

Subject card

Subject name and code	Quantum Thermal Machines, PG_00159206						
Field of study	Quantum Information Technology						
Date of commencement of studies	October 2025		Academic year of realisation of subject		2026/2027		
Education level	Master's studies		Subject group				
Mode of study	full-time studies		Mode of delivery		at the university		
Year of study	2		Language of instruction		English		
Semester of study	4		ECTS credits		6.0		
Learning profile	academic		Assessment form		exam		
Conducting unit	Faculty of Mathematics, Physics and Informatics -> Rector						
Name and surname of lecturer (lecturers)	Subject supervisor		dr Borhan Ahmadi				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	0.0	0.0	0.0	60
	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	60		0.0		30.0	90
Subject objectives	The aim of the course is to apply thermodynamics of non-dissipative and dissipative quantum systems in studying efficiency of energy transfer in the microscopic systems.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[QITL3_U01] is able to apply the scientific method in solving physical problems and reasoning in the field of quantum information theory	Student has the ability to apply the scientific method in studies of energy transfer in quantum physical systems.	[SU4] test/exam - oral or written
	[QITL3_W05] knows the theoretical foundations of computational methods and IT techniques used to model and simulate physical systems considered in quantum information theory	methods used to simulate many-body systems	[SW4] test/exam - oral or written
	[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 has in-depth knowledge about open system methods.	[SW4] test/exam - oral or written
	[QITL3_U05] has the ability to synthesize methods and ideas from various areas of physics and other branches of science; is able to notice that distant phenomena are sometimes described by similar models	Student has the ability to connect analytical methods of open quantum systems and techniques for their numerical simulation with tools used in different areas of physics	[SU4] test/exam - oral or written
	[QITL3_K02] is aware of the decisive role of experiment in the verification of physical theories; is aware of the existence of the scientific method in acquiring knowledge	Student knows the importance of the experimental implementation of quantum thermal systems in verifying theoretical predictions based on approximations	[SK4] test/exam - oral or written
	[QITL3_W01] has extended knowledge in the field of general physics and advanced knowledge in the area of quantum information theory; knows the history of the development of quantum information theory and its importance for the progress of science, knowledge of the world and social development	Student has extended knowledge in the field of thermodynamics and advanced knowledge in dissipative systems.	[SW4] test/exam - oral or written
	[QITL3_U02] has the skills to plan and conduct basic and advanced research and calculations in the area of quantum information theory or its applications	Student is capable of assessing regime of validity of approximations used in modelling of quantum open systems.	[SU4] test/exam - oral or written
	[QITL3_W06] has knowledge of current directions in the development of physics, in particular in the field of quantum information theory	Student is familiar with the present literature in the field of quantum thermal machines.	[SW4] test/exam - oral or written
	[QITL3_W04] knows advanced methods of theoretical and mathematical physics necessary in creating models of quantum mechanics	Student knows advanced analytical techniques to model physical systems for thermodynamic purposes.	[SW4] test/exam - oral or written
	[QITL3_W03] knows advanced experimental, observational and numerical techniques allowing to plan and perform a complex physical experiment or computer simulation	Student knows how to do numerical calculations and simulations to solve many-body differential equations.	[SW4] test/exam - oral or written
Subject contents	Quantum thermodynamic variables: Work and heat, Non-dissipative and dissipative quantum systems, Quantum thermal machines, Quantum transistors, Quantum Batteries.		
Prerequisites and co-requisites			
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	lecture part: exam	51.0%	50.0%
	tutorial part: test	51.0%	50.0%

Recommended reading	Basic literature	Quantum Thermodynamics: Emergence of Thermodynamic Behavior Within Composite Quantum Systems by Jochen Gemmer , M. Michel, Günter Mahler (2012)
	Supplementary literature	None.
	eResources addresses	
Example issues/ example questions/ tasks being completed		
Work placement	Not applicable	

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