EECS4141 – Introduction to Quantum Computing
Fall 2020 – Prof. Hamzeh Roumani

Calendar Description

This course presents an overview of the quantum computing field without assuming any prior exposure to quantum mechanics. Drawing parallels between quantum and classical computing, the course covers the physical layer briefly before moving to quantum gates, the circuit model, and quantum algorithms. Quantum information is covered through applications. The covered topics are organized in three areas:

- ***Foundational Concepts***
  - *Classical computing models and complexity*
  - *The qubit and its physical realizations*
  - *The Framework: State representation, superposition and entanglement, reversibility, no-cloning.*
- ***Quantum Computation***
  - *The quantum circuit model*
  - *Quantum search algorithm*
  - *Quantum Fourier transform*
- ***Quantum Information***
  - *Concepts and Entropy*
  - *Super-dense Coding and Error Correction*
  - *Quantum Cryptography*

Course Learning Objectives

1. *Work with, and operate on, the quantum state of single and multi-qubit systems.*
2. *Appreciate the novelty of concepts such as reversibility and measurement.*
3. *Become familiar with single and multi-qubit gates and the circuit model.*
4. *Use linear algebra to analyze a given quantum algorithm and predict its output.*
5. *Understand the implications of, and the challenges in, building a large-scale quantum computer.*
6. *Recognise the implication of quantum computing on cryptography.*

Course Learning Outcomes

1. *Employ linear algebra to represent, transform, and measure a given multi-qubit state.*
2. *Design a quantum circuit using single and multi-qubit gates or determine the function of a given circuit.*
3. *Analyze a given search or phase estimation quantum algorithm.*
4. *Demonstrate the potential of quantum computers and describe the challenges in building them.*
5. *Build a secure channel using quantum cryptography.*