

MASTER OF SCIENCE IN QUANTUM ENGINEERING

Quantum engineering is the discipline concerned with the design and implementation of systems, processes and devices based upon the scientific principles of quantum mechanics and field theory. Quantum engineers generally practice within the subareas of quantum computing, quantum sensing, quantum devices and quantum communications. Quantum informatics is concerned with the representation of data using quantum principles and generally encompasses a blend of quantum computing and communications. Quantum computing includes quantum computer architecture and the design and development of algorithms and software for quantum computers. Quantum sensing is concerned with the use of quantum principles to design and implement sensors, transducers and indicators that interface with the environment. Quantum communications includes the use of quantum principles for designing communications protocols and efficient and reliable data transmission and reception. Quantum devices is concerned with the design of system components that operate, at least partially, based upon the axioms of quantum mechanics or quantum field theory. Quantum engineers may also be involved in applications of quantum technology to other fields such as power systems, data science and cyber security. The SMU program in quantum engineering serves the needs of both full-time and part-time students.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for an M.S. degree, applicants are required to satisfy the following:

1. A bachelor's degree in computer engineering, electrical engineering, or other STEM degrees if appropriate electives are included (to be evaluated by the Program Director).
2. A minimum of one year of college-level calculus, an introductory course in probability and statistics, an undergraduate physics sequence that is calculus-based and includes mechanics, electricity and magnetism, linear algebra, and undergraduate courses in computer organization and software development. Representative courses offered at SMU that fulfill these requirements are listed in the Articulation section below.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for an M.S. degree, candidates are required to satisfy the following:

1. Satisfactory completion of the core curriculum encompassing the three courses:
ECE 7375 Random Processes in Engineering, or, **CS/OREM 7370** Probability and Statistics for Scientists and Engineers,
ECE 7383 Introduction to Quantum Informatics
ECE/CS 8381 Quantum Logic and Computing
2. For the coursework-only option, satisfactory completion of seven elective courses from the following list with the approval of the student's academic advisor. For the thesis option, satisfactory completion of five courses from the following list with approval from the student's thesis advisor, and the completion of six hours of M.S. thesis credit and successful defense of the M.S. thesis. 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 Algorithm Engineering (cross-listed with OREM 7350)
CS 8350 Algorithms II (cross-listed with OREM 8350)
ECE 7377 Embedded Wireless Design Lab
ECE 7379 Optimization in Wireless Networks
ECE 7310 Introduction to Semiconductors
ECE 7312 Compound Semiconductors and Fabrication
ECE 7322 Semiconductor Devices and Fabrication
ECE 7330 Electromagnetics: Guided Waves
ECE 7335 Quantum Electronics
ECE 7336 Introduction to Integrated Photonics
ECE 7381 Computer Architecture (cross-listed with CS 7381)

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 Cryptography and Data Security (cross-listed with CS 8352)
OREM 7361 Computer Simulation Techniques
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
PHYS 7321 Atomic Physics

Any deviation from the stated requirements must be approved in writing from the student's adviser and the MSQE program director. Some of the approved **MATH** and **PHYS** electives in the above list may require successful completion of prerequisite courses that are not normally required in engineering undergraduate programs administered by the Lyle School of Engineering.

Students desiring to focus in one of the subareas of quantum engineering may select a subset of appropriate elective courses with consent of their advisor. It is emphasized that the following focus areas are provided as an example only, designation of a focus area is not required. Students are free to select any set of elective courses from the approved list above to fulfill program requirements for the MSQE, with consent of their advisor. These example focus subarea examples are meant to be representative and are not exhaustive. Some subarea example courses can be substituted with other elective courses in the approved list while still remaining in a single focus subarea.

Quantum Devices Subarea, Example Elective Selection

ECE 7310 Introduction to Semiconductors
ECE 7312 Compound Semiconductors and Fabrication
ECE 7322 Semiconductor Devices and Fabrication
ECE 7335 Quantum Electronics
ECE 8310 Electronic Processes
ECE 8322 Semiconductor Optical Systems
ECE 7336 Introduction to Integrated Photonics

Quantum Communications Subarea, Example Selection

CS 7339 Computer System Security
CS 7349 Data and Network Security
ECE 8372 Cryptography and Data Security (cross-listed with CS 8352)
ECE 7377 Embedded Wireless Design Lab
ECE 7379 Optimization in Wireless Networks
ECE 8371 Information Theory
OREM 7361 Computer Simulation Techniques
OREM 8370 Stochastic Models

Quantum Informatics Subarea, Example Selection

CS 7339 Computer System Security
CS 7349 Data and Network Security
CS 7350 Algorithm Engineering (cross-listed with OREM 7350)
CS 8350 Algorithms II (cross-listed with OREM 8350)
ECE 7381 Computer Architecture (cross-listed with CS 7381)
ECE 8372 Cryptography and Data Security (cross-listed with CS 8352)
OREM 7361 Computer Simulation Techniques

Quantum Photonics Subarea, Example Selection

MATH 6343 Photonics Modeling and Simulations
ECE 7330 Electromagnetics: Guided Waves
ECE 7335 Quantum Electronics
ECE 7336 Introduction to Integrated Photonics
ECE 8322 Semiconductor Optical Systems
ECE 8323 Lasers and Photonics
ECE 8325 Infrared Systems Engineering

Quantum Engineering Theory. Example Selection

MATH 6341 Linear and Nonlinear Waves
CS 7350 Algorithm Engineering (cross-listed with OREM 7350)
CS 8350 Algorithms II (cross-listed with OREM 8350)
ECE 7330 Electromagnetics: Guided Waves
PHYS 6335 Quantum Mechanics I
PHYS 6336 Quantum Mechanics II
OREM 8370 Stochastic Models

Articulation. All students entering the program are expected to possess knowledge equivalent to the following Lyle courses:

1. **CS 1341** Principles of Computer Science
2. **CS 1342** Programming Concepts
3. **OREM 3340** Statistical Methods for Engineering and Applied Scientists,
or, **ECE 3360** Statistical Methods in Electrical Engineering
4. **MATH 3304** Introduction to Linear Algebra
5. **PHYS 1304** Introductory Electricity and Magnetism,
6. **ECE 3381** Microcontrollers and Embedded Systems,
or, **ECE 3382** Digital Computer Design,
or, **CS 4381** Digital Computer Design

Students entering the program with an undergraduate degree *other than those listed in Admission Requirements above* may be asked to take one or more articulation courses to be determined and assigned by the Program Director. Such students will receive conditional admission to the program. Students must receive a grade of *B* or better in each articulation course to continue in the program. Credit from the articulation courses will not count toward the 30-hour M.S. degree requirements.

Residency and Level Requirements

A minimum of 30 graduate credits must be earned toward an M.S. degree, of which at least 24 must be earned in residency at SMU. Up to six credits may be transferred with departmental approval. For M.S. thesis students, the requirements are six credit hours of ECE Master's Thesis with an additional 24 credits in courses at the 7000 level or higher.