ECE 8930 Quantum Microwave Engineering

Class Location/Time: TBD

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Teaching Assistant/Grader (if applicable): ____ _____
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Course Description

Review of quantum mechanics fundamentals, qubits, and superconducting circuit implementations of quantum gates. Review of microwave engineering fundamentals, microwave devices, circuits, and systems for superconducting qubits design, manipulation, and readout as well as basic techniques for quantum microwave measurement. Current status of superconducting quantum computing and sensing.

Prerequisites of the course: Consent of instructors.

Course Objectives

At the completion of the course, students should be able to understand the basic characteristics of superconducting qubits, their design, fabrication, manipulation and testing as well current advancements and challenges in quantum computing and quantum sensing.

Suggested Materials

1. Microwave Engineering, David Pozar, 4th Edition
2. RF Microelectronics (Prentice Hall Communications Engineering and Emerging Technologies) Behzad Razavi, 2nd Edition

Topical Outline

- Introduction to Quantum Information Science and Engineering (QISE) and its economic/societal impacts
- The weirdness of Quantum Mechanics: making sense of the probabilistic nature of the quantum world
- Quantum Computing: a gentle introduction to the main concepts
- Quantum circuits and quantum gates for single and multiple qubits: from pictures to real IBM-Q computers

- Doing quantum computing with superconducting microwave circuits: a brief intro to superconducting qubits
- Overview of microwave engineering for quantum engineers
- Microwave network analysis: scattering parameter matrix
- Quantum microwave devices, such as beam splitter, director couplers, for quantum state manipulation
- Quantum microwave circuits
- Quantum microwave measurements
- Superconducting qubits and cryogenic integration: talking about components needed for qubit drive and measurements.

Grading

1. **Letter grade assignment:**
   A – 90% - 100%
   B – 80% - Less than 90%
   C – 70% - Less than 80%
   D – 60% - Less than 70%
   F – Less than 60%
2. **Assignments, projects, test and weighting:**
   Homework assignments: mostly reading scientific articles with reports
   Projects: (1) presentations of homework reading
   (2) Design, build and measure microwave devices and circuits

   Tests: The final test is a project presentation, based on noise analysis and measurement of a chosen device or circuit.

1) Homework	**25%**
2) Project	**25% each**
3) Final exam	**25%**

Additional Policies

1. **Academic Integrity:** Anyone caught in an act of academic dishonesty (cheating) will be penalized to the maximum extent allowed by Clemson University Academic Regulations. The full academic integrity statement is included as a PDF file on your Canvas. Note that putting false information on a roll sheet is considered academic dishonesty in this course. Signing/writing another person's name on an attendance roll sheet is considered false information and is an act of academic dishonestly. Obviously, any form of cheating on a test or exam is academic dishonestly.
2. **Syllabus changes:** This syllabus may be updated at any time during the semester. Students will be given adequate lead time to react to updates.

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