GEORGE MASON UNIVERSITY
ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

Spring 2023 ECE 685: Nanoelectronics

Time and location: Tuesday 4:30 pm – 7:10 pm, Planetary Hall 126

Instructor: Qiliang Li, Engineering Bldg, Room 3250, Tel 703-993-1596, Email: qli6@gmu.edu

Office Hours: Tuesday 2:20pm – 4:20pm; other times by appointment.

COURSE DESCRIPTION

This course focuses on the fundamental concepts and principles of nanoelectronic materials and devices. Nanoelectronics is concerned with electronic devices with one or more dimensions at nanoscale. The lecture will cover the electronic properties of solids including semiconductors in samples of physical dimension of ~100 nm or less, and the corresponding basic device building blocks such as quantum dot (QD), single electron transistor (SET), nanowire, carbon nanotube (CNT), graphene, etc. The course will consider the design and analysis of a variety of nanoscale devices ("quantum" or "mesoscopic" devices) and examine the most notable, novel applications.

PREREQUISITES: ECE 584 – *Semiconductor Device Fundamentals* or equivalent courses

REQUIRED TEXTBOOK: "Fundamentals of Nanoelectronics" by George W. Hanson, Pearson/Prentice Hall (2008), ISBN 978-0131957084.

RECOMMENDED READINGS:

1. "Mesoscopic Electronics in Solid State Nanostructures" by Thomas Heinzel.
2. "Nanoelectronics and Information Technology", 2nd Ed. by Rainer Waser (Ed.)
3. "Semiconductor Physical Electronics" by S. Li, Springer, ISBN 978-0387288932

COURSE OUTLINE

1. Course and Syllabus Overview
2. Classical particles, classical waves, and quantum particles
3. Quantum Mechanics of Electrons
4. Confined Electrons / Electrons Subject to a Periodic Potential
5. Tunnel Junctions and Applications of Tunneling
6. Coulomb Blockade and the Single-Electron Transistor
7. Carbon Nanotubes and Nanowire Transistors
8. Many Electron Phenomena-Particle Statistics
9. Models of Quantum Wells, Quantum Wires and Quantum Dots
10. Nanowires, Ballistic Transport, and Spin Transport
11. NanoCMOS / Silicon-on-Insulator (SOI) CMOS
12. Fundamental Limits to Scaling

GRADING

Homework + project-1 + project-2	20% + 15% + 20%
Midterm Exam	20%
Final Exam	25%

(Exam will be announced in class at least two weeks before the exam.)