KAPITAŁ LUDZKI
NARODOWA STRATEGIA SPÓJNOŚCI

Projekt współfinansowany przez Unię Europejską w ramach Europejskiego Funduszu Społecznego

UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ SPOŁECZNY

Nazwa przedmiotu	Kod ECTS
Probability and Information Theory	13.2.0670

Nazwa jednostki prowadzącej przedmiot

Instytut Fizyki Teoretycznej i Astrofizyki

Studia

wydział	kierunek		
Wydział Matematyki, Fizyki i Informatyki	Quantum Information Technology	poziom	wszystkie
		forma	wszystkie
		moduł specjalnościowy	wszystkie
		specjalizacja	wszystkie

Nazwisko osoby prowadzącej (osób prowadzących)

dr Michał Studziński; mgr Chithra Raj; prof. UG, dr hab. Karol Horodecki

Formy zajęć, sposób ich realizacji i przypisana im liczba godzin

Formy zajęć

Wykład, Ćw. audytoryjne

Sposób realizacji zajęć

zajęcia on-line, zajęcia w sali dydaktycznej

Liczba godzin

Ćw. audytoryjne: 30 godz., Wykład: 30 godz.

Liczba punktów ECTS

6
lecture: 30 h, tutorial classes: 30 h, students own work: 90h
Total: 150h
Therefore, 150/25 = 6 ECTS

Termin realizacji przedmiotu

2023/2024 zimowy

Status przedmiotu

obowiązkowy

Język wykładowy

angielski

Metody dydaktyczne

- Analiza zdarzeń krytycznych (przypadków)
- Dyskusja
- Praca w grupach
- Rozwiązywanie zadań
- Wykład konwersatoryjny
- Wykład problemowy
- Wykład z prezentacją multimedialną

Forma i sposób zaliczenia oraz podstawowe kryteria oceny lub wymagania egzaminacyjne

Sposób zaliczenia

- Egzamin
- Zaliczenie (zal)

Formy zaliczenia

- egzamin pisemny z pytaniami (zadaniami) otwartymi
- egzamin pisemny (dłuższa wypowiedź pisemna / rozwiązanie problemu)

Podstawowe kryteria oceny

form	passing threshold	weight in final grade
passing the excersises	50%	50%
exam	50%	50%

Sposób weryfikacji założonych efektów uczenia się

Effect of teaching	problem solving	group work	discussion	critical incident (case) analysis	problem-focused lecture	seminar lecture	multimedia-based lecture
	Knowledge						
K_W01					X	X	X
K_W02					X	X	X
K_W04					X	X	X
K_W06					X	X	X
	Skills						
K_U01	X	X	X	X			
K_U02	X	X	X	X			
K_U03	X	X	X	X			
K_U05	X	X	X	X			
K_U06	X	X	X	X			
	Competences						
K_K01	X		X			X	

Określenie przedmiotów wprowadzających wraz z wymogami wstępnymi

A. Wymagania formalne

No formal requirements

B. Wymagania wstępne

Basic knowledge of mathematics at high school level is required

Cele kształcenia

The aim of this lecture is to provide students with specific knowledge of probability theory and statistics necessary to understand some aspects of quantum mechanics and quantum information theory. The student will also acquire basic knowledge in the field of application of the main concepts of information theory such as entropy, mutual information or relative entropy and their properties. The student will also learn the capacities of communication channels and methods of estimating them. Acquiring this knowledge will result in understanding of the possibilities and limitations of communication as well as will provide an introduction to other courses of quantum information theory. The student will be able to apply the knowledge learned in whatever context it can be used, including physics, statistics and cryptography.

Treści programowe

Lecture and excersises will cover the same main topics.

1. Basic notions of probability: probability space, standard normal distribution, random variable, expected value, variance.
2. Density function and the cumulative distribution function, independence of random variables.
3. Bayes theorem.
4. Law of large numbers and the central limit theorem for indenepent and identically distributed random variables.
5. Shannon entropy function, its interpretation and properties.
6. Entropy functions of many variables, including conditional entropy, mutual information, relative entropy, conditional mutual information and their properties, including data processing inequality and the chain principle for conditional mutual information.

7. Asymptotic Equipartition Property theorem, compression codes , error correction codes.
8. The concept of typical and total typical sequences, Shannon's theorem on the capacity of a communication channel, random code technique

9. Capacities of selected communication channel and Slepian-Wolf theorem on joint coding

10. Kraft and Mc Millan inequality

Wykaz literatury

A. Literature required to pass the course

E. Shannon, W. Weaver “ The Mathematical Theory of Communication”
Thomas M. Cover, Joy A. Thomas “Elements of Information theory”
R. W. Yeung “A First Course in Information Theory”

chapters of M. Nielsen, I. Chuang „Quantum Information and Computation” concerning IT
B. Extracurricular readings
other chapters of M. Nielsen, I. Chuang „Quantum Information and Computation”

Kierunkowe efekty uczenia się

K_W01 Student has extensive knowledge in the field of general physics and advanced knowledge in the field of quantum information theory; knows the history of the development of quantum information theory and its importance for the progress of exact and natural sciences, knowledge of the world and social development
K_W02 Student has in-depth knowledge of advanced mathematics as well as mathematical and computer methods, necessary to solve physical problems of medium complexity and advanced in the area of quantum information and its technological aspects
K_W04 Student knows advanced methods of theoretical and mathematical physics necessary to create models of quantum mechanics
K_W06 Student has knowledge of the current directions of development of physics, in particular within the theory of quantum information
K_U01 Student can apply the scientific method in solving physical problems and reasoning in the field of quantum information theory
K_U02 Student has the ability to plan and conduct basic and advanced research and calculations in the field of quantum information theory or its applications
K_U03 Student is able to make a critical analysis of observations or theoretical calculations together with the assessment of the accuracy of the results
K_U05 Student has the ability to synthesize methods and ideas from various areas of physics and other exact and natural sciences; is able to notice that sometimes distant phenomena are described by similar models
K_U06 Student is able to adapt knowledge and methodology of physics as well as applied theoretical methods to related scientific disciplines
K_K01 Student knows the limitations of his own knowledge and skills; can formulate questions precisely; understands the need for further education of oneself and others

Wiedza

W01: Student can define basic notions including entropy, mutual information, code, channel capacity, relative entropy, (K_W01)
W02 Student knows the proofs of the main facts such as Asymptotic Equipartition Property, Shanonn’s theorem etc., as well as knows basic methods such as compression algorithms (K_W02)
W04 Student knows statistical methods of theoretical and mathematical physics necessary to create and interpret models of quantum mechanics (K_W04)
W06 Student has knowledge of the current directions of development of physics, in particular within the theory of quantum information (K_W06)

Umiejętności

U09 Student can solve problems in teams and individually (K_U09)
U11 Student is able to determine the directions of further improvement of knowledge and skills in the field of Categorical Quantum Mechanics (K_U11)
U12 Though exposure to a course conducted in English language and English scientific literature, the student is able to use English to the extent that allows for independent completion of education and communication with specialists in the same or related specialization (K_U12)

Kompetencje społeczne (postawy)

K01 Student knows the limitations of his own knowledge in the vastly developing field of Quantum Mechanics(K_K01)
K03 Student can solve problems in teams and individually (K_K03)

Kontakt

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