ECE 498: Quantum Nanotechnology:

An Introduction to Quantum Mechanics for Nano Science and Technology

Prereqs: Math 215/216, Physics 240, co-req. EECS 230 or permission of instructor

TIME: 9-10:30 Tu-Th

The development and application of nano-technology is impacting nearly all the fields of engineering, from those who are developing it to those who use it. Future engineers working to design new devices will need a skill set that is considerably broadened to include the behavior of materials and devices when they become sufficiently small. Devices like transistors and quantum well lasers have already forced engineers to understand the impact of Fermi-Dirac statistics and energy quantization on devices. However, the emergent field of nano-technology is revealing that the concepts we have from our current scale devices are no longer adequate to predict correct device experience. Moreover, in this new regime, new physical properties are emerging that may revolutionize how we think about information, its storage, transmission and processing. This course introduces students to basic concepts that are relevant to novel device concepts. The course will explore the new properties of nano-vibrators, quantum LC circuits, the role of loss, the impact of the quantum vacuum on nano-switches, coherent superposition, quantum entanglement, light (one photon at a time) and quantum information and computing. **You will learn a new way to think about how things work.**

The course is aimed at undergraduate students who are likely to go into advanced R&D training and are considering nanotechnology as a likely area.

Motivation: How quantum behavior is impacting technology

Analysis of a Quantum Nanoelectromechanical (NEM) Device: Part I

Quantum Dots and Tunneling

The New Rules for Design: AKA The Postulates of Quantum Mechanics

Analysis of a Quantum Nanoelectromechanical (NEM) Device: Part II

Application to a Quantum LC-Circuit

Quantum Dynamics

Quantum Dissipation: Vibrators with loss, LC circuits with resistors

Hilbert Spaces

Quantum Gyroscopes, Angular Momentum, spin, SU2 algebra

Rabi oscillations, magnetic resonance imaging, and attojoule gates

Quantum information, quantum gates for quantum computing, quantum cryptography

The vacuum, photons (nanophotonics) and NEMS.