

## SYLLABUS

### 1. Date despre program

|                                     |                                                                                                                                                                                                                             |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.1 Institution of higher education | West University of Timisoara                                                                                                                                                                                                |
| 1.2 Faculty                         | Faculty of Physics                                                                                                                                                                                                          |
| 1.3 Department                      | Department of Physics                                                                                                                                                                                                       |
| 1.4 Field                           | Physics                                                                                                                                                                                                                     |
| 1.5 Study cycle                     | Master                                                                                                                                                                                                                      |
| 1.6 Study programme / Qualification | ADVANCED RESEARCH METHODS IN PHYSICS / according to COR:<br>physicist (211101); gymnasium teacher (232201 -according to the law); research assistant (248102); referent specialist in education (235204); analyst (213101). |

### 2. Information on the course

|                                     |                                     |              |   |                      |   |                 |        |
|-------------------------------------|-------------------------------------|--------------|---|----------------------|---|-----------------|--------|
| 2.1 Course title                    | <b>Defects in crystals ARMP2307</b> |              |   |                      |   |                 |        |
| 2.2 Lecturer instructor             | Assoc. Prof. Marius Ștef, PhD       |              |   |                      |   |                 |        |
| 2.3 Seminar / Laboratory instructor | Assoc. Prof. Marius Ștef, PhD       |              |   |                      |   |                 |        |
| 2.4 Year of study                   | II                                  | 2.5 Semester | 1 | 2.6 Examination type | E | 2.7 Course type | DS, Op |

### 3. Estimated time of study (hours per semester of didactic activities)

|                                                                         |     |             |    |                        |     |
|-------------------------------------------------------------------------|-----|-------------|----|------------------------|-----|
| 3.1 Number of hours per week                                            | 4   | of which:   | 2  | 3.3 seminar/laboratory | 2   |
|                                                                         |     | 3.2 lecture |    |                        |     |
| 3.4 Total hours from the curriculum                                     | 56  | of which:   | 28 | 3.6 seminar/laboratory | 28  |
|                                                                         |     | 3.5 lecture |    |                        |     |
| <b>Distribution of the allocated amount of time:</b>                    |     |             |    |                        | ore |
| Study of literature, course handbook and personal notes                 |     |             |    |                        | 42  |
| Supplementary documentation at library or using electronic repositories |     |             |    |                        | 26  |
| Preparing for laboratories, homework, reports etc.                      |     |             |    |                        | 26  |
| Exams                                                                   |     |             |    |                        |     |
| Tutoring                                                                |     |             |    |                        |     |
| Other activities.....                                                   |     |             |    |                        | -   |
| 3.7. Total number of hours of individual study                          | 94  |             |    |                        |     |
| 3.8. Total number of hours on semester                                  | 150 |             |    |                        |     |
| 3.9. Number of credits (ECTS)                                           | 6   |             |    |                        |     |

### 4. Prerequisites (if is the case)

|                 |                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4.1 curriculum  | <ul style="list-style-type: none"> <li>• Complements of Theoretical Physics;</li> <li>• Complements of Solid State Physics;</li> <li>• Complements of Atom and Molecule Physics.</li> </ul>                                                                                                                                                                         |
| 4.2 competences | <ul style="list-style-type: none"> <li>• General skills: the ability to accumulate basic knowledges; correct use of terminology in Physics; basic PC operation skills; the ability to work in a team;</li> <li>• Professional competences: identification and appropriate use of the main physical laws and principles; solving simple physics problems.</li> </ul> |

### 5. Requirements (if is the case)

|                                  |                                                                                                                                                                                          |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5.1 for lecture                  | <ul style="list-style-type: none"> <li>• blackboard, videoprojector, laptop.</li> </ul>                                                                                                  |
| 5.2 for the seminar / laboratory | <ul style="list-style-type: none"> <li>• blackboard, videoprojector, computers (2 students/computer);</li> <li>• Experimental setup for the study of the phenomena addressed.</li> </ul> |

### 6. Objectives of the discipline - expected learning outcomes to the formation of which the completion and promotion of the discipline contribute

|                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Knowledge                   | <ul style="list-style-type: none"> <li>- To know the advanced notions in the field of Physics, which involves a critical understanding of theories and principles;</li> <li>- To know the language specific to the field;</li> <li>- To know physical phenomena and interpret them by formulating hypotheses and operationalizing key concepts and the appropriate use of laboratory equipment;</li> <li>- To know the constructive and operating principles of the equipment for obtaining and characterizing materials and to explain how to use it.</li> </ul>                                                                                                                                                                                                                                                           |
| Skills                      | <ul style="list-style-type: none"> <li>- To compare the theoretical results provided by the specialized literature with those of an experiment carried out within a professional project;</li> <li>- To describe physical systems using specific theories and tools (experimental and theoretical models, algorithms, schemes, etc.);</li> <li>- To apply the principles and laws of physics in solving theoretical or practical problems, under conditions of qualified assistance.</li> <li>- To characterize the specific properties of some materials taking into account the field in which they are used;</li> <li>- To use experimental techniques for obtaining and characterizing materials;</li> <li>- To identify the most appropriate methods to develop new materials with well-defined properties.</li> </ul> |
| Responsibility and autonomy | <ul style="list-style-type: none"> <li>- To critically analyze a specialized report, scientific communication with a medium degree of difficulty in the field of physics;</li> <li>- To autonomously use information sources and resources for communication and assisted professional training (Internet portals, specialized software applications, databases, online courses, etc.) both in Romanian and in a language of international circulation.</li> </ul>                                                                                                                                                                                                                                                                                                                                                          |

### 7. Content

| <b>7.1 Lecture</b>                                                                                                                                                                                                                                                                                                                                                               |                                                           | Remarks |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|---------|
| Metode de predare: Expunere, prezentare, exemple etc. Suporturi de curs (inclusiv) pe e-learning/google classroom                                                                                                                                                                                                                                                                |                                                           |         |
| 1.                                                                                                                                                                                                                                                                                                                                                                               | Introduction. Classification of defects in crystals. (2h) | [1]     |
| 2.                                                                                                                                                                                                                                                                                                                                                                               | Thermodynamics of crystallization processes (2h)          | [1]     |
| 3.                                                                                                                                                                                                                                                                                                                                                                               | Homogeneous and heterogeneous nucleation (2h)             | [1,2]   |
| 4.                                                                                                                                                                                                                                                                                                                                                                               | Types of point defects. (2h)                              | [1-3]   |
| 5.                                                                                                                                                                                                                                                                                                                                                                               | Thermodynamics of point defects (2h)                      | [2]     |
| 6.                                                                                                                                                                                                                                                                                                                                                                               | Crystallization of multicomponent materials (2h)          | [1-3]   |
| 7.                                                                                                                                                                                                                                                                                                                                                                               | Segregation (2h)                                          | [1-3]   |
| 8.                                                                                                                                                                                                                                                                                                                                                                               | Impurities centers. (2h)                                  | [1]     |
| 9.                                                                                                                                                                                                                                                                                                                                                                               | Dislocations. (2h)                                        | [2]     |
| 10.                                                                                                                                                                                                                                                                                                                                                                              | Crystallization interface stability. (2h)                 | [1,2]   |
| 11.                                                                                                                                                                                                                                                                                                                                                                              | Phase diagrams (2h)                                       | [1-3]   |
| 12.                                                                                                                                                                                                                                                                                                                                                                              | F color centers (2h)                                      | [1]     |
| 13.                                                                                                                                                                                                                                                                                                                                                                              | F <sub>A</sub> color centers. (2h)                        | [2]     |
| 14.                                                                                                                                                                                                                                                                                                                                                                              | Laser color centers. (2h)                                 | [2]     |
| <b>7.2 Laboratory</b>                                                                                                                                                                                                                                                                                                                                                            |                                                           | Remarks |
| 1.                                                                                                                                                                                                                                                                                                                                                                               | Crystalline structures. (4h)                              |         |
| 2.                                                                                                                                                                                                                                                                                                                                                                               | Point defects in various crystals. (4h)                   | [1-3]   |
| 3.                                                                                                                                                                                                                                                                                                                                                                               | Direct observation of the dislocations. (4h)              | [1]     |
| 4.                                                                                                                                                                                                                                                                                                                                                                               | Determination of dislocation's density in crystals. (4h)  | [1-3]   |
| 5.                                                                                                                                                                                                                                                                                                                                                                               | Electrolytic coloration of the crystals. (4h)             | [1-3]   |
| 6.                                                                                                                                                                                                                                                                                                                                                                               | Optical characterization of F centers. (4h)               | [1-3]   |
| 7.                                                                                                                                                                                                                                                                                                                                                                               | Impurities in fluorite crystals (4h)                      | [1,2]   |
| References                                                                                                                                                                                                                                                                                                                                                                       |                                                           |         |
| 1. S. Amelinckx, <i>The direct observations of dislocations</i> , Acad. Press, N.Y. 1964<br>2. Y. Quere, <i>Physics of materials</i> , Gordon and Breach Science Publishers, 1998.<br>3. W. Fowler, <i>Physics of color centers</i> , Acad. Press, 19688. B. Henderson, R. Bartram, "Crystal-Field Engineering of Solid-State Laser Materials", Cambridge University Press, 2000 |                                                           |         |

## 8. Corroboration of the contents of the discipline with the expectations of representatives of the epistemic community, professional associations and representative employers in the field related to the program

Knowing and understanding the specific phenomena of the discipline, training and developing the practical skills of handling laboratory equipment, performing experiments, processing experimental data and interpreting the results correctly and completely, practicing the spirit of teamwork and the ability to organize and investigation, cultivating a scientific environment based on values, professional ethics and quality, are just a few arguments that motivate the usefulness of this discipline for training a future physicist.

## 9. Assessment

| Activity    | 9.1 Assessment criteria | 9.2 Assessment methods | 9.3 Weight of the final grade |
|-------------|-------------------------|------------------------|-------------------------------|
| 9.4 Lecture | Knowledge testing       | Grid test              | 50%                           |

|                                                                                                                                                                                                                                                                                                                                                                                                        |                    |  |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|--|-----|
| 9.5 Seminar / laboratory                                                                                                                                                                                                                                                                                                                                                                               | Presence, activity |  | 50% |
| 9.6 Minimum performance standard: Grade 5                                                                                                                                                                                                                                                                                                                                                              |                    |  |     |
| <ul style="list-style-type: none"><li>• Students to know the basic terminology;</li><li>• Students to prepare a laboratory report by identifying and using the main physical laws and principles from a real context (problem);</li><li>• Students to interpret the results of experimental measurements or theoretical calculations, by using appropriate numerical or statistical methods.</li></ul> |                    |  |     |

Discipline holder  
Conf. univ. dr. Marius Ștef



Date of approval in the department

Head of department  
Conf. univ. dr. Nicoleta Ștefu