MSE 461, Fall 2023

Electronic Materials II: **Physics of Electronic Materials and Devices**

Time: M/W/F 10-10:50 am

Location: 2018 CIF (Campus Instructional Facility)

Website: Canvas

Instructor: Prof. Yingjie Zhang, yjz@illinois.edu

TA/grader: TBD

Office hour: Wednesday 11 am – 12 pm, MRL 256

Credit: 3 undergraduate or graduate hours

Course description: This course introduces the fundamental mechanisms and design principles of electronic materials and devices. Topics include the traditional silicon-based electronic and optoelectronic devices, low-dimensional materials, and quantum transport. The goal is to gain fundamental physical insights into not only the modern microelectronics systems, but also future energy, nano and quantum technologies. Such knowledge will prepare students for both the semiconductor and energy industry and academic research.

Prerequisite: MSE 304 or Physics 460

Textbooks:

S. M. Sze and Kwok. K. Ng, Physics of Semiconductor Devices, 3rd Edition, Wiley & Sons, 2007. (ebook available at UIUC online library)

Quantum Transport: Atom to Transistor, 2nd ed., by S. Datta, Cambridge University Press, 2005. (ebook available at UIUC online library)

Course Topics:

1. Semiconductor Device Physics

Review of the physics of semiconductors

p-n junctions

Metal-semiconductor contacts

2. Optoelectronics

Photoconductors

Photodiodes

Solar cells

3. Nano and Quantum Electronics

Band structure of low-dimensional materials

Quantum transport

Single-electron transistor

Tunnel transistor

Grading:

Homework assignments	35%
In-class quizzes*	10%
Final project presentation	10%
Final project report	15%
Final exam (take home)	30%

*Note: Each quiz will consist of only one question. You will be given full score of the quizzes if you correctly answer at least 50% of all the quiz questions throughout the semester. Absence from the class when the quiz is given is equivalent to one wrong quiz answer. Please bring a pen with you to each lecture. Quizzes will take place sporadically throughout the semester.

Late policy:

Homework, final project reports, and completed final exams turned in within 24 hours after the deadline will be given 50% score. After 24 hours past the deadline, 0% score will be given.

Quizzes will only count if submitted during the allocated quiz time in the lectures, before the instructor explains the answers.

Academic Integrity:

Please familiarize yourself with academic integrity policies and consequences of academic dishonesty:

https://studentcode.illinois.edu/article1/part4/1-401/

In particular, while you are allowed to discuss homework problems with each other, **you are strictly prohibited from directly copying others' solutions**. **For the quizzes and take-home final exam, you are** allowed to look for existing resources from books or online, but are **strictly prohibited from any discussion with anyone through any media**.

Policy on conflicts or emergencies:

(1) For time conflicts with other events (e.g. another scheduled exam), or an official UIUC activity (e.g. varsity athletics, band concert), please show official documentation about the

conflict at least **one week** before the homework/report/exam due date. The due date will be extended if the excuses are legitimate.

(2) If you will not be able to make it to the exam or submit HW on time due to serious illness or other emergent personal crisis (e.g. car accident) that are not described in (1), you must send an email to the instructor (yjz@illinois.edu) at your earliest convenience, and submit a statement from the professionals that are authorized to evaluate your situation (e.g. doctors, police officers). The statement needs to clearly explain that you are not physically capable of submitting the HW/report/exam on time. The due date will be extended if the excuses are legitimate.

(3) You do not need to ask for permission to be occasionally absent from classes for any reason. However, if you will not be able to attend lectures during extended periods of time (more than 2 weeks in a row), please follow the same procedures as described in (1) and (2).