

Course: ECE 633
Nanoelectronics

Instructor: Prof. Youngki Yoon
Virtual Office Hours: Immediately after live lectures
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Type of Lectures: Synchronous & asynchronous

Synchronous Lecture Hour: [REDACTED] (Waterloo local time) on WebEx. It is a one-hour live session (which is recorded and posted). To attend the lecture, use the link provided on the Learn. The first live lecture is scheduled on September 13.

Asynchronous Lectures: A few pieces of pre-recorded video will be uploaded every week.

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

Course Objectives:

This course will help students with limited prior background in nanoelectronics

- Acquire the understanding of nanomaterials and nanoscale electronic devices, and
- Develop hands-on coding experience for plotting electronic band structures of various nanomaterials.

Course Schedule (Tentative)

Week	Synchronous Lecture	Topics
1	Sep 13	Introduction; Origin of current flow
2	Sep 20	Current flow in a single- and multi-level system; Conductance quantum
3	Sep 27	Nanotransistors; Current-voltage characteristics; Quantum capacitance
4	Oct 4	1D Schrödinger Equation; Boundary conditions; Finite difference method
	No class	Thanksgiving
5	Oct 18	2D Schrödinger Equation; Hydrogen atom and molecule
6	Oct 25	Basis function; Energy levels
7	Nov 1	Hilbert space; Basis transformation; Hermitian matrix
8	Nov 8	Diagonalization of Hermitian matrix; Density matrix
9	Nov 15	Band structure
10	Nov 22	Band structure (cont'd); Brillouin zone; Density of states
11	Nov 29	Graphene
12	Dec 6	Carbon nanotube; subbands

Assignments:

MATLAB will be used to plot the band structures of various nanomaterials and simulate current-voltage characteristics. No prior programming experience is required!

Project:

Online simulation tools will be used for a project.

MATLAB

Everyone at the university has unlimited access to Matlab and all toolboxes (until Sep 2021). 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.

General Reference:

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

Marking Scheme:

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