A COURSE SYLLABUS – DOCTORAL SCHOOL

REGARDING THE QUALIFICATION CYCLE FROM 2021 TO 2025

GENERAL INFORMATION ABOUT COURSE	
Course title	**PhD seminar**
Name of the unit running the course	Doctoral School at University of Rzeszów
Type of course *(obligatory, optional)*	obligatory
Year and semester of studies	2021 – 2025 (sem. I – VIII)
Discipline	Physical Sciences
Language of Course	Polish
Name of Course coordinator	Dr hab. Rafał Hakalla, prof. UR
Name of Course lecturer	Dr hab. Rafał Hakalla, prof. UR
Prerequisites	The scope of knowledge resulting from the master's degree program in the field of physics. Knowledge of the English language sufficiently to enable the use of foreign-language sources of scientific information, preparation of publications and presentation of scientific achievements at specialist conferences.

BRIEF DESCRIPTION OF COURSE
(100-200 words)

The doctoral seminar focuses on supporting the successive research stages, implementation of which is crucial for the preparation of a PhD dissertation. The content of the course focuses on preparing the sources of spectra of a selected diatomic molecule, obtaining high-quality spectra of this molecule using modern methods of high-resolution spectroscopy, conducting extended spectral analysis of strongly and extensively perturbed ro-vibronic states of this molecule in order to work out its physico-chemical properties that can be applied in cosmic, astrophysics and astronomical programs. The topics to be covered will be related to:

- acquiring knowledge and skills related to planning, conducting and improving scientific research of precise high-resolution spectroscopy,
- using knowledge from various fields of science for creative identification and innovative solution of complex spectroscopic, research and analytical problems,
- making a critical analysis and evaluation of the research results,
- developing the ability to present the research results through active participation in the international scientific community.

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.)	**The PhD student knows and understands:**			
1	World achievements, to the extent enabling the revision of the existing paradigms, including theoretical foundations as well as general and selected detailed issues appropriate for high resolution molecular spectroscopy.	P8S-WG/1	Lab	PhD project
2	The main trends of spectroscopy	P8S-WG/2	-||-	-||-
3	Scientific research methodology.	P8S-WG/3	-||-	-||-
4	Principles of sharing the results of scientific activity, also in the open access	P8S-WG/4	-||-	-||-

	mode.			
5	Basic principles of knowledge transfer to the economic and social area as well as commercialization of the results of scientific activity and know-how related to these results.	P8S-WK/3	-||-	-||-
Skills (no.)	**The PhD student can:**			
1	Use knowledge from various fields of science for creative identification and innovative solving of complex spectroscopic problems or performing research tasks, in particular: - define the purpose and subject of spectroscopic research, formulate a research hypothesis, - develop spectroscopic methods and techniques and creatively apply them, - conclude on the basis of spectroscopic research	P8S-UW/1	-||-	-||-
2	Perform a critical analysis and evaluation of the results of scientific research, expert activities and other creative works and their contribution to the development of spectroscopy	P8S-UW/2	-||-	-||-
3	Transfer the results of scientific activity to the economic and social area	P8S-UW/3	-||-	-||-
4	Communicate on the topics of molecular spectroscopy to a degree enabling active participation in the international scientific community	P8S-UK/1	-||-	-||-
5	Disseminate the results of scientific activity, also in popular forms	P8S-UK/2	-||-	-||-
6	Initiate a debate	P8S-UK/3	-||-	-||-
7	Participate in the scientific discourse on specialist topics	P8S-UK/4	-||-	-||-
8	Plan and implement individual and team research projects in the field of high resolution molecular spectroscopy, also in an international community	P8S-UO	-||-	-||-
9	Plan and act for his or her own development as well as inspire and organize the development of other people	P8S-UU/1	-||-	-||-
Social competence (no.)	**The PhD is ready to:**			
1	Critical evaluation of the achievements in high resolution molecular spectroscopy	P8S-KK/1	-||-	-||-
2	Critically evaluate your own contribution to the development of high resolution molecular spectroscopy,	P8S-KK/2	-||-	-||-
3	Recognize the importance of knowledge in solving cognitive and practical problems	P8S-KK/3	-||-	-||-
4	Maintaining and developing the ethos of research and creative communities, including:	P8S-KR	-||-	-||-

	- conducting research activities in an independent way - respecting the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection.			

LEARNING FORMAT – NUMBER OF HOURS

Semester (no.)	Lectures	Seminars	Lab classes	Internships	others	ECTS
I			30			
II			30			
III			30			
IV			30			
V			30			
VI			30			
VII			30			
VIII			30			

METHODS OF INSTRUCTION

LABORATORY CLASSES, DESIGNING AND CONDUCTING EXPERIMENTS, computer-assisted data analysis; preparing a presentation; scientific discussion and debate.

COURSE CONTENT

Stages of preparing a doctoral dissertation:

2021/2022; sem. I and II

1. Development of a precise methodology for measurement and spectroscopic analysis of a selected molecule, taking into account appropriate research techniques.
2. Designing and commissioning a source of spectra of a selected diatomic molecule.
3. Obtaining the ro-vibronic spectrum of the molecule in the selected measurement range.
4. Identification of the spectrum associated with the first vibrational level of the electronic key-state.
5. Selection of theoretical analytical methods appropriate for high resolution spectroscopy.

2022/2023; sem. III and IV

1. The deperturbation analysis for the first vibrational level of the electronic key-state.
2. Receiving and presenting the results and formulating conclusions and forecasts.
3. Writing a scientific article presenting the obtained results for the first vibrational level.
4. Identification of the spectrum associated with the higher vibrational level of the electronic key-state.
5. The deperturbation analysis for the higher vibrational level of the electronic key-state.
6. Obtaining and presenting results. Formulating conclusions and forecasts.
7. Writing an article presenting the obtained results.

2023/2024; sem. V and VI

1. Performing the deperturbation analysis for the next two higher vibrational levels of the electronic key-state.
2. Obtaining and presenting results. Formulating conclusions and forecasts.
3. Writing two publications presenting the obtained results.

2024/2025; sem. VII and VIII

1. Conducting a global deperturbation analysis with the participation of all analysed vibrational levels of the electronic key-state.
2. Writing an article presenting the global results.
3. Writing a PhD dissertation.

COURSE ASSESSMENT CRITERIA

Grade: Pass-Fail. Each odd semester is credited with promotion on the basis of the degree of involvement of the PhD student in the implementation of the tasks specified in the section "COURSE CONTENT". The condition for obtaining a credit after semester II, IV, VI and VIII is the actual completion of the following tasks:

- points 1-5 of the "COURSE CONTENT" section in 2021/2022; sem. I and II
- points 1-7 of the "COURSE CONTENT" section in 2022/2023; sem. III and IV
- points 1-3 of the "COURSE CONTENT" section in 2023/2024; sem. V and VI
- points 1-3 of the "COURSE CONTENT" section in 2024/2025; sem. VII and VIII.

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	240
Other contact hours involving the teacher (consultation hours, examinations)	100
Non-contact hours – student`s own work (preparation for classes or examinations, project, etc.)	400
Total number of hours	740
Total number of ECTS credits	

INSTRUCTIONAL MATERIALS

Compulsory literature:	1. J. Sadlej „Spektroskopia molekularna", WNT, 2002 2. W. Kołos, J. Sadlej „Atom i cząsteczka", WNT, 1998 3. W. Kołos „Chemia kwantowa", PWN, 1978 4. P. W. Atkins „Chemia fizyczna", PWN, 2001 5. H. Haken, H. Ch. Wolf „Fizyka molekularna z elementami chemii kwantowej", PWN, 1998. 6. H. Haken, H. Ch. Wolf „Atomy i kwanty", PWN, 2002 (2 wyd.) 7. P. Kowalczyk „Fizyka cząsteczek. Energie i widma", PWN, 1999. 8. A. Gołębiewski „Elementy mechaniki i chemii kwantowej", PWN, 1982. 9. Z. Leś „Wstęp do spektroskopii atomowej", PWN 2014.
Complementary literature:	1. G. Gauglitz, D.S.Moore, „Handbook of Spectroscopy", Wiley-VCH Verlag GmBH, 2014.