A COURSE SYLLABUS – DOCTORAL SCHOOL

REGARDING THE QUALIFICATION CYCLE FROM 2019 TO 2023

GENERAL INFORMATION ABOUT COURSE	
Course title	Doctoral 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	2021/2022; V i VI sem.
Discipline	Physical Sciences
Language of Course	Polish
Name of Course coordinator	Dr hab. Paweł Jakupczyk, prof. UR
Name of Course lecturer	Dr hab. Paweł Jakubczyk, prof. UR
Prerequisites	Knowledge of physics at the university level, particularly mathematical models of spin systems.

BRIEF DESCRIPTION OF COURSE
(100-200 words)

The content of the course is directly related to the concept and implementation of the PhD thesis. In particular, it covers: familiarizing the student with the methodology of scientific work, developing skills related to the scientific workshop, preparing the concept of the doctoral dissertation and writing the doctoral dissertation.

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.)	**(Knows and understands)**			
K1	Understands the context of the study of nanoscopic systems in relation to other research in physics and can evaluate promising directions of research.	**P8S-WG/1, P8S-WG/2, P8S-KK/3**	seminar	direct observation
K2	Knows the basic research tools, computer programs and laboratory methods to investigate properties and determine parameters of nanoscopic systems	**P8S-WG/3, P8S-WK/3**	seminar	direct observation
Skills (no.)	**(Able to)**			
S1	Be familiar with basic computational techniques and computer programs related to nanoscopic systems research methodology	**P8S-UW/1**	seminar	direct observation
S2	Be able to critically analyze the obtained research results and assess their usefulness in planning further research activities	**P8S-UW/2,** **P8S-KK/1**	seminar	direct observation
S3	Be able to explain the purpose of the research and to evaluate the chance of successful completion	**P8S-UK/3, P8S-UK/4, P8S-KK/2**	seminar	direct observation

	of the research			
S4	Be able to initiate collaboration with foreign researchers by clearly defining their role in joint research	**P8S-UO, P8S-UU/1**	seminar	direct observation
Social competence (no.)	**(Ready to)**			
SC1	Be able to write a scientific article in a chosen field of research	**P8S-WG/4, P8S-WK/3, P8S-UW/3**	seminar	direct observation
SC2	Is willing to make a public presentation of the obtained research results in a conference or in terms of popular science	**P8S-UW/3, P8S-UK/1, P8S-UK/2**	seminar	direct observation
SC3	Be able to respect the principles of public ownership of the results of scientific activity, including the protection of intellectual property	**P8S-KR**	seminar	direct observation

LEARNING FORMAT – NUMBER OF HOURS

Semester (no.)	Lectures	Seminars	Lab classes	Internships	others	ECTS
V-VI	—	60	—	—	—	0

METHODS OF INSTRUCTION

Individual work at a desk using paper and pen, dry erase board and computer equipment (computer programs).

COURSE CONTENT

1. Implementation of theoretical and numerical studies on selected nanoscopic systems
2. Analysis and interpretation of the obtained results
3. Attempt to create new mathematical models of entangled quantum systems
4. Preparation of a scientific paper presenting the obtained results

COURSE ASSESSMENT CRITERIA

Due to the individual nature of the course (working with one student), the checking and assessment of learning outcomes is done on an ongoing basis.

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	60
Other contact hours involving the teacher (consultation hours, examinations)	4
Non-contact hours – student`s own work (preparation for classes or examinations, project, etc.)	100
Total number of hours	164
Total number of ECTS credits	0

INSTRUCTIONAL MATERIALS	
Compulsory literature:	1. R. Horodecki, P. Horodecki, M. Horodecki, K. Horodecki, Quantum entanglement, Rev. Mod. Phys. 81:865-942, 2009. 2. Mark M. Wilde, Quantum information theory, Cambridge University Press, 2013. 3. Applied quantum mechanics / A. F. J. Levi. - 2nd ed., first paperback edition (with corrections). - Cambridge : Cambridge University Press, 2012. 4. Quantum theory of magnetism : magnetic properties of materials / Robert M. White. - 3 compl. rev. ed. - Berlin : Springer, cop. 2007. 5. C. Santamaria, H.T. Diep, Evidence of Partial Disorder in a Frustrated Heisenberg Spin System, J. Appl. Phys., 81 (1997), 5276-5278 6. D.D. Stancil, A. Prabhakar, „Spin Waves", Springer, Berlin 2009.
Complementary literature:	1. N.A. Spaldin, „Magnetic Materials. Fundamentals and Applications", Cambridge University Press, Cambridge 2010. 2. C. Lacroix, P. Mendels, F. Mila, „Introduction to Frustrated Magnetism: Materials, Experiments, Theory", Springer, Heidelberg 2011.