POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name

Advanced Laser Spectroscopy Laboratory [S2FT2>ZLSL]

Course

Field of study
Technical Physics

Year/Semester
1/1

Area of study (specialization)
–

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
0

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

1,00

Coordinators

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Lecturers

Prerequisites

Knowledge and skills in quantum physics, fundamentals of quantum engineering, atomic, molecular and solid state physics, optical structures and laser optics. Competencies in the analysis of measurement data consistent with the learning outcomes for the first-cycle studies in technical physics. The ability to self-educate and obtain information from literature, including English.

Course objective

Practical introduction to laser spectroscopy, LIF and ODMR methods, which are precursors of quantum engineering techniques implemented using laser light and microwave radiation.

Course-related learning outcomes

Knowledge:
Student:
1. knows the principle of professional and safe spectroscopic measurement using the laser-induced fluorescence (LIF) method, selected applications and limitations of this method;
2. knows the principle of professional and safe measurement using the optically detected magnetic resonance (ODMR) method, limitations and selected applications of this method.

Skills:
Student:
1. Is able to plan and conduct spectroscopic measurement using the laser-induced fluorescence (LIF) method in selected physical media using the phase-sensitive detection technique and analyze and interpret the obtained results.
2. Is able to plan and conduct measurement using the optically detected magnetic resonance (ODMR) method in selected material structures and analyze and interpret the obtained results for various parameters of the environment of the tested samples.
3. Is able to safely and professionally operate devices used in spectroscopic measurements using the LIF and ODMR methods, in particular: semiconductor laser, microwave radiation synthesizer, phase-sensitive amplifier, light detectors.

Social competences:
Student:
1. Applies the principles of safe and professional work with semiconductor lasers and with high-frequency radiation sources in the microwave frequency range, with particular emphasis on teamwork.
2. Understands the importance of reliable and orderly documentation and interpretation of obtained measurement results, with particular emphasis on teamwork.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

In terms of the methods used to verify the achieved learning outcomes, the following grading thresholds are applied:
50.1-60% - 3.0
60.1-70% - 3.5;
70.1-80% - 4.0;
80.1-90% - 4.5;
from 90.1% - 5.0
The assessment results from the preparation of a laboratory measurement protocol and/or oral response.

Programme content

I. Laser induced fluorescence (LIF) measurement technique
II. Optically detected magnetic resonance (ODMR) measurement technique for various sample environment parameters

Course topics

1. Laser spectroscopy tools - spectral characteristics of light emitted by a semiconductor laser and radio radiation generated by a microwave radiation synthesizer. Principles of safe work with laser light and microwave field synthesizers.
2. Laser spectroscopy tools - measurement principle and signal registration using a lock-in amplifier.
3. Registration of the laser-induced fluorescence signal (LIF) in gaseous media
4. Registration of the optically detected magnetic resonance signal (ODMR) in negatively charged nitrogen-vacancy centers in diamond using the phase-sensitive detection method
5. Numerical analysis and interpretation of spectroscopic signals recorded using the LIF and ODMR methods

Teaching methods

Laboratory exercises: practical exercises, conducting experiments in teams of several people, numerical analysis of measurement data, instruction, discussion

Bibliography

Basic:
1. Wolfgang Demtröder, Laser Spectroscopy 1. Basic Principles, Rozdz. 3.,4., Springer 2014
2. Wolfgang Demtröder, Laser Spectroscopy 2. Experimental Techniques, Rozdz. 1.8, Springer 2015,

3. High Sensitivity Magnetometers, ed. Asaf Grosz Michael J. Haji-Sheikh Subhas C., Rozdz. 18. Mukhopadhyay Kasper Jensen, Pauli Kehayias and Dmitry Budker, Magnetometry with Nitrogen-Vacancy Centers in Diamond, Springer 2017
4. Manuals for Laser Devices, Microwave Synthesizer, Phase-Sensitive Amplifier and Light Detectors

Additional:
1. Citation S V Kireev et al., Laser fluorescence complex for online iodine-129 and iodine-127 detection in gaseous media using a tunable diode laser, Laser Phys. Lett. 12 (2015), str. 015701, https://doi.org/10.1088/1612-2011/12/1/015701
2. Haimei Zhang et al., Little bits of diamond: Optically detected magnetic resonance of nitrogen-vacancy centers, Am. J. Phys. 86, (2018), str. 225-236, https://doi.org/10.1119/1.5023389
3. EPR of Free Radicals in Solids Trends in Methods and Applications, ed. Anders Lund, Masaru Shiotani, Rozdz. 15.,Springer 2003

Breakdown of average student's workload

	Hours	ECTS
Total workload	30	1,00
Classes requiring direct contact with the teacher	15	0,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	15	0,50