SYLLABUS

winter semester 2026/2027

Lecturer: dr hab. inż. Michał Bielejewski, prof. IFM PAN

Lecture title	**The basics of nuclear magnetic resonance: theory and applications**
Venue	Institute of Molecular Physics Polish Academy of Sciences (IMPPAS)
Language	English
Learning objectives	1. Upon completing the course, students will gain the practical and intellectual capabilities to: a. Design NMR experiments by selecting and optimizing sequences specific to their unique molecular or material research problems. b. Interpret experimental data by analyzing 1D and 2D spectra c. Integrate NMR into broader research by combining NMR methodology with complementary analytical or computational techniques 2. By attending the lectures, students will learn a basic, fundamental understanding of nuclear magnetic resonance phenomena including: a. Classical and basic quantum mechanical foundations of the physics behind NMR b. Basic pulse sequences in liquid and solid-state NMR c. Relaxation phenomena d. Selected methodologies such as 1D, 2D NMR spectroscopy, diffusion NMR, relaxometry NMR
Learning outcomes, according to Attachment 2 to the Program of the Study (valid from October 1st 2026)	**P8S_WG[pkt.1, 2, and 4]** (Covers the scientific achievements, fundamental theoretical principles, and specific advanced issues relevant to the discipline (e.g., understanding simple NMR pulse sequences, relaxation mechanisms) **P8S_WK[pkt.2]** (Covers the main developmental trends of the discipline, allowing the student to revise existing paradigms or apply NMR techniques to solve broad scientific problems) **P8S_UW[pkt. 1 i 2]** (The ability to creatively use knowledge from different fields to formulate and solve research problems, specifically by choosing correct NMR pulse sequences) **P8S_UK[pkt.3]** (The capability to communicate scientific topics and data effectively, such as presenting interpreted NMR data to the broader community) **P8S_UU/P8S_UO[pkt.1, 2]** (The ability to plan and execute tasks independently, including setting up specialized spectrometer configurations and optimizing data collection pipelines) **P8S_KR[pkt.1]** (The willingness to fulfill the public duties of a researcher, maintaining scientific integrity, and respecting intellectual property when sharing or publishing data) **P8S_KK[pkt.1]** (The readiness to evaluate the contribution of NMR findings to the field, recognizing the limitations of data models, and understanding the role of empirical verification)
Type of the course	obligatory lecture
Term/Year	summer semesters 2026/2027
Lecturer's name	dr hab. inż. Michał Bielejewski, prof. IFM PAN
Name of the examiner	dr hab. inż. Michał Bielejewski, prof. IFM PAN
Attendance requirements	Working knowledge of the English language and physics and solid-state physics at the university level
Number of ECTS points	2 ECTS per academic year
Number of lectures	*7 [15 /lesson hours]*
Balance of ECTS points	Two (2) ECTS credits
Didactic methods	Lectures with audiovisual techniques Preparing reports on laboratory classes
Methods of verification and assessment of learning outcomes	Written / oral exam. Preparation of laboratory reports.
Conditions of a positive evaluation	A passing grade on the exam. Active participation in laboratory sessions. Preparation of laboratory reports.
Course content	1. Introduction to nuclear magnetic resonance phenomena: atomic nature of matter, nuclei, and magnetic field 2. Nuclear magnetism and magnetization – a macroscopic view

	3. Magnetic interactions – chemical shifts, scalar and dipolar couplings 4. Technical aspects of NMR – the spectrometer 5. Experimental techniques 6. Practical classes – liquid-state NMR 7. Practical classes – high-resolution solid-state NMR
Literature constituting the course materials	1. James Keeler – Understanding NMR spectroscopy 2. Joseph B. Lambert, Eugene P. Mazzola – NMR spectroscopy 3. Lecture handouts.