Course Summary

Part I Introduction

- Challenges in Silicon Technology
- Key fundamental limits on TSI are derived from
- History of nanoelectronics
- Beyond the MOSFET: molecular FETs?

  & Beyond FETs?

Part II Nanoscale Electronic Materials

0-D, 1-D, and 2-D nanostructured materials

- Carbon nanotubes
- Semiconducting nanowires
- Graphene
- Molecules
- Atomic structures

Defects in Carbon-based Nanomaterials

Part III Nanoelectronic Devices

1. Single-electron transistors

   0-, 1- and 2-dimensional; single molecule;

2. Junction devices

   Intramolecular Junction; Heterostructure;

   Crossed Nanotube / Nanowires Junction; T-, Y-, Z-Junction

3. Field-effect transistors:

   Based on CNT, nanowires, graphenes

4. Molecular Devices and Atomic Scale Switches

5. Optoelectronic Devices

   Photodetectors and Photodiodes;

   LEDs and infrared emitter;

   Photovoltaics (Solar cells)

Part IV Physics of Nanoelectronics

1. Electronic structure and properties

DOS in 1, 2 and 3 dimensions materials

Electronic structure of 0D system

--Quantized Energy Levels

-- Physical properties of nanocrystals

Electronic Structure of graphene & nanotube;

2. Quantum size effects in nanoscale structures

Quantum Conductivity of Nanowires

3. Band-gap engineering in CNT and graphene

5. Coulomb blockade and single electron tunneling in

--a single island

--a double quantum dot

--few-electron quantum dots

--spin blockade and tunneling

6. Kondo Effect

Kondo transport in QD or SET

6. Contact resistance in nanoelectronics

Metal/semiconductor junction, M/1D nanomaterials and M/2D nanomaterials

7. Luttinger liquid (in Junction, QD and SET; 1D)

(Fermi Liquid Theory)

8. Quantum interference

A-B Effect,

Weak Localization;

Universal Conductance Fluctuations (UCF)

Ballistic transport

Part V Integration & Circuits

Nano assembly & fabrication techniques

Logic gates, circuits and microprocessor