Course: ECE 633
Nanoelectronics

Instructor: Prof. Youngki Yoon
Office: QNC 5623
Office Hours: After class; by appointment (via email) for other times
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Lecture Hours: TBA

Course Website: learn.uwaterloo.ca (login with your WatIAM userid and password)

Learning Outcomes:

- Describe the quantum nature of electrons based on the Schrödinger equation
- Understand the band theory of solids and the effect of quantum confinement in nanomaterials
- Describe carrier transport in nanoelectronic devices
- Gain hands-on coding experience for plotting electronic band structures of nanomaterials

Course Schedule (Tentative)

1. Bottom-up view on nanoelectronic devices (2 weeks)
   Origin of current flow; conductance quantum; current-voltage characteristics
2. Quantum mechanics of electrons (2 weeks)
   Schrödinger equation; finite difference method; hydrogen atom
3. Basis functions (2 weeks)
   Hydrogen molecule; basis functions; basis transformation; density matrix
4. Band theory of solids (2 weeks)
   Reciprocal lattice; Brillouin zone
5. Band structures of nanomaterials (2 weeks)
   Graphene, carbon nanotube, layered semiconductors
6. Nanomaterials to nanoelectronic devices (2 weeks)

Assignments:

MATLAB (or equivalent software package) will be used to plot the band structures of various nanomaterials. No prior programming experience is required!

MATLAB:

Currently, everyone at the university has unlimited access to MATLAB and all toolboxes. Students can access MATLAB in three ways:

- download MATLAB to their own computer
- access MATLAB through the MATLAB online cloud
- remote desktop into a university computer via EngLab (https://englab.uwaterloo.ca/)

For more details, please see:
https://uwaterloo.ca/engineering-computing/ and
https://uwaterloo.atlassian.net/wiki/spaces/ISTKB/pages/284525621/Download+or+use+MATLAB+online.

Textbook:

No textbook is required for this course.

General References:

- Quantum Transport: Atom to Transistor, Supriyo Datta, Cambridge University Press (2013).

Marking Scheme:

- Assignment: 25%
- Project: 25%
- No midterm exam
- Final Exam: 50%