MSE 498/599 Autumn 2019 – Quantum Theory of Nanomaterials

Instructor: Ting Cao (tingcao@uw.edu)

Prerequisites: Undergraduate-level quantum mechanics. Background knowledge of solid-state physics preferred.

Lectures: Mon. Th. 4:30-5:50 pm, MEB 235

Office hours: Mon. 11:00-12:00 am, ROB 311, beginning week of Sept. 30.

There may or may not be a TA, depending on course enrollment. There are no discussion sections scheduled at this time. Parts of the lecture notes will be distributed online.

This course introduces the quantum theories and methods needed to understand the behavior of nanomaterials. Material properties that exhibit size effects (including electronic, thermal, magnetic, and optical) will be presented and explained. The course also illustrates the promise and challenges of modern and future nanotechnology, and should be accessible to both experimentalists and theorists.

Topics include:

- Quantum electronic structure methods (e.g., tight-binding method, density-functional theory, etc.) and their applications to quantum dots, carbon nanostructures, and nanoscale heterostructures
- Quantum theory of transport and light-matter interactions.
- Working principle of experimental tools: the scanning tunneling microscope, angle-resolved photoemission spectroscopy, etc.
- Recent advances in nanomaterials research.

Grading: 1 HW (30%, available for download by mid-Oct., turn in by mid-term), 1 mid-term (30%, Oct. 28 in lecture), 1 final project (40%). Grading based on absolute scale.

Final project: Registered students in the course are asked to complete a short final project, which should consist of a two-page write up and a 10-minute oral presentation on a topic relevant to something discussed in the course. The presentation is tentatively scheduled during the last week of instruction. (You are not necessarily expected to carry out research on a topic, but you should reach the level of being able to lecture cogently and answer questions from your fellow students.)

Some possible topics:

Useful books:

Solid State Physics by Ashcroft and Mermin.

Fundamentals of Condensed Matter Physics by Cohen and Louie.

Religious Accommodations:

Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW's policy, including more information about how to request an accommodation, is available at Religious Accommodations Policy (https://registrar.washington.edu/staffandfaculty/religious-accommodations-policy/). Accommodations must

be requested within the first two weeks of this course using the Religious Accommodations Request form (https://registrar.washington.edu/students/religious-accommodations-request/).

Academic Integrity:

The University takes academic integrity very seriously. Behaving with integrity is part of our responsibility to our shared learning community. If you are uncertain about if something is academic misconduct, ask me. I am willing to discuss questions you might have.

Acts of academic misconduct may include but are not limited to:

- Cheating (working collaboratively on quizzes/exams and discussion submissions, sharing answers and previewing quizzes/exams)
- Plagiarism (representing the work of others as your own without giving appropriate credit to the original author(s))
- Unauthorized collaboration (working with each other on assignments) Concerns about these or other behaviors prohibited by the Student Conduct Code will be referred for investigation and adjudication by (include information for specific campus office).