COURSE DESCRIPTION CARD - SYLLABUS

Course name

Applications of magnetic resonance

Course

Field of study
Education in Technology and Informatics

Year/Semester
2/3

Area of study (specialization)

Profile of study
general academic

Level of study
Second-cycle studies

Course offered in
polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
30

Laboratory classes

Other (e.g. online)

Tutorials

Projects/seminars

Number of credit points

4

Lecturers

Responsible for the course/lecturer:
dr Gustaw Szawioła, docent dydaktyczny

Responsible for the course/lecturer:

Prerequisites

The knowledge detailed in the field of learning outcomes for 1st and 2nd degree studies (sem. 1 and 2) covering the issues of functional materials. Skills consistent with the directional learning outcomes for studies. I and II degree (sem. 1 and 2) degree in the field of IT education, including the ability to build research equipment, computer control of research equipment. social competences defined in the directional learning outcomes for 1st and 2nd cycle studies (sem. 1 and 2) in the field of IT education.

Course objective

The lecture discusses established and prospective (experimental) applications of magnetic resonance (NMR and EPR): analytical, imaging, metrological, technical. The detailed issues are preceded by the supplementation of the physical foundations necessary for the understanding of the discussed content.

Course-related learning outcomes

Knowledge

1. The student explains the concepts of selected applications and the operation of dedicated technical systems, including experimental ones [K2_W06], [K2_W12].

2. Student defines the scope of conditions and physical and technical limitations of analytical systems, NMR and EPR [K2_W03], [K2_W14].

Skills

1. Student specifies parameters of basic radio signals, including pulse sequences for selected applications of NMR spectroscopy [K2_U19], [K2_U18].

2. The student interprets the basic NMR and EPR and ODMR spectra of selected atomic structures

and materials and selects appropriate structures (materials) as markers for specific applications. [K2_U09], [K2_U10], [K2_U12].

3. The student plans NMR and EPR research and application systems from the available modules, prepares the technical specification of these modules for specific applications. [K2_U08], [K2_U13]

Social competences

1. The student is aware of the uncompromising reliability and safety of analytical and diagnostic systems [K2_K05].

2. The student understands the importance of systematic and methodical work [K2_K04].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture:

- form and components (percentage) of assessment: written exam (80%) ; constructive activity during lectures (20%)

- assessment criteria /grade: 96% - /5,0; 86%- 95% /4,5; 76%-85% /4; 66 -75% /3,5; 50%-65.0% /3; < 50% /2.

Programme content

1. Magnetic resonance imaging in simple spin systems - vector description and elements of quantum description.

2. Basics of NMR signal detection - construction of NMR spectrometers.

3. Pulse NMR spectroscopy, selected pulse sequences and relaxation effects.

4. Elements of two-dimensional NMR spectroscopy.

5. Analytical and numerical aspects of tomography.

6. MRI and fMRI imaging.

7. Physical basis of EPR spectroscopy.

8. Applications of EPR spectroscopy in chemical analysis and imaging.

9. Quantum generators on molecular and atomic beams - masers.

10. Application of EPR in radioelectronics - quantum microwave amplifiers.

11. Physical basics of double optical-radio resonance (laser-microwave) with examples of spectroscopy

12. Magnetometry with the use of magnetic resonance and double optical-microwave resonance.

13. Atomic time and frequency standards - cesium fountain.

14. Nano-imaging with the use of the ODMR technique.

15. Quantum information processing with the use of magnetic resonance.

Teaching methods

1. Lecture: multimedia presentation supplemented with examples given on the blackboard. Solving problems.

Bibliography

Basic

1. V. I. Chizhik i in., Magnetic resonance and its applications, Springer 2014

2. J.Stankowski, W. Hilczer, Wstęp do spektroskopii rezonansów magnetycznych, PWN 2005

3. J. Keeler, Understanding NMR Spectroscopy, 2nd Edition , Wiley 2010

4. B. Gonet, Obrazowanie magnetyczno-rezonansowe PZWL 2015

5. prace przeglądowe i oryginalne publikowane w periodykach naukowych cytowane w trakcie wykładu

Additional

1. A. Cygański, Metody spektroskopowe w chemii analitycznej, WNT 2012

2. red. A. Hrynkiewicz, Fizyczne metody diagnostyki medycznej i terapii, PWN 2013

3. M. H. Levitt, Spin Dynamics: Basics of Nuclear Magnetic Resonance, Wiley, 2008

4. R. W. Brown, i in, .Magnetic Resonance Imaging: Physical Principles and Sequence Design, Wiley-Blackwell 2014,

5. S.C. Bushong, G. Clarke, Magnetic Resonance Imaging: Physical and Biological Principles, Mosby 2014

Breakdown of average student's workload

	Hours	ECTS
Total workload	68	4
Classes requiring direct contact with the teacher	38	2,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	30	2,0

[1] delete or add other activities as appropriate