CENG 487 - Introduction to Quantum Computing

Middle East Technical University
Department of Computer Engineering

Syllabus
Fall 2023 v1.0

• **Course Description:** Fundamental concepts in quantum computing; quantum mechanics for computer scientists; quantum circuits and quantum instruction set; quantum programming languages; quantum algorithms; error correction and fault tolerance.

• **Instructor:**
  Murat Manguoğlu
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  Email: manguoglu[at]ceng.metu.edu.tr
  Office hours: Wednesday 11:00-12:00

• **Teaching assistant:**
  Mustafa Duymuş
  Office: B203
  Email: mduymus[at]ceng.metu.edu.tr
  Office hours: TBD

• **Schedule:**
  Monday 9:40-10:30 BMB2
  Wednesday 8:40-10:30 BMB2

• **Prerequisites:** Linear algebra and algorithms are required. A background in physics is not required.

• **Textbooks:**
  – Quantum Computing for Computer Scientists, Yanofsky and Mannucci, 2008

• **Grading:** (tentative) The grading policy is listed below. Exam dates will be announced later.

  Midterm 20%
  Homeworks (×4) 50%
  Final 30%

• **Homeworks:** There will be 4 programming homework assignments. Delayed submissions are accepted with a penalty of $-5 \times d^2$ where $d$ is the number of days in which the solution is submitted late.

• **Examinations** Midterm and final are closed book and notes. Only one page (no larger than A4) and hand written cheat sheet is allowed. Time and location will be announced later.
• **Attendance and Participation**

Attendance and participation in the class and office hours are encouraged. I will randomly check attendance and I may use it in your favor when assigning letter grades.

• **Communication:**

Announcements about the course will be made in class and on odtuclass. Please attend the class and follow odtuclass announcements.

• **Academic Integrity:**

All homeworks, midterm and final are expected to be individual work. Discussion of ideas or concepts are allowed and encouraged for the homeworks. However, when writing your code or solution you should not look at other people’s work. If you use a source (online or offline) you are expected to cite it. Violation of these general principles will be handled based on the university regulations and may result in disciplinary action.

• **Outline:** (tentative)

  – Introduction, history and motivation
  – Basic operations with 1 qubit and Elitzur-Vaidman bomb
  – Multi qubit systems, bell states, and teleportation and superdense coding
  – Quantum parallelism, Deutsch’s, Deutsch-Jozsa and Simon’s algorithms
  – Common and alternative physical implementations of quantum computers, quantum noise and basic quantum error correction
  – Quantum Fourier transform
  – Quantum phase estimation and eigenvalue solver
  – Quantum order finding
  – Grover’s search algorithm
  – Quantum Complexity
  – Quantum counting and other applications [if time permits].