - Statistical methods for data analysis - Problems of software development In addition to the extended list of research topics of the centers of the faculty, students have available projects that they can carry out within the collaboration agreements that the faculty has with research institutes (for example: Horia Hulubei National Institute for Physics and Nuclear Engineering, The National Institute for Science Materials, National Institute for Research and Development of Isotopic and Molecular Technologies INCDTIM Cluj-Napoca etc.).		

Bibliography - sample:

1. F. Halzen, A. Martin, Quarks and Leptons, An Introductory course in modern particle physics, John Wiley & Sons Inc., 1984
2. W. N. Cottingham and D. A. Greenwood, An introduction to the Standard Model of particle physics, Combridge University Press, 2007
3. Kazunori Hanagaki, Junichi Tanaka, Makoto Tomoto, Yuji Yamazaki, Experimental Techniques in Modern High-Energy Physics - A Beginner‘s Guide, Lecture Notes in Physics, Springer, 2022 https://library.oapen.org/bitstream/handle/20.500.12657/61321/978-4-431-56931-2.pdf?sequence=1&isAllowed=y
4. Delphes - a C++ framework, performing a fast multipurpose detector response simulation. https://cp3.irmp.ucl.ac.be/projects/delphes
5. PYTHIA 8, https://pythia.org/manuals/pythia8312/Welcome.html
6. MadGraph5_aMC@NLO, http://madgraph.phys.ucl.ac.be/
7. HEPForge, https://www.hepforge.org/
8. ATLAS: Detector and physics performance technical design report.
   TDR Volume 1 https://inspirehep.net/files/5057d1bc3edb9ef5d654888a22e6f7e5
   TDR Volume 2 https://inspirehep.net/files/315b42523bf67133e14db36eb9946109

9. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program)

The content of the research topics allows the students to develop skills and abilities for modeling and/or experimental investigation of the various physical phenomena studied in laboratories/research centers and their applications, in order to integrate them in specific activities of research institutes in the field of high energy physics, as well as in education.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture			
10.5.1. Tutorials			
10.5.2 Laboratory			
10.5.3 Project	- Attendance - Clarity, coherence and brevity of the exposure of the acquired	Colloquium	100%

	knowledge and the results obtained - The correct use of models, formulas and relations of calculation; - Correctly applying specific methods of solving for the given problem and interpreting the numerical results;		

10.6. Minimal requirements for passing the exam
Requirements for mark 5 (10 points scale) Attendance at the practical activities and final presentation.

Course coordinator
name(s) and signature(s) [redacted]

Călin Alexa, Paul Grăvilă, Zsolt Lazăr,
Daniel Radu, Roxana Zus

Date
10.06.2024

Date of approval

Head of Department
Lect.dr. Roxana Zus

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