

SYLLABUS

1. Information regarding the programme

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| 1.1 Higher education institution | <i>Babeş-Bolyai University, Cluj-Napoca</i> |
| 1.2 Faculty | <i>Physics</i> |
| 1.3 Department | <i>Condensed Matter Physics and Advanced Technologies</i> |
| 1.4 Field of study | <i>Physics</i> |
| 1.5 Study cycle | <i>Master</i> |
| 1.6 Study programme / Qualification | <i>Solid State Physics/</i> |

2. Information regarding the discipline

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| 2.1 Name of the discipline | <i>Photons, electrons and muons in experimental solid state physics</i> | | | | | | |
| 2.2 Course coordinator | <i>Conf. Dr. Daniel ANDREICA</i> | | | | | | |
| 2.3 Seminar coordinator | <i>Conf. Dr. Daniel ANDREICA</i> | | | | | | |
| 2.4. Year of study | <i>I</i> | 2.5 Semester | <i>II</i> | 2.6. Type of evaluation | <i>E</i> | 2.7 Type of discipline | <i>DA</i> |

3. Total estimated time (hours/semester of didactic activities)

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| 3.1 Hours per week | <i>3</i> | Of which: 3.2 course | <i>2</i> | 3.3 seminar/laboratory | <i>1</i> |
| 3.4 Total hours in the curriculum | <i>42</i> | Of which: 3.5 course | <i>28</i> | 3.6 seminar/laboratory | <i>14</i> |
| Time allotment: | hours | | | | |
| Learning using manual, course support, bibliography, course notes | <i>25</i> | | | | |
| Additional documentation (in libraries, on electronic platforms, field documentation) | <i>25</i> | | | | |
| Preparation for seminars/labs, homework, papers, portfolios and essays | <i>22</i> | | | | |
| Tutorship | <i>9</i> | | | | |
| Evaluations | <i>3</i> | | | | |
| Other activities: | <i>-</i> | | | | |
| 3.7 Total individual study hours | <i>84</i> | | | | |
| 3.8 Total hours per semester | <i>126</i> | | | | |
| 3.9 Number of ECTS credits | <i>5</i> | | | | |

4. Prerequisites (if necessary)

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| 4.1. curriculum | <ul style="list-style-type: none"> <i>elements of Solid State Physics,</i> |
| 4.2. competencies | <ul style="list-style-type: none"> <i>Identification and use of the main laws and principles of physics in a given context</i> <i>computer skills (text editors, using software for plotting the data)</i> |

5. Conditions (if necessary)

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| 5.1. for the course | <ul style="list-style-type: none"> <i>Lecture room with video projector (beamer), internet connection and blackboard. Dedicated software.</i> |
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| 5.2. for the seminar /lab activities | <ul style="list-style-type: none"> • Lectures room with video projector (beamer), internet connection and blackboard. Dedicated software. |
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6. Specific competencies acquired

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| Professional competencies | <ul style="list-style-type: none"> • Knowledge of the terminology • Be able to describe the mechanisms of the interaction between photons, electrons, neutrons and muons (FENM) with matter. • Knowledge of the type of information one can obtain using specific experimental techniques and select the proper experimental method for a specific need. • Use of dedicated software for data analysis and display • At the end of this course, students should have the conceptual and mathematical tools to read/understand current research papers in experimental solid state physics. • The development of some algorithms based on advanced models/theories. to solve problems. |
| Transversal competencies | <ul style="list-style-type: none"> • Identification of the advanced continuous formation opportunities and effective exploitation of learning techniques for the own development. • Involvement in scientific activities by solving selected case studies. • Critical thinking • Effective use of information sources and communication resources and training assistance, both in Romanian and in a foreign language |

7. Objectives of the discipline (outcome of the acquired competencies)

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| 7.1 General objective of the discipline | <ul style="list-style-type: none"> • Students will acquire fundamental knowledge needed for understanding the interaction between FENM and matter. • Students will be able describe the experimental methods presented and to analyse data from different experimental set-ups. • Students will acquire competences and develop abilities for using dedicated software in data analysis. |
| 7.2 Specific objective of the discipline | <ul style="list-style-type: none"> • Students will be able to use concepts describing the interaction of FENM with matter. • Develop self-confidence for performing research activities • Develop the intellectual tools for problem solving; identify the proper method for the specific needs. |

8. Content

| 8.1 Course | Teaching methods | Remarks |
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| <i>Crystal symmetry, Bragg law, reciprocal lattice, structure factors</i> | <i>Presentation, debate, lecture</i> | <i>presence to lectures is facultative</i> |
| <i>Production of FENM</i> | | |
| <i>Interaction of FENM with materials</i> | | |
| <i>Experimental set-ups.</i> | | |
| <i>Elastic and inelastic scattering of fotons and neutrons. Experimental methods</i> | | |
| <i>X-ray spectroscopies.</i> | | |
| <i>Using polarised neutrons for the study of magnetic materials.</i> | | |
| <i>Introduction to μSR.</i> | | |
| <i>Data analysis in μSR.</i> | | |
| 8.2 Seminar | Teaching methods | Remarks |
| <i>Presentation of the software “tools”.</i> | <i>Presentation, debate, case study.</i> | <i>2 absences are allowed.</i> |
| <i>Use of dedicated software for data analysis and data presentation (FULLPROF, MUSREDIT, VESTA, ...)</i> | | |
| <i>Case studies from the literature</i> | | |
| Bibliography [1] Lectures will be posted on the lecture’s web page, after each lecture. [2] Philip Willmott: <i>An Introduction to Synchrotron Radiation: Techniques and Applications</i> , Wiley, 2011 [3] J. Als-Nielsen and D. McMorrow: <i>Elements of Modern X-Ray Physics</i> , Wiley, 2011. [4] G.L. Squires, <i>Introduction to the Theory of Thermal Neutron Scattering</i> , Dover Publications (1997). [5] <i>Muon Spin Rotation, Relaxation, and Resonance, Applications to Condensed Matter</i> ", Alain Yaouanc and Pierre Dalmas de Réotier, Oxford University Press, ISBN: 9780199596478 [6] “ <i>Physics with Muons: from Atomic Physics to Condensed Matter Physics</i> ”, A. Amato https://www.psi.ch/lmu/EducationLecturesEN/A_Amato_05_06_2018.pdf | | |

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

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| <ul style="list-style-type: none"> The content of the discipline is in accordance with the subjects who are studied in the same field in romanian and foreign universities and with the specific demands of research institutes, economy and labour market. |
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10. Evaluation

| Type of activity | 10.1 Evaluation criteria | 10.2 Evaluation methods | 10.3 Share in the grade (%) |
|------------------|--|-------------------------|-----------------------------|
| 10.4 Course | Knowledge of the interactions between FENM and materials Knowledge of the types of information that can be obtained using the various experimental methods presented. | - Written evaluation | 75 |

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| 10.5 Seminar | -the ability to work with the gained knowledge. - the correctness and the originality of the homeworks | - Active presence in seminars - homeworks | 25 |
| 10.6 Minimum performance standards | | | |
| <ul style="list-style-type: none"> • To be present at minimum 75% of seminars • Basic knowledge of theory and ability to solve simple problems | | | |

Date

Signature of course coordinator

Signature of seminar coordinator

18.11.2019

Date of approval

Signature of the head of department

Prof. Dr. Romulus Tetean