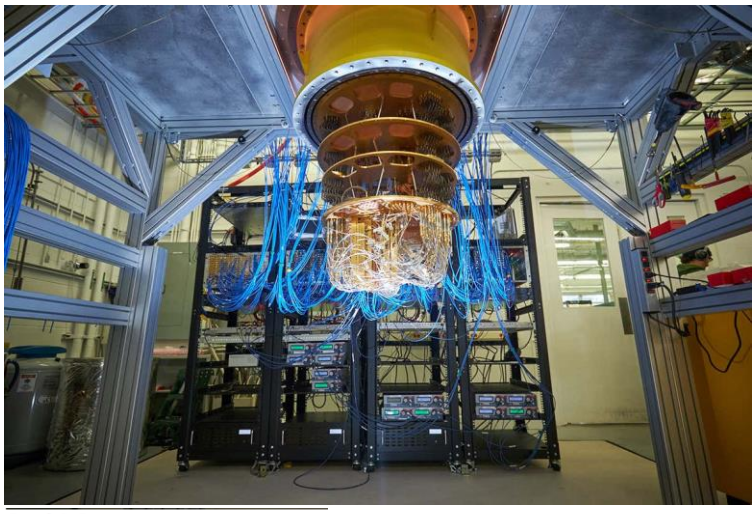
ECE 39595: Fundamentals of Quantum Technology

Instructor: Prof. Thomas Roth (rothte@purdue.edu)

Fall 2022



Google's Sycamore quantum computer
Rocco Ceselin/Google

Since the beginning of the 21st century, explosive advancement has occurred in the realization of quantum technologies. These technologies provide a new way for computing, communication, and sensing to occur that has the potential to surpass the performance of any classical alternative. To continue to advance these exciting quantum technologies, it is necessary for more engineers to become trained in this multidisciplinary field.

Objective: This course is intended to introduce engineers with no quantum background to the fundamental concepts of quantum physics. By the end of this course, students will have an awareness of many fundamental quantum principles and how these enable emerging technologies. It will also set them on a path to be able to pursue more advanced studies to become quantum-proficient engineers that will be integral in the development of emerging quantum technologies.

Applications: Throughout the course, implications of quantum effects are discussed in the context of the popular experimental platform of quantized circuits. This platform is behind many landmark demonstrations of a "quantum advantage" over all known classical hardware.

Prerequisites: Basic circuit analysis (ECE 20002), linear algebra and differential equations (MA 26500 and MA 26600, or MA 26200), and introductory physics (PHYS 241 or PHYS 272)

Topic 1: Fundamentals of the Schrodinger equation and wavefunctions

Topic 2: General mathematical framework of quantum mechanics

Topic 3: Quantum mechanics of simple circuits and relevant approximate methods in quantum mechanics

Topic 4: Quantized interactions between (artificial) atoms and linear circuits

Topic 5: Introduction to revolutionary quantum technologies such as quantum communication systems, quantum computers, and quantum sensing systems