Course Change Request

New Course Proposal

Date Submitted: 08/13/25 10:35 pm

Viewing: QSE 505 : Classical and Quantum Information Theory

Last edit: 08/19/25 2:57 pm

Changes proposed by: kgaj

Programs referencing this course	: Quantum Science and Engineering, MS

In Workflow

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

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

No

Effective Term: Spring 2026

Subject Code: QSE - Quantum Science and Engineering **Course Number:** 505

Bundled Courses:

Is this course replacing another course? No

Equivalent Courses:

Catalog Title: Classical and Quantum Information Theory

Banner Title: Classic and Quantum Inf Theory

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 and (QSE 501 or equivalent)

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 introduces students to classical and quantum information theory, which is essential to our understanding of quantum communications and quantum information processing. Students will learn the concepts of Shannon and Von Neumann entropy. Students will also learn to understand the fundamental limits of information transfer, the concept of quantum channels, and how noise impacts communication.

Justification: What: Create a new course.
Why: Information theory provides the foundation for understanding communication, computation, and storage in both classical and quantum systems. This course equips students with the theoretical tools to quantify, analyze, and optimize information processing in these domains.

Starting with classical Shannon theory, students learn about entropy, mutual information, and channel capacity before moving into quantum extensions, including von Neumann entropy, quantum channels, entanglement, and quantum error correction. The course emphasizes the fundamental limits imposed by physics and the implications of noise and decoherence on information transfer.

By integrating analytical methods, optimization techniques, and case studies from quantum communication protocols, students gain the ability to evaluate and design systems for secure, efficient, and robust information exchange. This prepares them for work in quantum networking, cryptography, and advanced computation, while providing a unifying theoretical framework for the QSE curriculum.

This course has limited overlap with ECE 664, which covers only classical information theory.
ECE 664 is geared toward electrical engineering students interested in traditional communication theory, while QSE 505 targets quantum science and engineering students interested in a unified framework for classical and quantum information theory.

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_505_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 an advanced quantum elective course for the new MS program in Quantum Science and Engineering.

Reviewer Comments

Key: 19078

QSE 505: Classical and Quantum Information Theory

Instructor: 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 introduces students to classical and quantum information theory, which is essential to our understanding of quantum communications and quantum information processing. Students will learn the concepts of Shannon and Von Neumann entropy. Students will also learn to understand the fundamental limits of information transfer, the concept of quantum channels, and how noise impacts communication.

Recommended Prerequisites

- QSE 500 and (QSE 501 or equivalent)

Useful Background

- Familiarity with principles of quantum mechanics or quantum computing

Textbook

- **Primary Text:** Mark Wilde, *Quantum Information Theory,* Cambridge University Press, 2nd Edition, 2017
- **Secondary Text:** Thomas M. Cover and Joy A. Thomas, *Elements of Information Theory,* Wiley-Interscience, 1991.

Course Learning Outcomes

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

- Analyze channel capacities

- Explain and apply fundamental theorems that limit the amount of information that one can transmit across a channel
- Analyze quantum and classical communications and coding schemes through entropy
- Apply Lagrangian optimization

Tentative Course Schedule

Week	Topic
1-2	Shannon Entropy
3	Density Matrices
4-5	Von Neumann Entropy
6-7	Quantum Channels
8-9	Communication Protocols
10-11	Continuous Optimization and Finance
12	Quantum Metrics
13-14	Information-theoretic limitations on communication
15	Entanglement

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:** Compliance with GMU Academic Standards required.
- **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.