NEW COURSE PROPOSAL
Undergraduate Programs

FLORIDA ATLANTIC UNIVERSITY

Department Mathematics and Statistics

College Charles E. Schmidt College of Science

*(To obtain a course number, contact **erudolph@fau.edu**)*

UUPC Approval 4-27-26
UFS Approval _____
SCNS Submittal _____
Confirmed _____
Banner Posted _____
Catalog _____

Prefix MAD **Number** 4515	*(L = Lab Course; C = Combined Lecture/Lab; add if appropriate)* **Lab Code**	**Type of Course** Lecture	**Course Title** Mathematics of Quantum Computing and Data Analysis

Credits *(See Definition of a Credit Hour)*: 3

Effective Date *(TERM & YEAR)*: Fall 2026

Grading *(Select One Option)*: Regular ◉ Sat/UnSat ○

Course Description *(Syllabus must be attached; see Template and Guidelines)*

This course introduces the mathematical ideas behind applications of quantum computing in data science, machine learning, and cybersecurity. Students learn how quantum algorithms can help solve problems involving large and complex datasets, including tasks such as optimization, data analysis, and pattern recognition. The course also discusses how quantum computing may affect modern cybersecurity, including its potential use in cryptanalysis. To complement the theoretical material, students will perform hands-on computational experiments using a D-Wave quantum annealing system.

Prerequisites, with minimum grade*

MAS 2103 with minimum grade of C

Corequisites

Registration Controls *(Major, College, Level)*

***Default minimum passing grade is D-.** Prereqs., Coreqs. & Reg. Controls are enforced for all sections of course*

WAC/Gordon Rule Course

☐ Yes ☑ No

WAC/Gordon Rule criteria must be indicated in syllabus and approval attached to proposal. See WAC Guidelines.

Intellectual Foundations Program (General Education) Requirement *(Select One Option)*

None

General Education criteria must be indicated in the syllabus and approval attached to the proposal. See Intellectual Foundations Guidelines.

Minimum qualifications to teach course

Member of the FAU graduate faculty and has a terminal degree in the subject area (or a closely related field).

Faculty Contact/Email/Phone

Veronika Kuchta / vkuchta@fau.edu

List/Attach comments from departments affected by new course

Contacted EECS and Physics

Approved by	*Date*
Department Chair	3/17/2016
College Curriculum Chair	4-16-2026
College Dean	4-17-26
UUPC Chair Korey Sorge	4-27-26
Undergraduate Studies Dean Dan Mesoff	4-27-26
UFS President	
Provost	

Email this form and syllabus to mjenning@fau.edu seven business days before the UUPC meeting.

MAD 4515
Mathematics of Quantum Computing and Data Analysis

3 credits
Fall 2026

Office:
Office hours:
Classroom:
Telephone:
Email:

Course Description
Mathematical Introduction to Quantum Algorithms
Prerequisites: MAS 2103 with grade of C or better

This course introduces the mathematical ideas behind applications of quantum computing in data science, machine learning, and cybersecurity. Students learn how quantum algorithms can help solve problems involving large and complex datasets, including tasks such as optimization, data analysis, and pattern recognition. The course also discusses how quantum computing may affect modern cybersecurity, including its potential use in cryptanalysis. To complement the theoretical material, students will perform hands-on computational experiments using a D-Wave quantum annealing system.

Instructional Method
In-person.

Prerequisites/Corequisites
Matrix Theory or Linear Algebra MAS 2103

Course Objectives/Student Learning Outcomes
Upon successful completion of this course, students will be able to:

1) Describe the basic ideas of quantum computing and explain how quantum systems can be used to perform computations.

2) Understand the mathematical ideas behind problems in data science and machine learning and explain how quantum algorithms may help address these problems.

3) Formulate combinatorial optimization problems as Ising or QUBO models, which can be solved using quantum annealing methods.

4) Use modern quantum computing tools and platforms, including running computational experiments on the department's D-Wave quantum annealing system.
5) Discuss the potential impact of quantum computing on cybersecurity, including the role of quantum algorithms in cryptanalysis.

6) Understand the basic concepts of topological data analysis, including persistent homology and the extraction of topological features from data.

7) Explore how quantum algorithms and topological methods can be combined to analyze complex datasets.

Required Texts/Readings

None. Because the course covers applications across multiple areas of applied mathematics, the instructor will draw from several textbooks and research articles. Additional reading materials and references will be provided throughout the course.

Supplementary/Recommended Readings

1) *Introduction to Quantum Algorithms, by Johannes A. Buchmann.*
   ISBN: 978-1-4704-7398-3 (year: 2024)
2) *Machine Learning with Quantum Computers, by Maria Schuld, Francesco Petruccione*
   ISBN: 978-3-030-83097-7 *(year 2021)*

Course Topical Outline

Week 1: Introduction to quantum computing
Overview of quantum computing and its applications in data science, machine learning, and cybersecurity.

Week 2: Mathematical foundations
Review of key linear algebra concepts used in quantum computing, including vectors, matrices, and complex vector spaces.

Week 3: Quantum information and quantum states
Representation of quantum states, qubits, and basic operations on quantum systems.

Week 4: Quantum algorithms for data processing
Introduction to how quantum algorithms can be used for data analysis and computational tasks.

Week 5: Optimization problems in data science
Introduction to combinatorial optimization problems and their importance in machine learning and data analysis.

Week 6: Ising models and QUBO formulations
Modeling optimization problems using Ising and QUBO formulations suitable for quantum computing.

Week 7: Quantum annealing
Principles of quantum annealing and its role in solving optimization problems.

Week 8: Introduction to quantum computing platforms
Overview of modern quantum computing tools and programming environments.

Week 9: Computational experiments with quantum annealing
Hands-on experiments using the **D-Wave quantum annealing system**.

Week 10: Quantum computing and cybersecurity
Overview of cryptography and how quantum computing may impact current security systems.

Week 11: Quantum cryptanalysis
Introduction to quantum algorithms that affect classical cryptographic systems.

Week 12: Introduction to topological data analysis
Basic ideas of topology in data analysis and the concept of shape in data.

Week 13: Persistent homology
Understanding persistent homology and how it identifies important features in datasets.

Week 14: Topological methods for complex data
Applications of topological feature extraction in data science and machine learning.

Week 15: Project Presentations and Future Directions

Course Evaluation Method

The grade for the course will be determined by the following scheme:

Quizzes (25%), Midterm Exam (30%), Project (15%), Final Exam (30%).

Quizzes: Regular quizzes are conducted weekly, lasting 15-20 minutes, covering specific topics for that week. They count for 25% of the final grade

Midterm Exam: The midterm exam counts for 30% of the final grade.

Group Project: Students will work in small groups to design and implement a project that applies quantum optimization techniques using the D-Wave quantum annealing system available through the department. The goal of the project is to formulate a real-world data science or cybersecurity problem as a Quadratic Unconstrained Binary Optimization (QUBO) or Ising model, and then solve the problem using D-Wave's quantum annealer.

Components of the Project:

-*Report* (e.g. 5-10 pages) summarizing the main techniques of the project.

-*Group presentation (20-30 minutes).* After the presentation, the examiner will ask questions on your report, on your understanding of the technical content of the research paper.

The group project counts for 15% of the final grade.

Final exam: The final exam will cover the totality of the syllabus. It counts for 30% of the final grade.

Bonus Opportunity: Active participation in class (e.g., volunteering to go to the board or helping peers with exercise solutions) can earn up to **5% bonus points** toward the final course grade.

Grading scale

At the end of the semester, the following scale for FAU grade will be used.

Total points	87-100	83-86	77-82	73-76	70-72	67-69	63-66	60-62	57-59	53-56	50-52	<50
Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F

Make-up Policies on Exams/Tests

If you miss a quiz, you must provide a written, verifiable excuse, if possible, in advance of the scheduled exam. Doctor notes, letters, emails from immediate family members are not accepted as proof of absence from any quizzes. Approval for a make-up quiz must be obtained from your instructor.

Special Course Requirements

Students are expected to be familiar and comply with the standard university policies. In addition, the following policies on assignments should be confirmed.

Collaboration policy on assignments. Collaboration on the group project is permitted and recommended for this course.

Artificial Intelligence Preamble

FAU recognizes the value of generative AI in facilitating learning. However, output generated by artificial intelligence (AI), such as written words, computations, code, artwork, images, music, etc., for example, is drawn from previously published materials and is not your own original work.

FAU students are not permitted to use AI for any course work unless explicitly allowed to do so by the instructor of the class for a specific assignment. **[Policy 10.16 Artificial Intelligence]**

Class policies related to AI use are decided by the individual faculty. Some faculty may permit the use of AI in some assignments but not others, and some faculty may prohibit the use of AI in their course entirely. In the case that an instructor permits the use of AI for some assignments, the assignment instructions will indicate when and how the use of AI is permitted in that specific assignment. It is the student's responsibility to comply with the instructor's expectations for each assignment in each course. When AI is authorized, the student is also responsible and accountable for the content of the work. AI may generate inaccurate, false, or exaggerated information. Users should approach any generated content with skepticism and review any information generated by AI before using generated content as-is.

If you are unclear about whether or not the use of AI is permitted, ask your instructor before starting the assignment.

Failure to comply with the requirements related to the use of AI may constitute a violation of the **Florida Atlantic Code of Academic Integrity, Regulation 4.001.**

Proper Citation: If the use of AI is permitted for a specific assignment, then use of the AI tool must be properly documented and cited. For more information on how to properly cite the use of AI tools, visit **https://fau.edu/ai/citation**

AI Language Specific To This Course

AI Prohibited: The use of AI to assist in any work assigned in this specific course is prohibited.

Policy on the Recording of Lectures

Because of a new Florida Statute in 2021, the following model language is suggested for inclusion in course syllabi, at the discretion of individual faculty: Students enrolled in this course may record video or audio of class lectures for their own personal educational use. A class lecture is defined as a formal or methodical oral presentation as part of a university course intended to present information or teach students about a particular subject. Recording class activities other than class lectures, including but not limited to student presentations (whether individually or as part of a group), class discussion (except when incidental to and incorporated within a class lecture), labs, clinical presentations such as patient history, academic exercises involving student participation, test or examination administrations, field trips, and private conversations between students in the class or between a student and the lecturer, is prohibited. Recordings may not be used as a substitute for class participation or class attendance and may not be published or shared without the written consent of the faculty member. Failure to adhere to these requirements may constitute a violation of the University's Student Code of Conduct and/or the Code of Academic Integrity.

Attendance Policy

Students are expected to attend all of their scheduled University classes and to satisfy all academic objectives as outlined by the instructor. The effect of absences upon grades is determined by the instructor, and the University reserves the right to deal at any time with individual cases of non-attendance. Students are responsible for arranging to make up work missed because of legitimate class absence, such as illness, family emergencies, military obligation, court-imposed legal obligations or participation in University-approved activities. Examples of University-approved reasons for absences include participating on an athletic or scholastic team, musical and theatrical performances and debate activities. It is the student's responsibility to give the instructor notice prior to any anticipated absences and within a reasonable amount of time after an unanticipated absence, ordinarily by the next scheduled class meeting. Instructors must allow each student who is absent for a University-approved reason the
opportunity to make up work missed without any reduction in the student's final course grade as a direct result of such absence.

Counseling and Psychological Services (CAPS) Center

Life as a university student can be challenging physically, mentally and emotionally. Students who find stress negatively affecting their ability to achieve academic or personal goals may wish to consider utilizing FAU's Counseling and Psychological Services (CAPS) Center. CAPS provides FAU students a range of services – individual counseling, support meetings, and psychiatric services, to name a few – offered to help improve and maintain emotional well-being.

For more information, go to http://www.fau.edu/counseling/

Disability Policy

In compliance with the Americans with Disabilities Act Amendments Act (ADAAA), students who require reasonable accommodations due to a disability to properly execute coursework must register with Student Accessibility Services (SAS) and follow all SAS procedures. SAS has offices across three of FAU's campuses – Boca Raton, Davie and Jupiter – however disability services are available for students on all campuses. For more information, please visit the SAS website at www.fau.edu/sas/.

Code of Academic Integrity

Students at Florida Atlantic University are expected to maintain the highest ethical standards. Academic dishonesty is considered a serious breach of these ethical standards, because it interferes with the university mission to provide a high quality education in which no student enjoys an unfair advantage over any other. Academic dishonesty is also destructive of the university community, which is grounded in a system of mutual trust and places high value on personal integrity and individual responsibility. Harsh penalties are associated with academic dishonesty. For more information, see University Regulation 4.001.

If your college has particular policies relating to cheating and plagiarism, state so here or provide a link to the full policy—but be sure the college policy does not conflict with the University Regulation.

Religious Accommodation Policy Statement

In accordance with the rules of the Florida Board of Education and Florida law, students have the

right to reasonable accommodations from the University in order to observe religious practices and beliefs regarding admissions, registration, class attendance, and the scheduling of examinations and work assignments. University Regulation 2.007, Religious Observances, sets forth this policy for FAU and may be accessed on the FAU website at www.fau.edu/regulations.

Any student who feels aggrieved regarding religious accommodations may present a grievance to the executive director of The Office of Civil Rights and Title IX. Any such grievances will follow Florida Atlantic University's established grievance procedure regarding alleged discrimination.

Time Commitment Per Credit Hour

For traditionally delivered courses, not less than one (1) hour of classroom or direct faculty instruction each week for fifteen (15) weeks per Fall or Spring semester, and a minimum of two (2) hours of out-of-class student work for each credit hour. Equivalent time and effort are required for Summer Semesters, which usually have a shortened timeframe. Fully Online courses, hybrid, shortened, intensive format courses, and other non-traditional modes of delivery will demonstrate equivalent time and effort.

Student Support Services and Online Resources

- Center for Learning and Student Success (CLASS)
- Counseling and Psychological Services (CAPS)
- FAU Libraries
- Office of Information Technology Helpdesk
- Center for Global Engagement
- Office of Undergraduate Research and Inquiry (OURI)
- Student Accessibility Services
- Student Athlete Success Center (SASC)
- Testing and Certification
- Test Preparation
- University Academic Advising Services

The Center for Teaching and Learning (CTL)

The CTL has a variety of FREE TUTORING and other academic support services to help you succeed in your courses. You are encouraged to build your academic support team early in the term and meet with your team regularly. At the CTL, you can practice difficult course content, develop skills, and learn academic success strategies -- in person and online. Learn more about FAU academic support at **www.fau.edu/ctl**.

Faculty Rights and Responsibilities

Florida Atlantic University respects the rights of instructors to teach and students to learn. Maintenance of these rights requires classroom conditions that do not impede their exercise. To ensure these rights, faculty members have the prerogative to:

• Establish and implement academic standards.

• Establish and enforce reasonable behavior standards in each class.

• Recommend disciplinary action for students whose behavior may be judged as disruptive under the Student Code of Conduct University Regulation 4.007.

Title IX Statement

In any case involving allegations of sexual misconduct, you are encouraged to report the matter to the University Title IX Coordinator in the Office of Civil Rights and Title IX (OCR9). If University faculty become aware of an allegation of sexual misconduct, they are expected to report it to OCR9. If a report is made, someone from OCR9 and/or Campus Victim Services will contact you to make you aware of available resources including support services, supportive measures, and the University's grievance procedures. More information, including contact information for OCR9, is available at **https://www.fau.edu/ocr9/title-ix/**. You may also contact Victim Services at **victimservices@fau.edu** or 561-297-0500 (ask to speak to an Advocate) or schedule an appointment with a counselor at Counseling and Psychological Services (CAPS) by calling 561-297-CAPS.