QUANTUM COMPUTING AND INFORMATION SYSTEMS

ECE 558 and 493-05, Spring 2025, MW 2:00 – 3:20 pm

Quantum information science (QIS) promises to revolutionize the world of computing and information processing by exploiting quantum mechanics' unique properties. In this class, we first answer three essential questions: How is quantum information represented? How is quantum information processed? How is classical information extracted from quantum states? We then move to (secure) multi-part(y) systems. The class focuses on 1) scenarios with multiple (secure) communication participants (e.g., quantum key distribution and elements of quantum information theory), 2) multi-player games and quantum correlations (e.g., CHSH and monogamy of entanglement in cryptographic protocols), 3) Noisy Intermediate-Scale Quantum (NISQ) systems, processing information in multiple hybrid quantum/classical iterations.

Prerequisites: Calculus, linear algebra, probability at an undergraduate level, and familiarity with complex numbers are required. Prior exposure to quantum mechanics is helpful but not essential.

Learning Objective:

The students will learn the fundamentals of quantum information science and secure quantum multi-party systems.

Grading: (weekly) homework 55%, two exams 15% each, project 15%.

Instructor: Emina Soljanin (Office hours are by appointment.)

Required reading:

Course notes will be posted weekly on the class Canvas web page.

Recommended reading:

T. Vidick and S. Wehner, *Introduction to Quantum Cryptography 1st Ed.*, Cambridge University Press, 2023.

L. S. Woody III, *Essential Mathematics for Quantum Computing: A beginner's guide to just the math you need without needless complexities*, Packt Publishing, 2022.

Supplemental reading: *(in alphabetical order)*

F. W. Byron and R. W. Fuller, *Mathematics of Classical and Quantum Physics*, Dover 1992.

J. D. Hidary, *Quantum Computing: An Applied Approach*, Springer 2019.

M. A. Nielsen and I. L. Chuang *Quantum Comput. and Quantum Informat.*, Cambridge University Press, 2010.

L. Susskind and A. Friedman, *Quantum Mechanics: The Theoretical Minimum*, Basic Books 2015.