Course Change Request

New Course Proposal

Date Submitted: 08/13/25 10:44 pm

Viewing: QSE 520 : Applications of Quantum Technology

Last edit: 08/19/25 3:02 pm

Changes proposed by: kgaj

Programs referencing this course	: Quantum Science and Engineering, MS

Are you completing this form on someone else's behalf?

No

Effective Term: Spring 2026

Subject Code: QSE - Quantum Science and Engineering **Course Number:** 520

Bundled Courses:

Is this course replacing another course? No

Equivalent Courses:

Catalog Title: Applications of Quantum Technology

Banner Title: Applications of Quantum Tech

In Workflow

1. **SC Curriculum Committee**
2. SC Assistant Dean
3. Assoc Provost-Graduate
4. Registrar-Courses
5. Banner

Will section titles vary by semester? No

Credits: 3

Schedule Type: Lecture

Hours of Lecture or Seminar per week: 3

Repeatable: May only be taken once for credit (NR)
GRADUATE ONLY

Default Grade Mode: Graduate Regular

Recommended Prerequisite(s): QSE 500

Recommended Corequisite(s):

Required Prerequisite(s) / Corequisite(s) (Updates only):

Registrar's Office Use Only - Required Prerequisite(s)/Corequisite(s):

And/Or	(	Course/Test Code	Min Grade/Score	Academic Level	)	Concurrency?

Registration Restrictions (Updates only):

Registrar's Office Use Only - Registration Restrictions:

Field(s) of Study:

Class(es):

Level(s):

Degree(s):

School(s):

Catalog Description:

This course surveys the practical applications of quantum computing and quantum technologies, spanning quantum chemistry, condensed matter physics, combinatorial optimization, machine learning, finance, and cryptanalysis. Students will understand real-world implications of quantum algorithms, including their capabilities and limitations, through detailed end-to-end complexity analyses.

Justification:

What: Create a new course.
Why: The rapid progress of quantum technologies is enabling applications across diverse scientific and industrial sectors. This course gives students a broad and adaptable understanding of how quantum algorithms and devices can be applied to real-world problems, fostering both technical depth and interdisciplinary awareness.

The course surveys application domains including quantum chemistry, condensed matter physics, combinatorial and continuous optimization, finance, cryptanalysis, and quantum machine learning. Students learn to assess the strengths, limitations, and complexity of quantum solutions in comparison to classical approaches, and to identify the contexts in which quantum technologies offer genuine advantages.

Through homework assignments, projects, and presentations, students develop the ability to communicate effectively about quantum applications to technical and non-technical audiences. The intentionally flexible structure allows the course to evolve alongside technological advances, ensuring graduates remain prepared to engage with the most current and impactful areas of quantum innovation.

This course overlaps to a small extent with ECE 570 / QSE 570, however the material will be complementary rather than redundant.

Does this course cover material which crosses into another department?

No

Learning Outcomes:

Will this course be scheduled as a cross-level cross listed section?	No
Attach Syllabus	QSE_520_syllabus.pdf
Additional Attachments	

Have you reached out to the Libraries to determine whether there are adequate resources to support your course? If not, please email Meg Meiman, Associate University Librarian for Learning, Research, and Engagement at mmeiman2@gmu.edu.

Yes

Additional Comments:	This is a core course for the new MS program in Quantum Science and Engineering.
Reviewer Comments	

Key: 19079

QSE 520: Applications of Quantum Technology

Potential Instructors:

Dr. Jessica Rosenberg
Department of Physics & Astronomy, College of Science
Email: jrosenb4@gmu.edu

Dr. Michael Jarret Baume
Department of Mathematical Sciences, College of Science
and Department of Computer Science, College of Engineering and Computing
Email: mjarretb@gmu.edu

Semester and Year: TBA

Class Meeting Day(s) and Time(s): TBA
Modality: Face-to-Face
Class Location: TBA

Office Hours: TBA
Office Hours Location: TBA

Course Description

This course surveys the practical applications of quantum computing and quantum technologies, spanning quantum chemistry, condensed matter physics, combinatorial optimization, machine learning, finance, and cryptanalysis. Students will understand real-world implications of quantum algorithms, including their capabilities and limitations, through detailed end-to-end complexity analyses.

Recommended Prerequisite

- QSE 500

Useful Background

- Basic Linear Algebra
- Familiarity with principles of quantum mechanics or quantum computing

Textbook

- **Primary Text:** Dalzell et al., *Quantum algorithms: A survey of applications and end-to-end complexities* (arXiv:2310.03011), 2023.

Course Learning Outcomes

By the end of this course, students will be able to:

- Analyze the utility and practical applicability of quantum solutions in diverse scientific domains.
- Explain the strengths and limitations of foundational quantum algorithms and their complexity.
- Evaluate quantum computational methods against state-of-the-art classical algorithms.
- Communicate effectively about quantum technology to diverse technical and non-technical audiences.

Tentative Course Schedule

Week	Topic	Activity
1	Introduction to Quantum Algorithms	Lecture & Discussion
2-3	Condensed Matter Applications	Case Studies, Problem Sets
4-5	Quantum Chemistry	Simulations & Reports
6	Quantum Nuclear and Particle Physics	Lecture & Discussions
7-8	Combinatorial Optimization	Workshop & Lab
9-10	Continuous Optimization and Finance	Project proposal due
11	Quantum Cryptanalysis	Analysis and Presentations
12	Quantum Algorithms for Differential Equations	Lecture & Interactive Session

13-14	Quantum Machine Learning	Final Project Workshop
15	Final Project Presentations and Review	Student Presentations

Grade Weights

- **Homework and Assignments:** 40%
- **Midterm Project:** 30%
- **Final Project and Presentation:** 30%

Grading Schema

A+	TBA	**B**	TBA
A	TBA	**B-**	TBA
A-	TBA	**C**	TBA
B+	TBA	**F**	TBA

Grading-related Policies

- **Assignment Submission:** Upload assignments to Canvas by deadlines.
- **Academic Integrity:** Adherence to GMU Academic Standards is mandatory.
- **Attendance:** Active participation recommended.
- **Late Submissions:** TBA

AI (Artificial Intelligence) Tools Policy

The use of AI-based tools is permitted for purposes of learning, exploring ideas, and identifying credible references. Students may use such tools to clarify concepts, brainstorm topics, or locate scholarly sources. However, AI tools must not be used to generate complete solutions to assignments, assessments, or projects, nor may students present AI-generated text, code, or other output as their own original work. Copying, paraphrasing, or otherwise incorporating AI-generated materials without attribution constitutes academic dishonesty and will be treated as plagiarism under the University's Academic Standards. Students are responsible for critically evaluating and verifying any information obtained through AI tools, ensuring that their submissions reflect their own understanding, analysis, and synthesis of course material.

Common Policies Affecting All Courses at George Mason University

Common policies affecting all courses at George Mason University, including

- Academic Standards
- Accommodations for Students with Disabilities
- FERPA and Use of GMU Email Addresses for Course Communication
- Title IX Resources and Required Reporting,

are available at

https://stearnscenter.gmu.edu/home/gmu-common-course-policies

You are strongly encouraged to get familiar with this additional information.