Course title:	Foundations of Quantum Computing
Course title in Polish:	Podstawy Obliczeń Kwantowych
Course for discipline:	Information and communication technology

Semester:	6	**Status of course:**	faculty	**Language:**	english
Academic year:		**Catalog number:**			

Coordinator of course:	dr Piotr Stachura
Lecturer od course:	dr hab. Arkadiusz Orłowski, dr Piotr Stachura, dr Andrzej Zembrzuski
Executing unit:	Institute of Information Technologuy
Ordering unit:	Doctoral School SGGW
Assumptions, goals and description of the course:	The goal of the course is to familiarize students with basics of quantum computing to enable them further studies in this fastly developing field of knowledge. We are going to begin with short survey of the most interesting aspects of quantum computers and quantum computing (quantum supremacy i.e. reduction of computational complexity of some algorithms, in particular threats for public key cryptography). In the next part we will introduce and discuss elementary but important mathematical (elements of linear algebra and probability theory) and physical (basic elements of quantum mechanics: pure and mixed states, observables, superposition, entanglement and non-locality) notions essential for understanding the subject field. After presentation of basic quantum algorithms (Quantum Fourier Transform, Shor's Algorith, Grover's Search Algorithm), time permitting, we are going to discuss other topics as quantum cryptography (key distribution), dense coding, quantum teleportation. Finally, the short information on technological and physical aspects of quantum computers and state of the art is also planned. We are going to engage students in form of projects and presentations.
Didactic form, number of hours:	lecture, 10
Teaching methods:	lecture, student presentation, discussion
Limit of people in the group:	20

Learning outcomes

KNOWLEDGE - the graduate knows and understands:	**SKILLS - the graduate is able to:**	**COMPETENCES - the graduate is ready to:**
To the extent enabling to revise the existing pradigms in the field/discipline - the world achievments, gathering theoretical background as well as general and selected detailed issues	Carry out critical assessment of the scientific research findings and expert activities and their contribution to the knowledge development in the field/discipline	Critically evaluate the achievments in the field/discipline represented
Major general development trends in the field/discipline		Recognise knowledge in solving cognitive and practical problems characteristic for the area of research (field/discipline) and in an interdisciplinary aspect
		Support the ethos of scientific circles and conduct independent research

The method of verification of learning outcomes:	presentation of choosen topic
Form of documentation of achieved learning outcomes:	presentation file
Elements and weights of the final grade:	attendence and activity - 30%, presentation - 70%
Place of the course:	Lecture room

Basic and supplementary literature

Basic literature:
M. A. Nielsen & I.L. Chuang "Quantum Computation and Quantum Information" Cambridge Univ. Press (selected chapters);
R. de Wolf "Quantum Computing: Lecture Notes", arXiv:1907.09415 ;
Supplementary literature:
A. Zeilinger "Experiment and the foundations of quantum physics", Rev. Mod. Phys. Vol. 71, No. 2, (1999);
M. Keyl "Fundamentals of quantum information theory", Phys. Rep. 369 (2002);
C. Easttom "Hardware for Quantum Computing ", Springer;
N. S. Yanofsky and M. A. Mannucci "Quantum computing for computer scientists", Cambridge Univ. Press;
E. Johnston, N. Harrigan, M. Gimeno-Segovia " Programming Quantum Computers : Essential Algorithms and Code Samples", O'Reilly Media 2019

Comments:	

Estimated number of hours of work of the doctoral student necessary to achieve the assumed learning outcomes:	30

Leraning outcomes reference to the second degree characteristics of the National Qualification Framework (level 8) covering doctoral competences:

Symbol:	**Learning outcomes:**	**8 level NQF**
SD1_KW01	To the extent enabling to revise the existing pradigms in the field/discipline - the world achievments, gathering theoretical background as well as general and selected detailed issues	P8S_WG
SD1_KW02	Major general development trends in the field/discipline	P8S_WG
SD1_KU05	Carry out critical assessment of the scientific research findings and expert activities and their contribution to the knowledge development in the field/discipline	P8S_UW

SD1_KK01	Critically evaluate the achievments in the field/discipline represented	P8S_KK
SD1_KK03	Recognise knowledge in solving cognitive and practical problems characteristic for the area of research (field/discipline) and in an interdisciplinary aspect	P8S_KK
SD1_KK08	Support the ethos of scientific circles and conduct independent research	P8S_KR