ECE 498 (4 Hours)

Title: INTRODUCTION TO QUANTUM MECHANICS FOR NANO SCIENCE AND TECHNOLOGY

Short Title: Quantum Nanotechnology

Text Book (strongly recommended) Liboff – Quantum Mechanics 4th ed.

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

TIME: 9-10:30 Tu-Th

Course Description: 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 is no longer adequate to predict correct device experience. Moreover, in this new regime, new physical properties are emerging that may revolutionize how we think of information and its storage, transmission and processing. This course aims to introduce students to basic concepts in quantum physics that our 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 and light, one photon at a time.

Syllabus (still evolving)

1. Introduction to Applied Quantum Mechanics – Why quantum behavior is impacting technology
2. Analysis of a Quantum Nanoelectromechanical (NEM) Device: Part I
3. Quantum Dots and Tunneling
4. The New Rules of Quantum Mechanics
5. Analysis of a Quantum Nanoelectromechanical (NEM) Device: Part II
6. Application to a Quantum LC-Circuit
7. Quantum Dynamics
8. Quantum Dissipation: Vibrators with loss, LC circuits with resistors
9. Hilbert Spaces
10. Quantum Gyroscopes, Angular Momentum, spin, SU2 algebra, Rabi oscillations, magnetic resonance imaging, and simple quantum gates.
11. The Vacuum, Light and NEMS