QUANTUM SCIENCE AND ENGINEERING, MS (CEC)

Banner Code: SC-MS-QSE

Academic Advising

Email: jrosenb4@gmu.edu

The MS degree program in Quantum Science and Engineering is designed to prepare students with knowledge and skills in quantum technologies. Students will learn basic quantum theory, quantum algorithms, and applications of quantum technologies. The program is designed to provide students with the necessary mathematics, algorithm analysis, computer programming, and software engineering skills to work in fields connected with classical and quantum computing. Through an experiential learning opportunity students will gain experience working in professional research and development settings. Graduates will be able to evaluate the utility of quantum solutions in academic and industrial research settings and to communicate foundational quantum concepts to technical and non-technical audiences.

Admissions & Policies

Admissions

University-wide admissions policies can be found in the Graduate Admissions Policies (https://catalog.gmu.edu/admissions/graduate-policies/) section of this catalog. International students and students having earned international degrees should also refer to Admission of International Students (https://catalog.gmu.edu/admissions/international-students/) section of this catalog.

Applications will be reviewed by the admissions committee. At the discretion of the program director, students without the requisite coursework in mathematics or computer programming may be required to take QSE 501 Mathematical Foundations of QSE or QSE 502 Programming Foundations of QSE (respectively) in place of other elective courses. Only one of either QSE 501 or QSE 502 (a total of 3-credit-hours) may be counted toward a 30-credit-hour degree. If the program director deems both QSE 501 and QSE 502 necessary, both should be taken, but only a total of 3 credit hours will count toward the 30-credit-hour coursework total.

Due to federal requirements, students on F1/J1 visas are not eligible for Provisional Admission to George Mason University. Please see Graduate Admission Policies (https://catalog.gmu.edu/admissions/graduate-policies/) for more information.

Eligibility

Individuals holding a baccalaureate degree with a strong background in science, technology, engineering, or mathematics (STEM) from an institution of higher education accredited by a Mason-recognized U.S. institutional accrediting agency or international equivalent and who have earned an overall GPA of 3.00 (out of 4.00) are invited to apply for admission.

Based on the program director's assessment, eligible applicants may be provisionally admitted into the program and required to make up one or two course deficiencies (the *Foundational Electives* curriculum section).

Application Requirements

To apply for this program, prospective students should submit the George Mason University Admissions Application (https://www2.gmu.edu/admissions-aid/apply-now) and its required supplemental documentation, a goals statement, resume, and two letters of recommendation from individuals with knowledge of the applicant’s preparation for and likelihood of success in studies for an MS in quantum science and engineering.

The GRE is not required.

Policies

For policies governing all graduate programs, see AP.6 Graduate Policies (https://catalog.gmu.edu/policies/academic/graduate-policies/).

Transferring Previous Graduate Credit into this Program

Previously earned and relevant graduate credits may be eligible for transfer into this program; details can be found in the Credit by Exam or Transfer (https://catalog.gmu.edu/policies/academic/graduate-policies/) section of this catalog.

Plan of Study

Before the beginning of their first semester, students are advised to meet with their academic advisor and develop a preliminary plan of study. A final plan of study must be approved by the program director at the start of the semester in which the student graduates.

Requirements

Degree Requirements

Total credits: 30-33

This program prepares students for the interdisciplinary quantum science and engineering workforce through the study of physics, mathematics, computer science, and engineering. Students must complete a minimum of 30 graduate credits. The plan of study for the degree must fulfill the requirements specified below.

Foundational Electives

Code	Title	Credits
Dependent upon their background when joining the program, students may need to take one or both of the following courses; only one of which can replace a Specialized Elective. If a second Foundational Elective is needed, it must be taken beyond the degree's total 30 credits.		0-6
QSE 501	Mathematical Foundations of QSE	

QSE 502	Programming Foundations of QSE	
Total Credits		**0-6**

Core Courses

Code	Title	Credits
QSE 500	Ideas in Quantum Science and Technology	3
QSE 511	Quantum Algorithms	3
QSE 520	Applications of Quantum Technology	3
QSE 570	Quantum Computing System Design	3
or ECE 570	Quantum Computing System Design	
QSE 798	Master’s Research Project	3
Total Credits		**15**

Advanced Quantum Electives

Code	Title	Credits
Select at least two courses from the following:		6-9
QSE 505	Classical and Quantum Information Theory	
QSE 611	Advanced Quantum Algorithms	
QSE 621	Quantum Error Correction	
QSE 799	Master’s Thesis	
Total Credits		**6-9**

Specialized Electives

Code	Title	Credits
Select the remaining credits from the following:		6-9
ASTR 601	Computer Simulation in Astronomy	
BINF 690	Numerical Methods for Bioinformatics	
CS 583	Analysis of Algorithms	
CS 630	Advanced Algorithms	
CS 635	Foundations of Parallel Computation	
CSI 690	Numerical Methods	
CSI 782	Statistical Mechanics for Modeling and Simulation	
CSI 786	Molecular Dynamics Modeling	
ECE 511	Computer Architecture	
ECE 547	Applied Cryptography	
ECE 578	Intellectual Property Protection for Engineers	
ECE 633	Error Control Coding	
ECE 647	Post-Quantum Cryptography	
GGS 579	Remote Sensing	
GGS 754	Earth Science Data and Advanced Data Analysis	
MATH 625	Numerical Linear Algebra	
MATH 685	Numerical Analysis	
MATH 686	Numerical Solutions of Differential Equations	
OR 541	Operations Research: Deterministic Optimization	
OR 542	Operations Research: Stochastic Models	
OR 646	Stochastic Optimization	
PHYS 510	Computational Physics I	
PHYS 613	Computational Physics II	
PHYS 736	Computational Quantum Mechanics	
With written approval from the program director, students may select 3 credits of additional and relevant coursework.		
Total Credits		**6-9**

Accelerated Master's

Bachelor's Degree (selected)/Quantum Science and Engineering, Accelerated MS

Overview

Highly-qualified undergraduates may be admitted to the combined bachelor's and accelerated master's degree pathway program (BAM Pathway) and obtain a Bachelor of Science degree in any College of Science major and a Master of Science in Quantum Science and Engineering in an accelerated time-frame after satisfactory completion of a minimum of 138 credits.

This accelerated option is offered jointly by undergraduate Bachelor of Science programs in the College of Science and the Quantum Science and Engineering, MS program, which is jointly offered by the College of Science (https://catalog.gmu.edu/colleges-schools/science/) and the College of Engineering and Computing (https://catalog.gmu.edu/colleges-schools/engineering-computing/).

Students in an accelerated master’s degree program must fulfill all university
requirements for the master's degree. See AP.6.7 Bachelor's/Accelerated Master's Degree (https://catalog.gmu.edu/policies/academic/graduate-policies/#ap-6-7) for policies related to this program. For policies governing all graduate degrees, see AP.6 Graduate Policies (https://catalog.gmu.edu/policies/academic/graduate-policies/).

BAM Pathway Admission Requirements

Applicants to all graduate programs at George Mason University must meet the admission standards and application requirements for graduate study as specified in Graduate Admissions Policies (https://catalog.gmu.edu/admissions/graduate-policies/) and accelerated master's degree policies (https://catalog.gmu.edu/policies/academic/graduate-policies/#ap-6-7).

Students must major in a College of Science Bachelor of Science program and will be considered for admission into the BAM Pathway after completion of a minimum of 60 credits.

Students who are accepted into the BAM Pathway will be allowed to register for graduate level courses after successful completion of a minimum of 75 undergraduate credits.

Accelerated Master's Admission Requirements

Undergraduate students already admitted to the BAM Pathway will be admitted to the intended master’s program if they have met the following criteria that will be verified:

- Submission of BAM Transition Form by stated deadline.
- Sufficient minimum 3.0 cumulative GPA for conferred undergraduate degree (which does not include any earned reserve graduate credits).
- Completion of approved advanced standing courses and any reserve graduate courses; please refer to policy A.P. 6.7 (https://catalog.gmu.edu/policies/academic/graduate-policies/#ap-6-7).
- Successful completion of required minimum of 120 credits needed for undergraduate degree conferral (after exclusion any satisfactory reserve graduate credits earned).
- Successfully meeting George Mason's requirements for undergraduate degree conferral (graduation) and timely submitting the application for graduation.

Accelerated Pathway Requirements

To maintain the integrity and quality of both the undergraduate and graduate degree programs, undergraduate students interested in taking graduate courses must choose from the following:

Advanced Standing Courses

Students must complete at least 3 credits from the following list of graduate-level courses while in undergraduate status, up to a maximum of 12.

Students are encouraged to consult with both their undergraduate advisor and the Quantum Science and Engineering, MS advisor:

Code	Title	Credits
Select from the following options:		**3-12**
Up to one 500-600 level specialized course from the following:		
ASTR 601	Computer Simulation in Astronomy	
BINF 690	Numerical Methods for Bioinformatics	
CS 583	Analysis of Algorithms	
CS 630	Advanced Algorithms	
CS 635	Foundations of Parallel Computation	
CSI 690	Numerical Methods	
ECE 511	Computer Architecture	
ECE 547	Applied Cryptography	
ECE 633	Error Control Coding	
ECE 647	Post-Quantum Cryptography	
GGS 579	Remote Sensing	
MATH 625	Numerical Linear Algebra	
MATH 685	Numerical Analysis	
MATH 686	Numerical Solutions of Differential Equations	
OR 541	Operations Research: Deterministic Optimization	
OR 542	Operations Research: Stochastic Models	
OR 646	Stochastic Optimization	
PHYS 510	Computational Physics I	
PHYS 613	Computational Physics II	
Remaining credits are selected from the following:		
QSE 500	Ideas in Quantum Science and Technology	
QSE 501	Mathematical Foundations of QSE [1]	
QSE 502	Programming Foundations of QSE [1]	
QSE 505	Classical and Quantum Information Theory	
QSE 511	Quantum Algorithms	
QSE 520	Applications of Quantum Technology	
QSE 570	Quantum Computing System Design	
or ECE 570	Quantum Computing System Design	

Reserve Credit Courses

Students may complete up to 6 credits while in undergraduate student status, of graduate-level coursework from the list below that will only count toward the graduate degree program.

Code	Title	Credits
Select up to 6 credits of not previously completed courses from the following:		**6**
QSE 500	Ideas in Quantum Science and Technology	
QSE 501	Mathematical Foundations of QSE [1]	
QSE 502	Programming Foundations of QSE [1]	
QSE 505	Classical and Quantum Information Theory	
QSE 511	Quantum Algorithms	
QSE 520	Applications of Quantum Technology	
QSE 570	Quantum Computing System Design	
or ECE 570	Quantum Computing System Design	

[1] As only one of these courses count for Quantum Science and Engineering, MS, credit, and these courses may not be necessary for all students, consult with an academic advisor prior to enrolling in QSE 501 Mathematical Foundations of QSE or QSE 502 Programming Foundations of QSE.

For more detailed information on coursework and timeline requirements, see AP.6.7 Bachelor's/Accelerated Master's Degree (https://catalog.gmu.edu/policies/academic/graduate-policies/#ap-6-7) and AP.1.4.4 Graduate Course Enrollment by Undergraduates (https://catalog.gmu.edu/policies/academic/registration-attendance/#ap-1-4-4).