QUANTUM COMPUTING AND INFORMATION SYSTEMS

ECE 558 and 493-05, Spring 2024, MW 2:00 – 3:20 pm

Quantum phenomena provide information-processing paradigms that are distinctly different and arguably much more powerful than their classical counterparts. 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 multi-part(y) systems. The class focuses on 1) scenarios with multiple 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), 3) multi-level and multi-mode representation of quantum information (harmonic oscillator) and 4) Noisy Intermediate-Scale Quantum (NISQ) systems, processing information in multiple hybrid quantum/classical iterations.

Prerequisites: Calculus, linear algebra, and 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, quantum multi-party systems, and some more advanced topics of their interests.

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

Instructor: Emina Soljanin (contact info on the web page, office hours by appointment).

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

Recommended reading: *(in alphabetical order)*

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

S. Haroche and J-M. Raimond, *Exploring the Quantum: Atoms, Cavities, and Photons*, Oxford University Press 2006

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.

J. Preskill, *Lecture Notes for Physics 229: Quantum Information and Computation.*

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

Registration: Undergrad students can request an SPN through a waiting list at http://www.ece.rutgers.edu → Academics