## DO.110.2 HEP Data Acquisition Methods in HEP I

### 1. Study program

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| 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**

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|---|---|---|---|---|---|---|---|---|
| 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 | 1 | 2.6. Semester | 2 | 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)

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|---|---|---|---|---|---|
| 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** |

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

**4. Prerequisites** (if necessary)

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| 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)

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

**6. Specific competences acquired**

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| Professional competences | • Identification and proper use of the main laws and principles of physics in a given context; identification and use of notions<br>• Solving physics problems under imposed conditions<br>• Creatively applying the knowledge acquired in order to understand and model the processes and physical properties<br>• Communication and analysis of information of a didactic, scientific and popular character in the field of physics<br>• 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<br>• 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**

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| 7.1. General objective | Introduction in the Data Acquisition Modern Techniques<br>Familiarization with classic data acquisition systems |
| 7.2. Specific objectives | Being able to build and understand a classic data acquisition hardware system. |

**8. Contents**

| **8.1. Lecture** [chapters] | Teaching techniques | Observations |
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| 1) Objectives of Data Acquisition (DAQ) Systems<br>Data Collection; Signal Processing; Event Selection; Data Storage; Real-Time Monitoring | Systematic presentation - lecture. Examples | 6 hours |
| 2) Components of a DAQ System:<br>Front-End Electronics; Trigger System; Readout System; Data Concentrators; Data Storage; Control and Monitoring | Systematic presentation - lecture. Examples | 8 hours |
| 3) Key DAQ Methods<br>Triggered DAQ; Triggerless DAQ; Synchronous vs. Asynchronous DAQ. | Systematic presentation - lecture. Examples | 4 hours |
| 4) Data Processing Techniques<br>Digitization; Compression; Noise Filtering; Data Formatting | Systematic presentation - lecture. Examples | 6 hours |
| 5) Data Transmission:<br>High-speed communication protocols; Examples | Systematic presentation - lecture. Examples | 2 hours |
| 6) Real-Time Data Monitoring and Data Control System (DCS)<br>Detector and DAQ performance; Interfaces for data visualization; | Systematic presentation - lecture. Examples | 2 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 |
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| **8.3. Practicals** [practical activities, projects, etc.] | Teaching and learning techniques | Observations |
| 1. Introduction to DAQ Hardware for Particle Physics.<br>2. Building a data acquisition chain for a dedicated detector.<br>3. Implementing a complete DAQ logic using different software frameworks. | Guided work | 4 h<br>12 h<br>12 h |
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| Bibliography:<br>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 |
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| **10.4. Lecture** | - coherence and clarity of exposition<br>- correct use of equations/mathematical methods/physical models and theories<br>- ability to indicate/analyse specific examples | Oral examination | 70% |
| **10.5.1. Tutorials** | | | |
| **10.5.2. Practicals** | - ability to use specific problem solving methods<br>- ability to analyse the results<br>- 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**<br>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)**<br>• Carrying out all the activities during the semester | | | |

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| • Obtaining note 5 by summing the points obtained at the activities during the course and examination, according to the weights specified |

Practicals/Tutorials instructor(s)

Teacher's name and signature

Date
04.09.2024

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]