DEPARTMENT OF ENERGY SCIENCE AND TECHNOLOGY
COURSE SYLLABUS

Course Details				
Code	**Academic Year**			**Semester**
EBT309	3			Fall
Title	**T**	**A**	**L**	**ECTS**
Introduction to Quantum Energy Systems	3	1	0	6

Language	German					
Level	**Undergraduate**	**X**	**Graduate**		**Postgraduate**	
Department / Program	Energy Science and Technology					
Forms of Teaching and Learning	Face-to-face					
Course Type	**Compulsory**		**Elective**	**X**		
Objectives	The main aim of the course to introduce and investigate the fundamental concepts of quantum enery systems. An introduction to quantum physics will be given and the governing laws of quantum thermodynamics will be presented to eloborate quantum energy systems					
Content	Fundamental Concepts of Quantum Theory. Quantum Thermodynamic Systems and their properties. Quantum thermodynamical processes, work, heat for closed and open systems. Quantum Heat engines, refrigerators. Markov and Non-Markov Processes.					
Prerequisites	None					
Coordinator						
Lecturer(s)						
Assistant(s)						
Work Placement	None					

Recommended or Required Reading	
Books / Lecture Notes	Thermodynamics in the Quantum Regime-Fundamental Aspects and New Directions, Felix Binder, Luis A. Correa, Gerardo Adesso, Fundamental Theories in Physics 195, Springer
Other Sources	Quantenmechanik: Einführung, W. Greiner Thermodynamik und Statistische Mechanik, W. Greiner Quantum Computation and Quantum Information, Micheal A. Nielsen and Isaac L. Chuang Quantum Thermodynamics: Emergence of Thermodynamic Behavior Within Composite Quantum Systems, Jochen Gemmer, M. Michel, G. Mahler,Lecture Notes in Physics, 2nd Ed. Springer

Additional Course Material	
Documents	
Assignments	
Exams	

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Course Composition		
Mathematics und Basic Sciences	50	%
Engineering	-	%
Engineering Design	-	%
Social Sciences	-	%
Educational Sciences	-	%
Natural Sciences	50	%
Health Sciences	-	%
Expert Knowledge	-	%

Assessment		
Activity	**Count**	**Percentage (%)**
Midterm Exam	-	-
Quiz	10	30
Assignments	10	10
Attendance	-	-
Recitations	-	-
Projects	1	20
Final Exam	1	40
	Total	**100**

ECTS Points and Work Load			
Activity	**Count**	**Duration**	**Work Load (Hours)**
Lectures	13	3	39
Self-Study	14	7	98
Assignments			
Presentation / Seminar Preparation	1	4	4
Midterm Exam			
Recitations	14	1	14
Laboratory			
Projects	1	10	10
Final Exam	1	2	2
		Total Work Load	**167**
		ECTS Points (Total Work Load / Hours)	**6**

Learning Outcomes	
1	Quantum thermodynamic concepts and their application
2	

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Weekly Content	
1	Fundamentals: Probability Theory and Linear Algebra
2	Introduction to Quantum Theory: Vector Formalism
3	Postulates of Quantum Theory
4	Density matrix theory
5	Overview of classical thermodynamics
6	Introduction to quantum thermodynamics
7	Quantum heat engines: Quantum Otto Cycle
8	Midterm week
9	Quantum heat engines: Other Cycles
10	Non-equilibrium thermodynamic systems: Open Quantum Systems (Theory)
11	Non-equilibrium thermodynamic systems: Open Quantum Systems (Example)
12	Markovian Equations (Theory)
13	Markovian Equations (Example)
14	Non-Markovian Equations (Theory and Example)
15	Final exam

Contribution of Learning Outcomes to Program Objectives (1-5)

	P1	P2	P3	P4	P5	P6	P7
1	5	5	5	5	5	3	1

Contribution Level	1: Low 2: Low-intermediate 3: Intermediate 4: High 5: Very High

P1 Working with modern scientific sources.
P2 Having modern scientific knowledge and scientific analysis abilities and being able to apply them to scientific problems.
P3 Having theoretical and practical skills in the area of Energy Science and Technology.
P4 Having foreign language skills to follow the worldwide advancements in the field of Energy Science and Technology and to be able to discuss them with foreign colleagues.
P5 Having computational skills for research data analysis purposes.
P6 Having appropriate skills for academic and industrial jobs, being ready to take responsibility in working life.
P7 Having knowledge about work occupational work and safety.

Compiled by:	
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