



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

dr Gustaw Szawiola

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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:

When assessing learning outcomes, the following assignment of grades to percentage ranges applies:

- <50-60)% - 3,0,
- <60-70)% - 3,5,
- <70-80)% - 4,0,
- <80-90) %-4,5,
- <90-100>%- 5,0.

The assessment is based on the performance of individual exercises, summarized in a written report including detailed measurement and test results and their in-depth analysis.

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. Tools used in the laser-induced fluorescence spectroscopy technique.
2. Recording the laser-induced fluorescence (LIF) signal.
3. Analysis of measurement results obtained using the LIF method.
4. Tools used in the optically detected magnetic resonance (ODMR-CW) technique.
5. Recording the optically detected magnetic resonance (ODMR-CW) signal.
6. Analysis of measurement results obtained using the optically detected magnetic resonance (ODMR-CW) method.

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