# AYDIN ADNAN MENDERES UNIVERSITY
# COURSE INFORMATION FORM

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|---|---|---|---|---|---|---|---|---|---|
| Course Title | Quantum Computation and Quantum Information | | | | | | | | |
| Course Code | FZK529 | | Couse Level | Second Cycle (Master's Degree) | | | | | |
| ECTS Credit | 6 | Workload | 150 *(Hours)* | Theory | 3 | Practice | 0 | Laboratory | 0 |
| Objectives of the Course | Performing the operations of quantum computation and information via quantum mechanical concepts | | | | | | | | |
| Course Content | Some quantum mechanical concepts, quantum circuits, quantum algorithms, quantum entenglement and applications, quantum information, quantum computers. | | | | | | | | |
| Work Placement | | | | | | | | | |
| Planned Learning Activities and Teaching Methods | Explanation (Presentation), Discussion, Case Study, Individual Study, Problem Solving | | | | | | | | |
| Name of Lecturer(s) | | | | | | | | | |

| Assessment Methods and Criteria | | |
|---|---|---|
| Method | Quantity | Percentage (%) |
| Midterm Examination | 1 | 20 |
| Final Examination | 1 | 35 |
| Quiz | 2 | 10 |
| Attending Lectures | 14 | 28 |
| Assignment | 7 | 7 |

| Recommended or Required Reading | |
|---|---|
| 1 | Quantum Computation ad Quantum Information, Michael A. Nielsen, Isaac L. Chuang |
| 2 | Principles of Quantum Computation and Information Vol.I-II, Giuliano Benenti, Giulio Casati, and Giuliano Strini |
| 3 | Classical and Quantum Computing, Yorick Hardy and Willi-Hans Steeb |
| 4 | The Physics of Quntum Information, Dirk Bouwmeester, Artur Ekert, and Anton Zeilinger |
| 5 | Lectures on Quantum Information, Dagmar Brub and Gerd Leuchs |

| Week | Weekly Detailed Course Contents | |
|---|---|---|
| 1 | Theoretical | Introduction to basic concepts of quantum computing and quantum information |
| | Preparation Work | Quantum Computation ad Quantum Information, Michael A. Nielsen, Isaac L. Chuang .(p.1-36)<br>Principles of Quantum Computation and Information Vol.I.(p.99-118) |
| 2 | Theoretical | General and brief owerview of quantum mechanics |
| | Preparation Work | Principles of Quantum Computation and Information Vol.I.(p.49-97).<br>Quantum Computation ad Quantum Information, Michael A. Nielsen, Isaac L. Chuang .(p.60-80) |
| 3 | Theoretical | Quantum circuits |
| | Preparation Work | Quantum Computation ad Quantum Information, Michael A. Nielsen, Isaac L. Chuang .(p.171-216) |
| 4 | Theoretical | Introduction to quantum algorithms |
| | Preparation Work | Quantum Computation ad Quantum Information, Michael A. Nielsen, Isaac L. Chuang .(p.216-226) |
| 5 | Theoretical | Decomposition to multipliers algorithm of shor |
| | Preparation Work | Principles of Quantum Computation and Information Vol.I.(p.161-164).<br>Quantum Computation ad Quantum Information, Michael A. Nielsen, Isaac L. Chuang .(p.226-248) |
| 6 | Theoretical | Search algorithm of Grover |
| | Preparation Work | Quantum Computation ad Quantum Information, Michael A. Nielsen, Isaac L. Chuang .(p.248-277)<br>Principles of Quantum Computation and Information Vol.I.(p.144-152). |
| 7 | Theoretical | Quantum entenglement |
| | Preparation Work | The Physics of Quntum Information, Dirk Bouwmeester, Artur Ekert, and Anton Zeilinger.(p.7-14) |
| 8 | Intermediate Exam | Midterm Exam |

| | | |
|---|---|---|
| 9 | Theoretical | Application of entenglement: quantum teleportation, exchange of entenglement, super dense coding |
| | Preparation Work | The Physics of Quntum Information, Dirk Bouwmeester, Artur Ekert, and Anton Zeilinger.(p.49-53) |
| 10 | Theoretical | Quantum criptology |
| | Preparation Work | The Physics of Quntum Information, Dirk Bouwmeester, Artur Ekert, and Anton Zeilinger.(p.15-47) |
| 11 | Theoretical | Quantum noise and quantum error correction |
| | Preparation Work | Quantum Computation ad Quantum Information, Michael A. Nielsen, Isaac L. Chuang .(p.425-500) |
| 12 | Theoretical | Entropy and information |
| | Preparation Work | Quantum Computation ad Quantum Information, Michael A. Nielsen, Isaac L. Chuang .(p.500-510) |
| 13 | Theoretical | Shannon and von Neumann entropies |
| | Preparation Work | Quantum Computation ad Quantum Information, Michael A. Nielsen, Isaac L. Chuang .(p.510-519) |
| 14 | Theoretical | Some examples of physical realization of quantum computers |
| | Preparation Work | Quantum Computation ad Quantum Information, Michael A. Nielsen, Isaac L. Chuang .(p.277-353) |
| 15 | Theoretical | Some examples of physical realization of quantum computers |
| | Preparation Work | Quantum Computation ad Quantum Information, Michael A. Nielsen, Isaac L. Chuang .(p.277-353) |
| 16 | Final Exam | Final Exam |

**Workload Calculation**

| Activity | Quantity | Preparation | Duration | Total Workload |
|---|---|---|---|---|
| Lecture - Theory | 14 | 4 | 3 | 98 |
| Assignment | 5 | 3 | 3 | 30 |
| Quiz | 2 | 1 | 1 | 4 |
| Midterm Examination | 1 | 6 | 3 | 9 |
| Final Examination | 1 | 6 | 3 | 9 |
| | | | Total Workload (Hours) | 150 |
| | | | [Total Workload (Hours) / 25*] = **ECTS** | 6 |

**25 hour workload is accepted as 1 ECTS*

**Learning Outcomes**

| | |
|---|---|
| 1 | To be able to define q-bits and do calculations by them |
| 2 | To be able to establish relationship between operators and quantum logic gates |
| 3 | To be able to define the concept of entenglement |
| 4 | To be able to analyse the quantum circuit shemes |
| 5 | To be able to explain the differences between the quantum and classical algorithms |
| 6 | To be able to explain the applications of entenglement |
| 7 | To be able to represent the basic criptological protocols |
| 8 | To be able to represent some examples of physical realisms of quantum computers |

**Programme Outcomes** *(Physics Master)*

| | |
|---|---|
| 1 | The student should conceive the concepts in physics and may apply them on her/his own |
| 2 | The student should be able to conceive the relationship between the different physics laws and integrity of them and apply them in solving different physics problems |
| 3 | The student should know the basic principles of classical, quantum and relativistic physics and use them in the solutions of problems |
| 4 | The student should be able to do research in a specific area of physics |
| 5 | The student should be able to prepare reports on papers on the subject of her/his research and present her/his research subject in scientific conferences |
| 6 | The student should be able to explain the relationship between complicated problems and basic physics laws. |
| 7 | The student should be able to use computers for solving complicated physics problems |
| 8 | The student should be able to interrelate between the theory and the experiment. If she/he is experimentalist he/she has to explain the theory behind her/his work. If she /he is a theorist she/he should has to know the experiments in her/his subject. |

**Contribution of Learning Outcomes to Programme Outcomes** *1:Very Low, 2:Low, 3:Medium, 4:High, 5:Very High*

| | L1 | L2 | L3 | L4 | L5 | L6 | L7 | L8 |
|---|---|---|---|---|---|---|---|---|
| P1 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| P2 | 5 | 5 | 4 | 5 | 4 | 5 | 3 | 5 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| P3 | 5 | 4 | 5 | 5 | 5 | 4 | 4 | 5 |
| P4 | 5 | 4 | 3 | 3 | 3 | 3 | 3 | 5 |
| P5 | 4 | 4 | 4 | 5 | 5 | 4 | 3 | 3 |
| P6 | 3 | 4 | 4 | 4 | 5 | 3 | 5 | 4 |
| P7 | 2 | 2 | 4 | 4 | 5 | 3 | 5 | 4 |
| P8 | 3 | 3 | 5 | 4 | 5 | 4 | 3 | 5 |