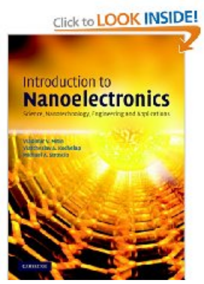
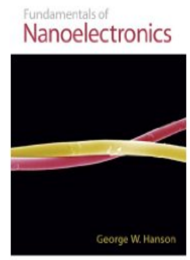
ECE597-6097 NE: Nanoelectronics
Fall 2021

Instructor: Prof. Eric Polizzi
Office: Marcus 201C
Day, Time : Mon-Wed 2:30-3:45
Office Hours: by appointment
Prerequisite: ECE344 or equivalent + basics of quantum mechanics

Textbook (recommended, not required):

- “Introduction to Nanoelectronics” V. Mitin, V. A. Kochelap, M. A. Stroscio, Cambridge University Press (2008)
- “Fundamentals of Nanoelectronics” G. W. Hanson, Pearson (2008)





Course Goals:
1- Cover the fundamental of the nanoelectronics discipline ranging from nanophysics, to nano structures and nanodevices.
2- Review the fundamental of quantum mechanics required for understanding the electronic properties of matter at the nanoscale.
3- Analyze the electronic properties of atoms, molecules and nanostructures including Carbon nanotubes and Nanoribbons.
4- Introduce quantum electron transport properties in nanostructures.
5- Propose a seminar series to provide the students with a complementary coverage of the theoretical, computational and experimental aspects on nanotechnology; The seminar includes talks on nanofabrication, electronic structure calculations, information at the nanoscale, nanoenergy and applications, THz sensing, and nano-computing.

Relation of Course Goals to Student Outcomes:

STUDENT OUTCOMES	**COURSE GOALS**				
	1	**2**	**3**	**4**	**5**
1. Able to apply engineering, science, and math to identify, formulate, and solve complex problems	Y	Y	Y	Y	N
2. Able to apply engineering design to produce solutions that meet specified needs	N	N	N	N	N
3. Able to communicate effectively with a range of audiences	N	N	N	N	Y
4. Able to recognize ethical and professional responsibilities, and make informed judgments	N	N	N	N	N
5. Able to function effectively on a team	N	N	N	N	N
6. Able to develop and conduct experiments, analyze and interpret data, and draw conclusions	N	N	Y	N	N
7. Able to acquire and apply new knowledge as needed, using appropriate learning strategies	N	N	Y	N	N

Outline:

I. Nanophysics:

This chapter will provide an overview of fundamental physical principles required for understanding the electronic properties of matter at the nanoscale; it includes:

Review of quantum mechanics: light, electrons, wave mechanics, Schrodinger equation;

Free and confined electrons: quantum wells, wires and dots;

Atoms: Hydrogen and beyond.

II. Nanostructures:

This chapter will review the main electrical property differences between molecules, dots, nanotubes, nanowires, nanoribbons, and other nanoscale structures. The goal is to provide a basic understanding of nanoelectronics by bridging the gap between nanoscale physics and nanoscale devices. It includes:

Theory of solid: Crystal structure, periodic potential, band theory and semiconductors;

Electronic structure calculations; **Materials**: Molecules, Graphene, Carbon Nanotube, Si Nanowires.

III. Nanodevices

This last chapter will describe the electron transport properties in nanostructures. It includes:

Quantum tunneling and single electron device;

Electrons in low dimensional systems: Density of states and quantum statistics, electron transport, ballistic limit, Landauer formula, quantum conductance,

Emerging devices and applications.

Grading:

5 Quiz : 40% and 3-4HW : 20%

1 project report +presentation (by group of 2): 40%

Few Nanoseminars (some examples from previous years)

Prof. Sigfrid Yngvesson:

- *Nanofabrication*
- *Nanoelectronics Device Examples- CNT and THz*

Prof. Neal Anderson:

- *Information and noise in nanoelectronic computing.*

Prof. Eric Polizzi:

- *Computational nanoelectronic*

Prof: Andras Moritz:

- *Fundation of Computing at the Nanoscale*

Prof. Qiangfei Xia:

Nanostructure Engineering

Prof. Zlatan Aksamija

Nanoenergy

Prof. Joshua Yang

Memristors