Doctoral School
Warsaw University of Technology

COURSE OFFERED IN THE DOCTORAL SCHOOL

Code of the course	4606-ES-DFGHKLP-0340	Name of the course	Polish	**Kompetencje Kwantowe**	
			English	**Quantum Literacy**	
Type of the course	specialized				
Course coordinator	Teodor Buchner	Course teacher	Teodor Buchner		
Implementing unit	Faculty of Physics	Scientific discipline / disciplines*	physical sciences chemical sciences biomedical engineering biotechnology civil engineering, geodesy and transport materials engineering mechanical engineering		
Level of education	doctoral studies	Semester	winter		
Language of the course	English				
Type of assessment	passing	Number of hours in a semester	30	ECTS credits	2
Minimum number of participants	10	Maximum number of participants	24	Available for students (BSc, MSc)	Yes

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week			2		
	in a semester			30		

* does not apply to the Researcher's Workshop

1. Prerequisites

Physical literacy on the level of 1-st grade physics classes.

2. Course objectives

The objective of the course is to build literacy in quantum technology (QT) and its applications, and its particular aim is introduction of quantum sensors, as among all quantum use cases (computing, cryptograph, sensors) they represent the largest market and may have a leveraging effect on European economy, industry, defense and society. The course is transdisciplinary by definition and it covers a broad area, which starts from physics and ends at the topics selected by the students and rooted in their own curricula. The role of the instructor is delivery of knowledge and expertise, but most of the course results will be delivered by the students themselves. Active participation, dedication and team building are essential. The role of the instructor is not to build enthusiasm by demonstrating the virtues of the QT, as the students are obliged to find it for themselves, with a minimum help of the instructor.
Literacy in internet search and ability to communicate with LLM assistant will be helpful.
A product of the course is the set of business plans for introduction of quantum technology in a selected application field, in a form of presentation. Each business plan will be delivered by a different student group. Depending on the baseline of the students, the presentation may concentrate on technical aspect, application aspects and background related to specific market need, market evaluation or all of above.
The specific steps are.

1. Understanding physical principles behind quantum technologies to an extent necessary to understand their course of action
2. Identifying area within students own curriculum in which quantum technology can be applied – identification of market need
3. Building description of use-cases in Project Based Learning / Design Thinking approach
4. Performing gap Identifying the market offer in the selected area
5. Performing economic analysis of the project for introduction of quantum technologies

6. Preparing plan for introduction of quantum technology
7. Preparing a presentation
8. Presentation and discussion of group results

Each of subject comprises of a component delivered by the instructor and the component delivered by the students, who voluntarily organize into 2-5 person groups. Elements of agile project managements will be used. Deliverables must include social communication of the project, which could explain the society the importance of quantum technology in solving a particular problem.

3. Course content (separate for each type of classes)

Lecture

Hrs	Subject	Role model	
		Instructor	Students
1	Introduction into QT (1h)	Moderates the process	Introduce themselves, share motivations and expectations
2	Introduction into QT (1h)	Explains what is the scope of quantum technologies and what are possible use-cases. Gives instructions concerning the process of target area identification	Note, comment
4	Identification of use-cases (2h)	Moderation, identification of theoretical aspects for scientific introduction, fostering group formation	Present the results of desk research, discuss, form groups of interest
6	Scientific introduction into selected area of quantum technology (2h)	Presentation, moderation of discussion	Active participation, on-line digging, discussion, identification of knowledge gaps
8	Filling knowledge gaps in QT (2h)	Presentation, moderation of discussion	Active participation, feedback on scientific introduction process and aims for improvement – in particular gap analysis concerning potentially useful simulation and visualization tools
9	Team work organization methods (1h)	Presentation of task & Knowledge management techniques, introduction to tools (Atlassian Jira and similar)	Identification of their preferred style of group work
10	Action plan management (1h)	moderation of discussion	Groups discuss organizational issues, decide on the tools, that will be used in project development

12	Presentation of group objectives (2h)	Refinement. Assistance in group organization and action plan development.	Present project ideas and distribution of tasks, deliverables and responsibilities. Prepare an action plan. Identify critical technologies and parameter values for the success of the proposed action, perform gap analysis / value chain analysis.
26	Group activities (7 x 2h)	Supervision, ad hoc expert support	Action, preparation of deliverables, preparation of presentation, preparation of social communication
28	Group presentation part 1 (2h)	Session chair, comments	Present group results, plenary discussion
30	Group presentations part 2 (2h)	Session chair, comments, wrap up	Present group results, plenary discussion

4. Learning outcomes			
Type of learning outcomes	Learning outcomes description	Reference to the learning outcomes of the WUT DS	Learning outcomes verification methods*
Knowledge			
W01	Identification of market needs related to deep tech. Operational knowledge of capabilities of quantum technologies	SD_W1	active participation during classes
W02	Identification of methods for quantum technology	SD_W2	active participation during classes
W03	Identification of methods for application of quantum technology,	SD_W5, SD_W4	presentation evaluation
Skills			
U01	Ability to perform value chain analysis and gap analysis in the quantum technology area	SD_U3	presentation evaluation
U02	Group communication, responsibility	SD_U4, SD_U6, SD_U7	active participation during classes
U03	Leadership skills	SD_U5	active participation during classes
Social competences			

K01	Creative thinking	SD_K4	active participation during classes
K02	Understanding role of deep tech, in particular QT in solving problems of modern society.	SD_K2, SD_K3	presentation evaluation
K03	Developing methods to fulfill obligations towards the society in return to free-of-charge/low charge access to knowledge, social communication	SD_K3, SD_K4, SD_K2	presentation evaluation

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria

Assessment criteria are based on the evaluation of quality of the delivered presentation. It will be verified:

- Does it fulfill the minimum criteria defined for the scope and content (definition of done)
- Does it contain attribution of authors to assess individual responsibilities
- Is it neat and expressed in professional language, does it have a professional layout
- Is it understandable to potential business partners / investors
- Does it contain slide devoted to social communication and is it understandable by general public.

6. Literature

Primary references:

[1] Aslam, N., Zhou, H., Urbach, E.K. *et al.* Quantum sensors for biomedical applications. *Nat Rev Phys* **5**, 157–169 (2023). https://doi.org/10.1038/s42254-023-00558-3

[2] Michal Krelina Quantum Technology for Military Applications https://arxiv.org/abs/2103.12548

[3] https://io.nihr.ac.uk/wp-content/uploads/2025/03/NIHR-IO-Quantum-Sensing-Technology-Report_Jan-2025.pdf

[4] https://www.oelabs.com/info-detail/the-crucial-role-of-magnetometers-in-inertial-navigation-systems

[5] Chung-Jui Yu, Stephen von Kugelgen, Daniel W. Laorenza, and Danna E. Freedman, A Molecular Approach to Quantum Sensing, ACS Central Science 2021 7 (5), 712-723, DOI: 10.1021/acscentsci.0c00737

[6] Adrisha Sarkar et al. ,High-precision chemical quantum sensing in flowing monodisperse microdroplets.Sci. Adv.10,eadp4033(2024).DOI:10.1126/sciadv.adp4033

Secondary references:

[1] Liu J, Zhang W, Cheng S. Quantum metrology and its applications in civil engineering. *Measurement*. 2024;240:115550. doi:10.1016/j.measurement.2024.115550

[2] Pęczalski, K., Sobiech, J., Buchner, T. *et al.* Synchronous recording of magnetocardiographic and electrocardiographic signals. *Sci Rep* **14**, 4098 (2024). https://doi.org/10.1038/s41598-024-54126-5

7. PhD student's workload necessary to achieve the learning outcomes**

No.	Description	Number of hours
1	Hours of scheduled instruction given by the academic teacher in the classroom	30
2	Hours of consultations with the academic teacher, exams, tests, etc.	
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	30
4	Amount of time devoted to the preparation for exams, test, assessments	
	Total number of hours	**60**

ECTS credits	**2**

** 1 ECTS = 25-30 hours of the PhD students work (2 ECTS = 60 hours; 4 ECTS = 110 hours, etc.)

8. Additional information	
Number of ECTS credits for classes requiring direct participation of academic teachers	2
Number of ECTS credits earned by a student in a practical course	2