QUANTUM ENGINEERING - MINOR

The minor in quantum engineering provides training and a solid foundation in quantum technologies. Quantum technologies have applications in quantum-enhanced sensors, quantum communications and quantum computing. The goal is to introduce students to the fundamentals of quantum theory and explore all of the major hardware platforms. This will allow graduates to easily adapt to the variety of technologies seen in industry. The skills obtained in this minor are important to students who expect to participate in real-world situations that increasingly involve quantum technologies.

Requirements

The quantum engineering minor requires a minimum of 18 credit hours.

A minor in quantum engineering can be earned in conjunction with any CU Boulder major.

Students earning a BS in Electrical Engineering or Electrical & Computer Engineering are also eligible for this minor, but the three required courses (ECEN 3915, ECEN 4925, CSCI/PHYS 3090) may not apply as advanced concentration electives or technical electives toward their bachelor's degree. The quantum engineering minor can be completed alongside no more than one of the following minors: computer engineering, electrical engineering and signals & systems engineering.

Prerequisites

Students must have completed these courses with a C- or higher before declaring the minor:

- **Programming**: ASEN 1320, ECEN 1310, CSCI 1300, APPM 3050, PHYS 2600 or similar.
- **Calculus 2** (minimum): APPM 1360, MATH 2300 or similar.
- **Linear Algebra**: APPM 2360, MATH 2130, MATH 2135, MATH 3135, APPM 3310, CSCI 2820 or similar.

Additionally, it is recommended that students have taken Calculus 3 (APPM 2350, MATH 2400 or similar), probability (APPM 3570, STAT 3100, MATH 3510, ECEN 3810 or similar) and PHYS 2130 as preparatory subjects for the minor.

Grade Requirements

A minimum cumulative GPA of 2.000 is required in the courses used to satisfy the minor requirements. Each individual course that is counted toward this minor must be passed with a grade of D- or higher (note that a minimum grade of C- is required in all prerequisite courses).

Residency Requirements

At least 9 credit hours for the minor must be taken on the CU Boulder campus.

Required Courses and Credits

Within the quantum engineering minor, there is a theory and experimental track. It will consist of a set of required core courses and a selection of electives, as follows.

Code	Title	Credit Hours
Foundations Courses (to be taken by both Theory & Experimental Track students)		
ECEN 3915	Foundations of Quantum Engineering	3-6
or PHYS 3220 & PHYS 4410	Quantum Mechanics 1 and Quantum Mechanics 2	
ECEN 4925	Foundations of Quantum Hardware	3
Track Course		
Theory Track		
CSCI/PHYS/ECEN 3090	Introduction to Quantum Computing	3
Experimental Track (to be offered starting in 2024 or 2025)		
ECEN 4XXX Quantum Engineering Lab		
Electives		
Choose 9 credit hours of approved upper-division technical coursework. [1]		9
Total Credit Hours		**18-21**

[1] Refer to the course options listed on the ECEE Quantum Engineering Minor (https://www.colorado.edu/ecee/academics/undergraduate-programs/minor-programs/#quantum_engineering-545)webpage.