

**ABDULLAH GÜL UNIVERSITY  
GRADUATE SCHOOL OF ENGINEERING & SCIENCE  
MATERIALS SCIENCE AND MECHANICAL ENGINEERING PROGRAM  
COURSE DESCRIPTION AND SYLLABUS**

| Course Title  | Code    | Semester | T+L Hours | Credit | ECTS |
|---|---------|----------|-----------|--------|------|
| INTERDISCIPLINARY INTRODUCTION TO QUANTUM ENGINEERING | AMN 576 | FALL     | 3 + 0     | 3      | 10   |

**Prerequisite Courses** None

|                          |  |
|--------------------------|--|
| <b>Type</b>              | Selective  |
| <b>Language</b>          | English  |
| <b>Coordinator</b>       | Assoc. Prof. Dr. Sergey Borisenok  |
| <b>Instructor</b>        | Assoc. Prof. Dr. Sergey Borisenok  |
| <b>Adjunt</b>            | None   |
| <b>Aim</b>               | Interdisciplinary introduction to basic concepts of modern engineering of small scale objects; Learning the social impact of modern engineering; Learning the role of modern engineering in the solution of global challenge problems.   |
| <b>Learning Outcomes</b> | <ul style="list-style-type: none"> <li>• Learn the basic principles of interdisciplinary approach to modern engineering science;</li> <li>• Learn the basic of quantum approach to modern engineering;</li> <li>• Learn the basic areas of application for quantum engineering;</li> <li>• Learn the methods of quantum engineering in the developing of modern and forthcoming technologies;</li> <li>• Learn the social impact of modern engineering science;</li> <li>• Learn the contribution of quantum engineering to the solution of global challenge problems.</li> </ul>  |
| <b>Course Content</b>    | <ul style="list-style-type: none"> <li>• Basic principles of quantum approach to modern engineering;</li> <li>• Concepts of engineering for quantum dots, wires, wells and nanoscale objects;</li> <li>• Concepts of special and energy control of small scale objects;</li> <li>• Basic concepts of quantum computation and quantum communication;</li> <li>• Application of quantum engineering to bio- and medical technologies;</li> <li>• Social impacts of quantum engineering;</li> <li>• Role of quantum engineering in the developing of modern and forthcoming technologies.</li> <li>• Contribution of quantum engineering to solving global challenge problems.</li> </ul> |

**WEEKLY TOPICS AND PRELIMINARY STUDY**

| Week | Topic  | Preliminary Study                         |
|------|--|---|
| 1    | Quantum natural science as a base for modern engineering. Historical remarks. First steps of quantum engineering. Nano and beyond. | The relevant articles from the literature |
| 2    | World of quantum objects. Basic laws and concepts. Coherence and decoherence.  | The relevant articles from the literature |
| 3    | Effects of low dimension. Quantum dots, wires and wells. Nanoparticles and clusters.   | The relevant articles from the literature |
| 4    | Graphene, carbon nanotubes and related objects.  | The relevant articles from the literature |
| 5    | Spatial control of quantum objects. Beam splitters. Traps. Nanofabrication.  | The relevant articles from the literature |
| 6    | Quantum engineering and photonics.   | The relevant articles from the literature |
| 7    | Commercial aspect of quantum engineering. Social impact of quantum engineering.  | The relevant articles from the literature |
| 8    | Midterm Exam.  | The relevant articles from the literature |
| 9    | Energy control of quantum objects. Cooling. Demons and quantum heat machines.  | The relevant articles from the literature |
| 10   | Qubits. Quantum gates. Quantum computer.   | The relevant articles from the literature |
| 11   | Quantum communication. Quantum teleportation. Quantum engineering and security.  | The relevant articles from the literature |
| 12   | Quantum engineering for bio- and medical technologies. Quantum engineering in neuroscience.  | The relevant articles from the literature |

|    |  |   |
|----|--|---|
| 13 | Quantum engineering and space technologies.                                  | The relevant articles from the literature |
| 14 | Geography of quantum engineering. QE in the leading countries. QE in Turkey. | The relevant articles from the literature |
| 15 | Perspectives of quantum engineering. QE and global challenges.               | The relevant articles from the literature |
| 16 | Final Exam.  |   |

| <b>SOURCES</b>       |   |
|----------------------|---|
| <b>Lecture Notes</b> | Lecture slides  |
| <b>Other Sources</b> | <p><b>Textbook:</b></p> <ul style="list-style-type: none"> <li>P. Zagoskin, A. M. 2011. Quantum Engineering, Theory and Design of Quantum Coherent Structures, Cambridge University Press. ISBN-13: 978-0521736121.</li> <li>Vijay Kumar Arora. 2015. Nanoelectronics. Quantum Engineering of Low-Dimensional Nanoensembles, CRC Press. ISBN: 9781498705752.</li> </ul> <p><b>Recommended Books:</b></p> <ul style="list-style-type: none"> <li>Miller, D. 2008. Quantum Mechanics for Scientists and Engineers, Cambridge. ISBN: 9780521897839.</li> <li>Scientific articles.</li> </ul> |

| <b>COURSE MATERIALS SHARING</b> |                                    |
|---------------------------------|------------------------------------|
| <b>Documents</b>                | Lecture notes and slides           |
| <b>Homeworks</b>                | Students will be given 6 homeworks |
| <b>Exams</b>                    | 1 Midterm and 1 Final Exam         |

| <b>EVALUATION SYSTEM</b>              |               |                     |
|---------------------------------------|---------------|---------------------|
| <b>SEMESTER STUDY</b>                 | <b>NUMBER</b> | <b>CONTRIBUTION</b> |
| Midterm                               | 1             | 30                  |
| Homework                              | 6             | 30                  |
| Quizzes                               | 2             | 10                  |
| <b>SUB-TOTAL</b>                      |               | 70                  |
| <b>Contribution of Semester Study</b> |               | 70                  |
| <b>Contribution of Final Exam</b>     | 1             | 30                  |
| <b>TOTAL</b>                          |               | 100                 |

| <b>Course Category</b>   |     |
|--------------------------|-----|
| Sciences and Mathematics | 70% |
| Engineering              | 30% |
| Social Sciences          | 0%  |

| <b>RELATIONSHIPS BETWEEN LEARNING OUTCOMES AND PROGRAM QUALIFICATIONS</b> |  |                    |   |          |          |          |
|---|--|--------------------|---|----------|----------|----------|
| No  | Program Qualifications   | Contribution Level |   |          |          |          |
|   |  | 1                  | 2 | 3        | 4        | 5        |
| 1   | Accessing knowledge, evaluating and interpreting information by doing scientific research in the field of Quantum Engineering                            |                    |   |          |          | <b>X</b> |
| 2   | Ability to use science and engineering knowledge for development of new methods in Quantum Engineering   |                    |   |          |          | <b>X</b> |
| 3   | To be able to understand and analyze materials by using basic knowledge on Quantum Engineering   |                    |   |          |          | <b>X</b> |
| 4   | Design and implement analytical, modeling and experimental research  |                    |   |          |          | <b>X</b> |
| 5   | Solve and interpret the problems encountered in experimental research  |                    |   |          | <b>X</b> |          |
| 6   | Considering scientific and ethical values during the collection and interpretation of data   |                    |   |          | <b>X</b> |          |
| 7   | Integrating knowledge of different disciplines with the help of scientific methods, and completion and implementation of scientific knowledge using data |                    |   | <b>X</b> |          |          |
| 8   | To gain leadership ability and responsibility in disciplinary and interdisciplinary team works   |                    |   |          |          | <b>X</b> |

|    |   |  |  |  |  |  |   |
|----|---|--|--|--|--|--|---|
| 9  | To be able to contribute to the solution of social, scientific and ethical problems encountered in the field of Quantum Engineering |  |  |  |  |  | X |
| 10 | To be able to define, interpret and create new information about the interactions between various discipline of Quantum Engineering |  |  |  |  |  | X |

\*Increasing from 1 to 5.

| <b>ECTS / WORK LOAD TABLE</b>                               |        |                  |                 |
|---|--------|------------------|-----------------|
| Activities  | Number | Duration (Hours) | Total Work Load |
| Course Length (includes exam weeks: 16x total course hours) | 16     | 3                | 48              |
| Out-of-class Study Time (Pre-study, practice)               | 16     | 5                | 90              |
| Internet search, library work, literature search            | 16     | 4                | 64              |
| Presentation  | 8      | 4                | 32              |
| Homework  | 6      | 5                | 30              |
| Midterm   | 1      | 20               | 20              |
| Final Exam  | 1      | 20               | 20              |
| <b>Total Work Load</b>                                      |        |                  | 304             |
| <b>Total Work Load / 30</b>                                 |        |                  | 304/30          |
| <b>Course ECTS Credit</b>                                   |        |                  | 10              |