Quantum Engineering, M.S.

Quantum engineers design and implement systems, processes and devices based upon the axioms of quantum mechanics and quantum field theory. Technologies in the field of quantum engineering are generally categorized into the areas of quantum computation, quantum sensing, quantum communications, application specific systems, and components that are based upon quantum physics phenomena. Some quantum engineering artifacts are mature and have a long history of engineering development including systems such as Magnetic Resonance Imagers (MRI) and photonic telecommunications networks, devices such as atomic clocks or lasers and lighting components or semiconductors. Alternatively, many new applications have emerged within the last five years including commercially available quantum computers, quantum data networks and quantum navigational sensors. A quantum engineer may be engaged in any portion of the lifecycle of such systems, devices and components or, they may be engaged in the development of processes such as algorithms for quantum computers or manufacturing protocols for quantum technology. Quantum engineers may also be involved in applications of quantum technology to other fields such as power systems, data science and cyber security. Quantum engineering should not be confused with quantum science. Quantum scientists are charged with the discovery of new phenomena in nature whereas the quantum engineers are charged with the application of quantum science results to design and develop new technology for the benefit of humanity.

The MS in Quantum Engineering (MSQE) comprises 30 credit hours of coursework, or, 24 credit hours of coursework and six hours of MS thesis credit.

Admission Requirements

In addition to meeting the admission requirements of the Lyle School of Engineering for M.S. degree programs, additionally MSQE students are required to meet the following requirements.

1. A bachelor's degree in computer engineering or electrical engineering. Students holding bachelor's degrees in other STEM fields, such as computer science, may be admitted to the program after review of their undergraduate transcripts to ensure their elective course are appropriate for entry into the program.
2. In terms of preparation and articulation, prospective MSQE students should possess knowledge equivalent to that gained from the following undergraduate courses or their equivalents. MSQE students may be conditionally admitted to the program after demonstrating they possess this knowledge and they may be required to successfully complete one or more undergraduate courses to satisfy this requirement based upon a determination of the MSQE Program Director.
    - Calculus-based physics sequence including mechanics, electricity and magnetism
    - Calculus-based introductory probability and statistics
    - Introductory linear algebra
    - Undergraduate computer programming
    - Introductory computer organization or architecture

Degree Requirements

Required Core Courses

In addition to the general requirements for an MS degree within the Lyle School of Engineering, students of the MSQE are required to satisfactorily complete three core curriculum courses.

- CS 7370/OREM 7370 - Probability and Statistics for Data Analytics
  or
- ECE 7375 - Random Processes in Engineering

- ECE 7383 - Introduction to Quantum Informatics
- ECE 8381/CS 8381 - Quantum Logic and Computing

Elective Courses

In addition to the core course requirements, satisfactory completion of seven elective courses from the following list of elective courses as approved by the student's adviser or five courses plus the master's thesis option. Unless special permission is obtained from the MSQE program director, a minimum of twelve (12) semester credit hours of coursework must be obtained from elective courses administered by departments within the Lyle School of Engineering.

- MATH 6341 - Linear and Nonlinear Waves
- MATH 6343 - Photonics Modeling and Simulations
- CS 7339 - Computer System Security
- CS 7349 - Data and Network Security
- CS 7350/OREM 7350 - Algorithm Engineering
- CS 8350/OREM 8350 - Algorithms II
- ECE 7310 - Introduction to Semiconductors
- ECE 7312 - Compound Semiconductor Devices and Processing
- ECE 7322 - Semiconductor Devices and Fabrication
- ECE 7330 - Electromagnets: Guided Waves
- ECE 7335 - Quantum Electronics
- ECE 7336 - Introduction to Integrated Photonics
- ECE 7377 - Embedded Wireless Design Lab
- ECE 7379 - Optimization in Wireless Networks
- ECE 7381/CS 7381 - Computer Architecture

- ECE 8310 - Electronic Processes
- ECE 8322 - Semiconductor Optical Systems
- ECE 8323 - Lasers and Photonics
- ECE 8325 - Infrared Systems Engineering
- ECE 8371 - Information Theory
- ECE 8372/ECE 8372 - Cryptography and Data Security
- OREM 7361 - Simulation for Systems Analytics
- OREM 8370 - Stochastic Models
- PHYS 6335 - Quantum Mechanics I
- PHYS 6336 - Quantum Mechanics II
- PHYS 6338 - Condensed Matter Physics
- PHYS 6351 - Statistical Mechanics
- PHYS 7314 - Quantum Field Theory I
- PHYS 7315 - Quantum Field Theory II

Master's Thesis

For those students wishing to fulfill their requirements with a research focus, six hours of credit will be awarded for research and the successful defense of a MS thesis. Students must also take five advanced elective courses to be approved by the student's adviser.