A COURSE SYLLABUS – DOCTORAL SCHOOL

REGARDING THE QUALIFICATION CYCLE FROM 2021 TO 2025

GENERAL INFORMATION ABOUT COURSE	
Course title	**Scientific Research Methodology**
Name of the unit running the course	Doctoral School at University of Rzeszów
Type of course *(obligatory, optional)*	obligatory
Year and semester of studies	First year, winter semester
Discipline	Physics
Language of Course	Polish/English
Name of Course coordinator	Dr hab. Igor Tralle, prof. UR
Name of Course lecturer	Dr hab. Igor Tralle, prof. UR
Prerequisites	Master degree in Physics or Mathematics

Introduction. What is science – definition and history of development starting from the times of ancient Greece up to XXI century. Knowledge and truth. Misconceptions regarding research work. The attitude of different scientists and philosophes towards science starting from F. Bacon and I. Newton till T. Kuhn, P. Feyerabend and K. Popper. Methods of complete and incomplete induction. Inductive reasoning. The principles of scientific approach: *do not trust anything, but doubt only what it is worth doubting.*

Elements of modern Quantum Mechanics, omitted in standard University course of QM. Measurement as an indispensable stage of any experiment. The peculiarities of experiments conducted in the framework of QM.

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.) **1.**	To be able to revise the existing paradigms, that is the most important scientific achievements, including its theoretical foundations and general and selected specific issues that are appropriate to the scientific discipline. What is science – definition and history of development starting from the times of ancient Greece up to XXI century. Knowledge and truth. The PhD student possesses knowledge regarding modern quantum theory.	**P8S-WG/1**	Lectures, seminars	Observation and discussions at classes, control of PhD student ability to solve the problems independently and to analyse the open problems. Credit on base of correct answers to prosed questions and solutions of problems.
2.	Main trends in developing of the scientific disciplines which are the PhD student field of study. The structure of science.	**P8S-WG/2**	Lectures, seminars	Discussions, test
3.	Methodology of research.	**P8S-WG/3**	Lectures, seminars	Observation

	Misconceptions regarding research work. The attitude of different scientists and philosophes towards science starting from F. Bacon and I. Newton till T. Kuhn, P. Feyerabend and K. Popper.			and discussions at classes, control of PhD student ability to solve the problems independently and to analyse the open problems. Credit on base of correct answers to prosed questions and solutions of problems.
4.	The principles of dissemination of the research results also in the open access, ethics in science, publications, including arXiv internet site.	**P8S-WG/4**	Lectures, seminars	Discussions, test
Skills (no.) 1.	PhD student should be able to use the knowledge from various fields of science to creatively identify and innovatively solve complex problems or utilize the methods of research, in particular, to define the goal and topics of research, to formulate research hypothesis, to develop methods and research techniques and to apply them creatively, make conclusions on base of research.	**P8S-UW/1**	Lectures, seminars	Observation and discussions at classes, control of PhD student ability to solve the problems independently and to analyse the open problems. Credit on base of correct answers to prosed questions and solutions of problems.
Social competence (no.)				

LEARNING FORMAT – NUMBER OF HOURS

Semester (no.)	Lectures	Seminars	Lab classes	Internships	others	ECTS
Winter semester	10	20	——	——	——	0

METHODS OF INSTRUCTION

E.G. LECTURE, TEXT ANALYSIS AND DISCUSSION; PROBLEM SOLVING

COURSE CONTENT

1. Lectures/ Seminars:

1. Introduction. What is science – definition and history of development starting from the times of ancient Greece up to XXI century.
2. Misconceptions regarding research work. The attitude of different scientists and philosophes towards science starting from F. Bacon and I. Newton till T. Kuhn, P. Feyerabend and K. Popper.
3. Methods of complete and incomplete induction. Inductive reasoning.
4. The principles of scientific approach: *do not trust anything, but doubt only what it is worth doubting.*
5. Elements of modern Quantum Mechanics, omitted in standard University course of QM. The peculiarities of experiments conducted in the framework of QM.
6. Pure and mixed states.
7. Qu-bits; decoherence due to interaction between quantum system and environment.
8. Entangled states. The basics of Quantum Information

Seminar:

COURSE ASSESSMENT CRITERIA

The PhD student is obliged to be present at all lectures and classes. He/she should actively participate in the discussion of raised issues and to analyse independently the open problems.
Credit on the basis of the answers to the formulated questions and independent solutions to the posed problems,
for the excellent grade – not less than 95% of correct answers to the posed questions and solutions of the formulated problems;
for the good grade - not less than 80% of correct answers to the posed questions and solutions of the formulated problems;
for the satisfactory grade - not less than 60% of correct answers to the posed questions and solutions of the formulated problems.

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	10 h . - lectures + 20 h classes
Other contact hours involving the teacher (consultation hours, examinations)	
Non-contact hours – student`s own work (preparation for classes or examinations, project, etc.)	50 h
Total number of hours	8o h
Total number of ECTS credits	

INSTRUCTIONAL MATERIALS

Compulsory literature:	1. A. Grobler, Metodologia nauk, Wyd. Aureus –Wyd. Znak, Kraków 2008 2. G. Polya, *Mathematics and Plausible Reasoning*. 3. G. Polya, *Mathematical Discovery*. J.Wiley&Sons, NY, London 1962-1965 4. Dieter Heiss (Ed.) *Fundamentals of Quantum Information.* Springer.

Complementary literature:	1. S. WEINBERG, FOUR GOLDEN LESSONS, NATURE, 2003, 426, 389 2. Roger Penrose The Road to Reality. 2004 3. Z. Michalewicz, David B. Fogel, How to Solve It: Modern Heuristics, Springer-Verlag, 2004 4. Y. Aharonov, D. Rohrlich, *Quantum Paradoxes.* Wiley-VCH Verlag, 2005