

Subject card

Subject name and code	Programming, PG_00159197						
Field of study	Quantum Information Technology						
Date of commencement of studies	October 2025		Academic year of realisation of subject		2025/2026		
Education level	Master's studies		Subject group		Obligatory subject group in the field of study		
Mode of study	full-time studies		Mode of delivery		at the university		
Year of study	1		Language of instruction		English		
Semester of study	1		ECTS credits		3.0		
Learning profile	academic		Assessment form		credit		
Conducting unit							
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Piotr Mironowicz				
	Teachers		dr hab. inż. Piotr Mironowicz mgr Fernando Almaguer Angeles				
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	15.0	0.0	0.0	30
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours		Self-study	SUM
	Number of study hours	30		0.0		15.0	45
Subject objectives	The aim of this course is to provide a student a comprehensive overview of programming methodology that can be useful in further independent research in quantum information						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[QITL3_W02] has in-depth knowledge in the field of advanced mathematics and mathematical and computer methods, necessary to solve physical problems of medium complexity, and advanced knowledge in the area of quantum information and its technological aspects		Student can program in Python, Matlab, C++		[SW4] test/exam - oral or written [SW5] implementation of a problem task		
	[QITL3_W05] knows the theoretical foundations of computational methods and IT techniques used to model and simulate physical systems considered in quantum information theory		Student knows computational complexity classes and formal programming structures		[SW4] test/exam - oral or written [SW5] implementation of a problem task		

Subject contents	Review and systematics of programming languages. Imperative and declarative programming. History and labor market. Programming environments.Program structure in C ++, Python, Matlab.Basic constructions. Variables, loops, conditional statements, functions, I / O operations, operators.Object-oriented programming. Classes. Basic data structures. Array, list, heap, map, graph.Code organization. Comments, headers, libraries, naming conventions. Programming Pragmatics. Programming styles. Version control systems.Doxygen.Recursion. Dynamic programming. Basic algorithms. Searching, sorting, graph searching.STL library in C ++. Design patterns. Processes and threads. Multi-threaded programming. Data Representations. XML. Sparse matrices. COO andCRS formats.Functional programming.Numerical Methods. Newton-Raphson method, Simpson method, Runge-Kutta method, matrix decompositions.Numpy and scipy packages in Python. Matlab QETLAB package.Linear and semi-definite programming. Solvers.Computational models. Turing machine. Church's thesis. Computational and memory complexity of algorithms. Complexity classes P, NP, NPC,PSPACE. Compilation process and parameters. Debugging and profiling. Unit tests.Code optimization techniques. Language interoperability. MEX files in Matlab. Extension modules in Python.CISC and RISC architectures. Flynn taxonomy. MMX, SSE, AVX instruction sets. Programming on graphic cards. CUDA, PyTorch.Virtual machines and emulators. Bytecode in Python. Assembler and low-level code optimization.BPP, BQP, QMA complexity classes. Quantum programming languages		
Prerequisites and co-requisites	None.		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	lecture part: test	51.0%	50.0%
	laboratory part: test	51.0%	50.0%
Recommended reading	Basic literature	None.	
	Supplementary literature	None.	
	eResources addresses		
Example issues/ example questions/ tasks being completed			
Work placement	Not applicable		

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