A COURSE SYLLABUS – DOCTORAL SCHOOL

REGARDING THE QUALIFICATION CYCLE FROM 2024/2025 TO 2027/2028

GENERAL INFORMATION ABOUT COURSE	
Course title	**OPTIONAL SPECIALIZED SUBJECT: Resonance methods of materials testing.**
Name of the unit running the course	Doctoral School at University of Rzeszów
Type of course *(obligatory, optional)*	compulsory - optional specialized
Year and semester of studies	year I, semester II
Discipline	materials engineering
Language of Course	Polish/English language
Name of Course coordinator	dr hab. Ireneusz Stefaniuk, prof. UR
Name of Course lecturer	dr hab. Ireneusz Stefaniuk, prof. UR
Prerequisites	Knowledge of materials engineering, as well as fundamentals of physics and chemistry

BRIEF DESCRIPTION OF COURSE
(100-200 words)

The purpose of the course is to familiarize the doctoral school student with resonance methods with particular emphasis on the electron paramagnetic resonance (EPR) method in materials research. The doctoral student will gain up-to-date knowledge of the solutions used in the field of these measurement techniques, and will acquire skills in operating an EPR spectrometer. He will learn the physical basis of EPR spectroscopy and how to describe theoretically and interpret EPR spectra.

COURSE LEARNING OUTCOMES AND METHODS OF EVALUATING LEARNING OUTCOMES

Learning outcome	The description of the learning outcome defined for the course	Relation to the degree programme outcomes (symbol)	Learning Format (Lectures, classes,...)	Method of assessment of learning outcomes (e.g. test, oral exam, written exam, project,...)
Knowledge (no.)	knows and understands, has knowledge			
1. P8S_WG1 P8S_WG2 P8S_WG3	He has advanced theoretical knowledge and is familiar with current scientific achievements in the application of resonance methods in materials research. Knows the theoretical basis of EPR spectroscopy, the structure and principle of operation of the EPR spectrometer. Is familiar with selected resonant methods of materials research: EPR, ferromagnetic resonance, pulsed technique and the study of radicals using spin traps. Knows and understands the scientific terminology used in EPR spectroscopy in native and foreign languages.	**P8S_WG**	laboratory	Observation During class, written work
2. P8S_WK1	He knows and understands the need for the development of impulse techniques and the impact on the development of civilization.	**P8S_WK**	laboratory	Observation During class, written work

Skills (no.)	can			
1. P8S_UW1	Based on interdisciplinary knowledge, he can identify and solve the research problem, define the purpose of the research, formulate the hypothesis and the object of scientific research. Can prepare samples for EPR measurements and perform measurements on an EPR spectrometer and analyze and interpret the obtained spectra.	**P8S_UW**	laboratory	Observation During class, written work
2. P8S_UW2 P8S_UW3	Able to use the available scientific literature in the field of EPR spectroscopy and interdisciplinary literature to diagnose and solve research problems and innovative activities related to the with the conducted scientific work .	**P8S_UW**	laboratory	Observation During class, written work
3. P8S_UK6	Able to carry out research work based on foreign-language literature. And present the results of scientific research in a foreign language.	**P8S_UK**	laboratory	Observation During class, written work
Social competence (no.)	is ready to			
1. P8S_KK3	With his knowledge, he solves cognitive and practical problems in the application of EPR spectroscopy in the study of materials	**P8S_KK**	laboratory	Observation During class,

LEARNING FORMAT – NUMBER OF HOURS

Semester (no.)	Lectures	Seminars	Lab classes	Internships	others	ECTS
II	-	-	**15**	-	-	**2**

METHODS OF INSTRUCTION

SCIENTIFIC DISCUSSION, LAB WORK, HANDS-ON ACTIVITIES.

COURSE CONTENT

Laboratory:

1. physical fundamentals of EPR spectroscopy, types of centers paramagnetic, Spectroscopic splitting factor g
2. spin Hamiltonian, subtle and hyperfine structure of EPR spectra.
3. methods of observation of EPR spectra . Ferromagnetic resonance (FMR) and antiferromagnetic resonance (AFMR).
4. computational methods ZFS, superposition model.
5. EPR pulse technique, spin echo, relaxation times.

COURSE CREDIT CONDITIONS (GRADING CRITERIA)

COURSE ASSESSMENT CRITERIA

Preparation of a written review paper on the physical basis of EPR spectroscopy and methods of observation of EPR spectra.
The prerequisite for passing the course is the achievement of all the established learning outcomes.
The grade of the exam is determined by the number of points obtained:
2.0 - less than 50%
3,0 - 51-60%;
3,5 - 61-70 %;
4,0 - 71-80%;
4,5 - 81-90%;
5,0 - 91-100 %.

Active attendance in class can raise the grade by half a grade.

TOTAL PhD STUDENT WORKLOAD REQUIRED TO ACHIEVE THE INTENDED LEARNING OUTCOMES – NUMBER OF HOURS AND ECTS CREDITS

Activity	Number of hours
Scheduled course contact hours	**15**
Other contact hours involving the teacher (consultation hours, examinations)	**1**
Non-contact hours – student`s own work (preparation for classes or examinations, project, etc.)	**39**
Total number of hours	**55**
Total number of ECTS credits	**2**

INSTRUCTIONAL MATERIALS

Compulsory literature:	1. A. Abragam, B. Bleaney, **Electron Paramagnetic Resonance of Transition Ions** 1986; 2. Jan Stankowski, Andrzej Graja; Wstęp do elektroniki kwantowej. WKŁ. 1972; 3. J. Stankowski, W. Hilczer Wstęp do spektroskopii rezonansów magnetycznych PWN 2005; 4. John Ashley Weil, James R. Bolton, Electron paramagnetic resonance: elementary theory and practical applications, John Wiley and Sons, 2007; 5. S. A. Altszuler, B. M. Kozyriew, Elektronowy rezonans paramagnetyczny, PWN, Warszawa 1965;
Complementary literature:	1. G. R. Eaton et al Foundations of Modern EPR,., 1997; 2. F. Gerson, W. Huber **Electron Spin Resonance Spectroscopy of Organic Radicals**, 2003; 3. **A.** Schweiger, G. Jeschke **Principles of Pulse Electron Paramagnetic Resonance**, 2001;

*(1 ECTS CREDIT CORRESPONDS TO 25 - 30 HOURS OF THE TOTAL WORKLOAD OF A DOCTORAL STUDENT, NEEDED TO ACHIEVE THE ESTABLISHED EFFECTS).

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Date and signature of the Course lecturer

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Approved by the Head of the Department or an authorised person