**SYLLABUS**

**regarding the qualification cycle FROM** 2023 **TO** 2024**.**

1. Basic Course/Module Information

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| Course/Module title | EPR as a research method for engineering materials |
| Course/Module code \* |  |
| Faculty (name of the unit offering the field of study) | College of Natural Sciences |
| Name of the unit running the course | Institute of Material Engineering |
| Field of study | Material Engineering |
| Qualification level | II |
| Profile | generally academic |
| Study mode | Full time |
| Year and semester of studies | II year, II semester |
| Course type | directional |
| Language of instruction | Polish/English |
| Coordinator | dr. hab. Ireneusz Stefaniuk prof.UR |
| Course instructor | dr hab. Ireneusz Stefaniuk prof.UR |

\* - as agreed at the faculty

1.1.Learning format – number of hours and ECTS credits

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Semester  (n0.) | Lectures | Classes | Colloquia | Lab classes | Seminars | Practical classes | Internships | others | **ECTS credits** |
| 3 |  |  |  | 30 |  |  |  |  | **5** |

1.2. Course delivery methods

- carried out in a traditional way

- involving distance education methods and techniques

1.3. Course/Module assessment (exam, pass with a grade, pass without a grade)

Laboratory: assessment: credit with a grade

2. Prerequisites

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| Basic knowledge of physics, including. general physics, elements of modern physics |

3. Objectives, Learning Outcomes, Course Content, and Instructional Methods

3.1. Course/Module objectives

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| O1 | The aim of the course is to familiarize students with the basics of EPR spectroscopy and its application in materials research |

3.2. Course/Module Learning Outcomes (to be completed by the coordinator)

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| --- | --- | --- |
| Learning Outcome | The description of the learning outcome  defined for the course/module | Relation to the degree programme outcomes |
| LO\_01 | The student has extended and deepened knowledge of quantum and solid state physics. | IMII\_W01  IMII\_W07 |
| LO\_02 | The student has extended and in-depth knowledge of the following: the construction of matter has knowledge of the directions of development of material technologies. | IMII\_W02  IMII\_W06 |
| LO\_03 | Students can obtain information from the scientific literature on EPR spectroscopy. | IMII\_U01 |
| LO\_04 | The student is able to prepare written works using sources in Polish and English. | IMII\_U03 |
| LO\_05 | The student is able to interpret the results obtained from the EPR measurements. | IMII\_U07 |
| LO\_06 | The student is able to select the method of processing the results obtained. | IMII\_U08 |
| LO\_07 | Students can use the EPR method to measure the magnetic properties of materials. | IMII\_U09 |
| LO\_08 | The student understands the need to improve his or her qualifications. | IMII\_K01 |
| LO\_09 | The student knows how to estimate the time required to carry out EPR measurements. | IMII\_K03 |

**3.3. Course content (to be completed by the coordinator)**

1. Lectures

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1. Classes, tutorials/seminars, colloquia, laboratories, practical classes

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| Content outline |
| 1. Electron Paramagnetic Resonance - determination of the spectroscopic decay factor g, line shape analysis for DPPH. 2. Electron paramagnetic resonance: fine structure of the spectrum, determination of the fine structure tensor D. 3. Electron paramagnetic resonance - hyperfine structure of the spectrum, determination of the hyperfine structure tensor A. |

3.4. Methods of Instruction

e.g.

*Lecture: a problem-solving lecture/a lecture supported by a multimedia presentation/ distance learning*

*Classes: text analysis and discussion/project work (research project, implementation project, practical project)/ group work (problem solving, case study, discussion)/didactic games/ distance learning*

*Laboratory classes: designing and conducting experiments*

Lecture and multimedia presentation,

Exercises in the laboratory: performing experiments, designing experiments

4. Assessment techniques and criteria

4.1 Methods of evaluating learning outcomes

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| Learning outcome | Methods of assessment of learning outcomes (e.g. test, oral exam, written exam, project, report, observation during classes) | Learning format (lectures, classes,…) |
| LO-01 | *reports, observation during classes, oral test* | classes |
| LO-02 | *reports, observation during classes, oral test* | classes |
| LO-03 | *reports, observation during classes, oral test* | classes |
| LO-04 | *reports, observation during classes, oral test* | classes |
| LO-05 | *reports, observation during classes, oral test* | classes |
| LO-06 | *reports, observation during classes, oral test* | classes |
| LO-07 | *reports, observation during classes, oral test* | classes |
| LO-08 | *observation during classes* | classes |
| LO-09 | *OBSERVATION DURING CLASSES* | classes |

4.2 Course assessment criteria

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| Completion of the course will confirm the student's achievement of the intended learning outcomes. The verification of the learning outcomes is continuously monitored during the course of the classes. The grade obtained from passing the subject will assess the degree of effects achieved. The verification of the learning outcomes of the teacher's knowledge and skills takes place through tests, reports, class participation, and discussion. Verification of the learning outcomes of the classes without the participation of teachers will be based on the assessment of the student's preparation for laboratory exercises. The verification of social competences will take place through active participation in classes and participation in discussions.  Laboratory: Form of credit: credit with grade  The condition of passing the course is to obtain a grade from knowledge and substantive preparation for the exercises and colloquia.  The final grade is the average of partial grades.  Ects grading scale:  A – excellent (91 – 100)%  B - very good (81 – 90)%  C – good (71 – 80)%  D – satisfactory (61 – 70)%  E – sufficient (51 – 60)%  F – fail (0 – 50)% |

5. Total student workload needed to achieve the intended learning outcomes

– number of hours and ECTS credits

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| --- | --- |
| Activity | Number of hours |
| Scheduled course contact hours | 30 |
| Other contact hours involving the teacher (consultation hours, examinations) | 5 |
| Non-contact hours - student's own work (preparation for classes or examinations, projects, etc.) | 90 |
| Total number of hours | 125 |
| Total number of ECTS credits | 5 |

\* One ECTS point corresponds to 25-30 hours of total student workload

6. Internships related to the course/module

Not applicable

7. Instructional materials

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| Compulsory literature:  1. Z. Kęcki “Podstawy spektroskopii molekularnej” PWN Warszawa 1998.  2. Z. Jóźwiak G. Bartosz, Biofizyka- Wybrane zagadnienia wraz z ćwiczeniami. PWN 2005  3. Jan Stankowski, Andrzej Graja; Wstęp do elektroniki kwantowej. WKŁ. 1972  4. J. Stankowski, W. Hilczer Wstęp do spektroskopii rezonansów magnetycznych PWN 2005.  5. John Ashley Weil, James R. Bolton, Electron paramagnetic resonance: elementary theory and practical applications, John Wiley and Sons, 2007  6. W. Demtroder „Spektroskopia laserowa”, PWN 1993  7. Handbook of Spectroscopy, Edited by G. Gauglitz and T. Vo-Dinh, 2003 WILEY-VCH – udostępnia prowadzący  8. J. W. Hennel, J. Klinowski, Podstawy magnetycznego rezonansu jądrowego, PWN, Warszawa 2000;  9. S. A. Altszuler, B. M. Kozyriew, Elektronowy rezonans paramagnetyczny, PWN, Warszawa 1965; |
| Complementary literature:  1. A. Oleś, Metody doświadczalne fizyki ciała stałego, Wydawnictwa Naukowo-Techniczne, Warszawa 1998.  2. J. Jezierska, A. Jezierski i T. Cukierka, Ćwiczenia laboratoryjne z fizyki chemicznej. Spektroskopia EPR, Wydawnictwo Uniwersytetu Wrocławskiego, Wrocław 1995 – udostępnia prowadzący  3. M. Symons, Spektroskopia EPR w chemii i biochemii, PWN, Warszawa 1987. |

Approved by the Head of the Department or an authorised person