Warsaw University of Technology

# COURSE OFFERED IN THE DOCTORAL SCHOOL

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| Code of the course | 4606-ES-0000JKL-0265 | Name of the course | Polish | **Przełomowe prace w fizyce** | |
| | | | English | **Seminal papers in physics** | |
| Type of the course | specialized | | | | |
| Course coordinator | Prof. dr hab. Janusz Hołyst | | Course teacher | Prof. dr hab. Janusz Hołyst | |
| Implementing unit | WF | Scientific discipline / disciplines* | Physics, mathematics, chemistry | | |
| Level of education | Doctoral studies | Semester | Winter | | |
| Language of the course | English | | | | |
| Type of assessment | credit | Number of hours in a semester | 30 | ECTS credits | 2 |
| Minimum number of participants | 10 | Maximum number of participants | 30 | Available for students (BSc, MSc) | Yes/~~No~~ |

| Type of classes | | Lecture | Auditory classes | Project classes | Laboratory | Seminar |
|---|---|---|---|---|---|---|
| Number of hours | in a week | 2 | | | | 2 |
| | in a semester | 4 | | | | 26 |

* does not apply to the Researcher's Workshop

## 1. Prerequisites

none

## 2. Course objectives

The aim of the course is to offer students a possibility to get acquainted with groundbreaking discoveries in the field of physics and related research that have influenced or may influence the development of entire field. The seminal results and their impacts will be discussed during seminar meetings where students will present materials of selected publications. The choice of discussed papers will be dependent on seminar participants upon the agreement of the course coordinator but the primary option are materials related to Nobel Prizes and original papers of Nobel Prize Laureates.

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

### Seminar

Topics of seminar meetings can be related for example to research that has been awarded by Nobel Prizes in Physics or that are based on physical methods and were awarded by a Nobel Prizes in another disciplines. Below are a few proposals.

1. How entanglement has become a powerful tool for quantum information - discussion on groundbreaking experiments of Alain Aspect, John Clauser and Anton Zeilinger who have demonstrated the potential to investigate and control particles that are in entangled states (Nobel Prize in Physics 2022)

2. How one can model Earth's climate, quantify variability and reliably predict global warming – discussion on research of Syukuro Manabe and Klaus Hasselmann (Nobel Prize in Physics 2021)

3. Interplay of disorder and fluctuations in physical systems from atomic to planetary scales - discussion on groundbreaking discoveries of Giorgio Parisi (Nobel Prize in Physics 2021)

4. Topological phase transitions and topological phases of matter – discussion on theoretical discoveries of David J. Thouless, F. Duncan M. Haldane and J. Michael Kosterlitz (Nobel Prize in Physics 2016)

5. Bose-Einstein condensation in dilute gases of alkali atoms, and early fundamental studies of the properties of the condensates, discussion on achievements of Eric A. Cornell, Wolfgang Ketterle and Carl E. Wieman (Nobel Prize in Physics 2001)

6. Method to determine the value of financial derivatives - discussion on discoveries of Fisher Black, Robert C. Merton and Myron S. Scholes (Nobel Prize in Economy 1997)

7. How methods developed for studying order phenomena in simple systems can be generalized to more complex forms of matter, in particular to liquid crystals and polymers - discussion on discoveries of Pierre-Gilles de Gennes (Nobel Prize in Physics 1991)

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| Laboratory |
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| 4. Learning outcomes | | | |
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| Type of learning outcomes | Learning outcomes description | Reference to the learning outcomes of the WUT DS | Learning outcomes verification methods* |
| Knowledge | | | |
| K01 | Zna i rozumie w stopniu umożliwiającym rewizję istniejących paradygmatów – światowy dorobek, obejmujący podstawy teoretyczne oraz zagadnienia ogólne i wybrane zagadnienia szczegółowe – właściwe dla fizyki , w tym najnowsze osiągnięcia fizyki w obszarze prowadzonych badań | SD_W2 | Evaluation of presentation, evaluation of activity during the seminar meetings |
| K02 | Zna i rozumie główne trendy rozwojowe fizyki oraz związane z tym metodologie badań naukowych | SD_W3 | Evaluation of presentation, evaluation of activity during the seminar meetings |
| K03 | | | |
| Skills | | | |
| S01 | Potrafi dokonywać krytycznej analizy i oceny wyników badań naukowych, działalności eksperckiej i innych prac o charakterze twórczym oraz ich wkładu w rozwój fizyki. | SD_U2 | Evaluation of presentation, evaluation of activity during the seminar meetings |
| S02 | Potrafi inicjować debatę oraz uczestniczyć w dyskursie naukowym oraz przytaczać właściwe argumenty w dyskusjach naukowych i debatach publicznych o różnorodnej tematyce | SD_U4 | Evaluation of presentation, evaluation of activity during the seminar meetings |
| Social competences | | | |

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| SC01 | Jest gotów do krytycznej oceny dorobku reprezentowanej dyscypliny naukowej, w tym własnego wkładu w rozwój tej dyscypliny | SD_K1 | Evaluation of presentation, evaluation of activity during the seminar meetings |

*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 |
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| Quality of presentation; quality of active participation during seminars |

| 6. Literature |
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| Primary references:<br>[1] https://www.nobelprize.org/prizes/physics/ ; especially advanced descriptions of awarded research, e.g. https://www.nobelprize.org/uploads/2022/10/advanced-physicsprize2022-3.pdf<br>[2] https://www.nobelprize.org/prizes/economic-sciences/1997/advanced-information/<br><br>Secondary references:<br><br>Seminal papers of corresponding Nobel Prize laureates; e.g.:<br>[1] A. Aspect, P. Grangier and G. Roger, *Experimental tests of realistic local theories via Bell's theorem*, Phys. Rev. Lett. **47**, 460 (1981).<br>[2] K. Hasselmann, *Stochastic climate models part I. Theory*. Tellus 28(6), 473-485. 1976.<br>[3] Black, F., M. Scholes, 1973, *The Pricing of Options and Corporate Liabilities*, Journal of Political Economy, Vol. 81, pp. 637-654,<br>[4] Black, F., 1989, *How We came Up with the Option Formula*, The J. of Portfolio Management, **15,** pp. 4-8, |

| 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. | 2 |
| 3 | Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework | 20 |
| 4 | Amount of time devoted to the preparation for exams, test, assessments | 0 |
| | **Total number of hours** | **52** |
| | **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 | |
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| 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 | 0 |