# DEPARTMENT OF ENERGY SCİENCE AND TECHNOLOGY
# COURSE SYLLABUS

| **Course Details** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Code** | | | | **Academic Year** | | | **Semester** |
| EBT 309 | | | | 3 | | | **5** |
| **Title** | | | | **T** | **A** | **L** | **ECTS** |
| Nuclear Energy | | | | 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** | * | | | |
| **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. | | | | | | |
| **Prerequisites** | None | | | | | | |
| **Coordinator** | Asst. Prof. Elif Yunt | | | | | | |
| **Lecturer(s)** | Asst. Prof. Elif Yunt | | | | | | |
| **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<br>*Quantenmechanik: Einführung*, W. Greiner<br>*Thermodynamik und Statistische Mechanik*, W. Greiner | | | | | | |
| **Other Sources** | *Quantum Computation and Quantum Information*, Micheal A. Nielsen and Isaac L. Chuang<br>*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** | - | % |
| **Engineering** | 30 | % |
| **Engineering Design** | - | % |
| **Social Sciences** | - | % |
| **Educational Sciences** | - | % |
| **Natural Sciences** | 70 | % |
| **Health Sciences** | - | % |
| **Expert Knowledge** | - | % |

| Assessment | | |
|---|---|---|
| **Activity** | **Count** | **Percentage (%)** |
| **Midterm Exam** | 1 | %40 |
| **Quiz** | 4 | %20 |
| **Assignments** | - | - |
| **Attendance** | - | - |
| **Recitations** | -- | - |
| **Projects** | - | - |
| **Final Exam** | 1 | %40 |
| | **Summe** | **100** |

| ECTS Points and Work Load | | | |
|---|---|---|---|
| | **Count** | **Duration** | **Work Load (Hours)** |
| **Activity** | 14 | 5 | 70 |
| **Lectures** | 14 | 8 | 112 |
| **Self-Study** | | | |
| **Assignments** | | | |
| **Presentation / Seminar Preparation** | | | |
| **Midterm Exam** | 1 | 2 | 2 |
| **Recitations** | | | |
| **Laboratory** | | | |
| **Final Exam** | 1 | 2 | 2 |
| | | **Total Work Load** | **186** |
| | | **ECTS Points (Total Work Load / Hours)** | **6** |

| Learning Outcomes | |
|---|---|
| **1** | To gain an understanding of quantum physics |

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| | |
|---|---|
| **2** | To gain an understanding of quantum correlations and entanglement |
| **3** | To learn how the laws of quantum physics and laws of thermodynamics are reconciled. |
| **4** | To learn how different kinds of quantum engines function. |
| **5** | |
| **6** | |
| **7** | |
| **8** | |
| **9** | |
| **10** | |
| **11** | |
| **12** | |
| **Weekly Content** | |
| **1** | Fundamentals: Probability Theory and Linear Algebra |
| **2** | Introduction to Quantum Theory: Vector Formalism I |
| **3** | Introduction to Quantum Theory: Vector Formalism II |
| **4** | Postulates of Quantum Theory I |
| **5** | Postulates of Quantum Theory II |
| **6** | Density matrix theory |
| **7** | Quantum Correlations and Entanglement Measures |
| **8** | Midterm |
| **9** | Overview of classical thermodynamics |
| **10** | Introduction to quantum thermodynamics |
| **11** | Quantum heat engines: Quantum Otto Cycle |
| **12** | Quantum heat engines: Other Cycles |
| **13** | Non-equilibrium thermodynamic systems: Open Quantum Systems (Theory) |
| **14** | Non-equilibrium thermodynamic systems: Open Quantum Systems (Example) |
| **15** | Advanced Quantum Energy Systems |

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

| | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
|---|---|---|---|---|---|---|---|
| **1** | 5 | 5 | 5 | 5 | | | |
| **2** | | | | | | | |
| **3** | | | | | | | |
| **4** | | | | | | | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **5** | | | | | | | |
| **6** | | | | | | | |
| **7** | | | | | | | |
| **8** | | | | | | | |
| **9** | | | | | | | |
| **10** | | | | | | | |
| **11** | | | | | | | |
| **12** | | | | | | | |

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

| | |
|---|---|
| **Compiled by:** | Asst. Prof. Dr. Elif Yunt |
| **Date of Compilation:** | 05.04.2024 |