TO: The Faculty of the College of Engineering

FROM: Elmore Family School of Electrical and Computer Engineering

RE: New Graduate Course, ECE 50651 Applied Quantum Computing 2 - Hardware

The faculty of the School of Electrical and Computer Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

ECE 50651 Applied Quantum Computing 2 - Hardware
Sem. 2, Lecture 3, Cr. 1, 5 weeks.
Prerequisite: MA 26500 or MA 26200, PHYS 17200, ECE AQC 1 (permanent number requested – ECE 50651)

Description: This course is part 2 of the series of Quantum computing courses, which covers aspects from fundamentals to present-day hardware platforms to quantum software and programming. The goal of part 2 is to provide the essential understanding of how the fundamental quantum phenomena discussed in part 1 can be realized in various material platforms and the underlying challenges faced by each platform. To this end, we will focus on how quantum bits (qubits, the building block of quantum information processing) can be defined in each platform, how such qubits are manipulated and interconnected to form larger systems, and the sources of errors in each platform. With an emphasis on present-day leading candidates, we will discuss following specific quantum material platforms: 1) Superconductor-based and 2) Atom/ion traps-based. The material will appeal to engineering students, natural sciences students, and professionals whose interests are in using and developing quantum information processing technologies.

Reason: This is an introductory course in applied quantum computing aimed at students want to enter the field. The course is offered as part of the Quantum MicroMasters program through edX. This course focuses on computing aspects quantum technologies and complements other quantum courses developed in ECE.

Course Enrollment History: Spring 2021 – 49, Spring 2022 – 38, Spring 2023 – 39, Spring 2024 - 51

T.S. Mithuna

Mithuna Thottithodi,
Associate Head for Teaching and Learning
Elmore Family School of Electrical and Computer Engineering

Schedule:

ECE 50651 Applied Quantum Computing II- Hardware

Spring 2024

Instructor: Pramey Upadhyaya
Assistant Professor
Electrical and Computer Engineering, Purdue University
465 Northwestern Avenue, West Lafayette, IN 47907-2088

Email: prameyup@purdue.edu

Instructor's personal webpage:
https://engineering.purdue.edu/ECE/People?resource_id=182798&group_id=2571

Class Hours: Online, asynchronous; we will also meet MWF 1:30-2:20 EST for a live recitation session online: https://www.youtube.com/playlist?list=PL9BnFkj_JF9bUuZ-ahuX7TgaQxroD-Uao

Course Webpage: https://www.edx.org/course/quantum-computing-i-fundamentals

Help and Office Hours: The most efficient way to have your question answered (one that will help other students also) is to post your questions on the discussion board at Piazza. Either the TA or I will attempt to answer your questions within one business day. Please note that we may not be able to answer your questions over the weekends and when other extraordinary circumstances delay us.

Contact for office hours through internet/audio conferencing web link will be provided at the Piazza discussion board.

Course Overview:

Objective: Learn how present-day material platforms are built to perform quantum information processing tasks.

Description: This hardware course is part 2 of the series of quantum computing courses and covers aspects from fundamentals to present-day hardware platforms to quantum software and programming. The goal of part 2 is to provide the essential understanding of how the fundamental quantum phenomena discussed in part 1 can be realized in various material platforms and the underlying challenges faced by each platform. To this end, we will focus on how quantum bits (qubits, the building block of quantum information processing) can be defined in each platform, how such qubits are manipulated and interconnected to form larger systems, and the sources of errors in each platform.

Schedule:

With an emphasis on present-day leading candidates, we will discuss following specific quantum material platforms: Superconductor-based and Ion traps-based.

Outline by Topical Areas:

- Canonical Models and techniques in quantum mechanics
- Superconducting quantum platforms
- Trapped-ion quantum platforms

Prerequisites:

Undergraduate linear algebra, differential equations, physics, and chemistry, Quantum Computing 1: Fundamentals

None required, lecture videos and handouts will serve as the main material

References:

- The course draws from a wide array of references that will be mentioned throughout the lectures.

Homeworks: A total of 4 homeworks will be assigned over the semester. The assignments are meant to help understand concepts and provide practice for the tests.

Exams: Two exams, each 90 minutes long. There will **not** be a comprehensive final exam.

Evaluation Criteria

Two exams (equally weighted)	85%
Homeworks (equally weighted)	15%

Late Work Policy: Late work will be accepted, however, a penalty of 10% will be assessed for each day the assignment is late. This late penalty will not be assessed if you have a special situation such as illness.

Computer Requirements: We will primarily use GNU Octave for statistical calculations. The software is available under GNU General Public license from https://www.gnu.org/software/octave/. GNU Octave is a Scientific Programming Language that is free and largely compatible with Matlab. Octave runs on Windows, Mac and Linux, uses the same function names as Matlab and runs many Matlab scripts without modification.

Miscellaneous: Exams will test your ability to synthesize the material learned in class and practiced in the homeworks. Exams may not be identical in form to the homeworks.