DO.204.3 HEP Data Acquisition Methods in HEP II

1. Study program

1.1. University	University of Bucharest
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	High Energy Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	**Data Acquisition Methods in HEP II**							
2.2. Teacher				Dr. Gabriel Stoicea, Dr. Dorel Pietreanu				
2.3. Tutorials instructor(s)								
2.4. Practicals instructor(s)				Dr. Gabriel Stoicea, Dr. Dorel Pietreanu, Dr. Mihai Marciu				
2.5 Year of study	2	2.6. Semester	1	2.7. Type of evaluation	E	2.8. Type of course unit	Content[1)]	**DS**
							Type[2)]	**DO**

[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	**2**	Practicals/Tutorials	**2**
3.2. Total hours per semester	**56**	distribution: Lecture	28	Practicals/Tutorials	28

Distribution of estimated time for study	**hours**
3.2.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	**44**
3.2.2. Research in library, study of electronic resources, field research	**18**
3.2.3. Preparation for practicals/tutorials/projects/reports/homeworks	**28**
3.2.4. Exams	**4**
3.2.5. Other activities	**0**

3.3. Total hours of individual study	**90**
3.4. Total hours per semester	**150**
3.5. ECTS	**6**

4. Prerequisites (if necessary)

4.1. curriculum	Equations of mathematical physics, Electricity, Atomic physics, Nuclear physics, Optics, Quantum physics, Statistical physics
4.2. competences	Physical data processing and numerical methods

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Classroom (preferably, but not required, multimedia facilities)
5.2. for practicals/tutorials	Desktops

6. Specific competences acquired

Professional competences	• Identification and proper use of the main laws and principles of physics in a given context; identification and use of notions • Solving physics problems under imposed conditions • Creatively applying the knowledge acquired in order to understand and model the processes and physical properties • Communication and analysis of information of a didactic, scientific and popular character in the field of physics • Use / development of specific software tools
Transversal competences	• Efficient use of information sources and resources for communication and training, including in a language of international circulation • Carrying out professional tasks in an efficient and responsible manner, in compliance with the legislation, ethics and deontology specific to the field.

7. Course objectives

7.1. General objective	Learning Hardware Programming
7.2. Specific objectives	Implementing a Programmable Logic in a Field Programmable Gate Array (FPGA)

8. Contents

8.1. Lecture [chapters]	Teaching techniques	Observations
1) Modern Innovations and Challenges: Machine Learning (ML); Distributed Computing; FPGA and GPU Integration; Quantum Computing (Emerging).	Systematic presentation - lecture. Examples	4 hours
2) Introduction to Hardware Programming: VHDL; LabView FPGA and Sci-Comp frameworks.	Systematic presentation - lecture. Examples	8 hours
3) Hardware Programming Techniques for Particle Physics	Systematic presentation - lecture. Examples	4 hours
4) Signal Pulse Processing using Programmable Logic	Systematic presentation - lecture. Examples	12 hours
Bibliography: 1. W.R. Leo - Techniques for Nuclear and Particle Physics Experiments: A How-To Approach; Springer-Verlag, 1994. ISBN: 978-3540572800 2. John C. D. Milton and V. S. Ramachandran - Modern Instrumentation for Scientists and Engineers; Springer, 1986. ISBN: 978-0387963792 3. Stan Gibilisco - Data Acquisition and Signal Processing for Smart Sensors; McGraw-Hill Education, 2003. ISBN: 978-0071399535 4. Wolfgang Riegler and Dieter Schlatter - Particle Detectors; Oxford University Press, 2023. ISBN: 978-0198785154 5. C. Grupen, B. A. Swartz, Particle Detectors, Cambridge University Press 2008 6. Particle Data Group, http://pdg.lbl.gov		
8.2. Tutorials [main themes]	Teaching and learning techniques	Observations
8.3. Practicals [practical activities, projects, etc.]	Teaching and learning techniques	Observations

1. Introduction to Hardware Programming Languages. 2. Implementation of a Trigger DAQ Algorithm in a Programmable Logic.	Guided work	14 h 14 h
Bibliography: Îndrumar de laborator – format electronic		

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)

This course unit develops some theoretical competences, which are fundamental for a Master student in the field of modern physics, corresponding to national and international standards. The contents is in line with the requirement of the main employers of research institutes and universities.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/mathematical methods/physical models and theories - ability to indicate/analyse specific examples	Oral examination	70%
10.5.1. Tutorials			
10.5.2. Practicals	- ability to use specific problem solving methods - ability to analyse the results - ability to present and discuss the results	Reports	30%
10.5.3. Project [only if included in syllabus]			
10.6. Minimal requirements for passing the exam Correct understanding of the concepts and phenomena, the ability to work with them and obtain accurate numerical results on topics imposed.			
Requirements for mark 5 (10 points scale) • Carrying out all the activities during the semester • Obtaining note 5 by summing the points obtained at the activities during the course and examination, according to the weights specified			

Teacher's name and signature

Practicals/Tutorials instructor(s)

Date
05.09.2024

Dr. Gabriel Stoicea [redacted]
Dr. Dorel Pietreanu [redacted]

Dr. Gabriel Stoicea [redacted]
Dr. Dorel Pietreanu
Lect. Dr. Mihai Marciu [redacted]

Date of approval

Head of Department
Lect. Dr. Roxana Zus
[redacted]