Syllabus

ECE6451: Introduction to the Theory of Microelectronics

FALL 2026

Time: Section A: MW 9:30-10:45PM

Location: Love Building 184

TITLE: ECE6451 (3-0-0-3): Introduction to the Theory of Microelectronics.

PREREQUISITES: None. However, familiarity with linear operators, vector spaces, differential and integral equations, linear algebra, eigenvalue problems, and cylindrical and spherical coordinate systems are assumed. Also, some basic understanding of classical mechanics will be helpful as well.

DESCRIPTION: Basis of quantum mechanics, statistical mechanics, and the behavior of solids to serve as an introduction to the modern study of semiconductors and semiconductor devices.

TEXTBOOKS: Brennan, *The Physics of Semiconductors with Applications to Optoelectronic Devices*, Cambridge Univ. Press, 1999. ISBN 0-521-59662-9.

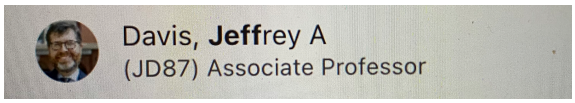
OPTIONAL READINGS:

Chapter 1 of Cohen-Tannoudji, et al, *Quantum Mechanics*, John Wiley &Sons, New York, 1977.

Manjit Kumar **,** *Quantum : Einstein, Bohr and the Great Debate about the Nature of Reality*, International Edition, January 1, 2009.

PROFESSOR:

Dr. Jeffrey Davis, Klaus 3314
Teams Chat:



Phone: 404.894.4770
E-mail: jeff.davis@ece.gatech.edu

GTA: There is not graduate teaching assistant for this class.

OFFICE HOURS: You can visit me in-person or you can contact me via our MS Teams video chat. You can always send me a message on Teams as well.

Monday 4:45 PM-6:15PM (Location Klaus 3314)

Wednesday 10:30AM-12:00PM (Location Klaus 3314)

ASSIGNMENTS & GRADING:

Homework:		(20%)
Exam 1:	TBA (Monday)	(25%)
Exam 2:	TBA (Wednesday)	(25%)
Final Exam:	TBA (Friday)	(30%)

COMMUNICATIONS: Verbal notices may be given during class. It is your responsibility to obtain this information in class. If you are not present, you must get this information from other students or recorded

lectures. Notices and other communications may also be delivered via email; read your email regularly. The best way to reach me is by email.

MISSING TESTS: If you must miss a test or quiz for a serious condition, you must let me know as soon as you know that you cannot attend. Any excused absence must be accompanied by proper documentation.

ACADEMIC HONESTY Students in this class are expected to abide by the Georgia Tech Honor Code, and to avoid any instance of academic misconduct, including but not limited to:

- Possessing, using, or exchanging improperly acquired oral or written information in the preparation or taking of a quiz or exam,
- Submission of material that is substantially identical to that created or published by another individual, except as noted below,
- False claims of performance or work that has been submitted by the student.

Additionally, it is expected that students will respect their peers and the instructor such that no one takes unfair advantage of any other person associated with the course. Any suspected cases of academic dishonesty will be reported to the Dean of Students for further action. The URL for the GT honor code is:

http://www.policylibrary.gatech.edu/student-affairs/academic-honor-code

ACCOMMODATIONS: If you have any learning disabilities that require special assistance, please obtain documentation from the Office of Disability Services for Tech Students (disabilityservices.gatech.edu).

STUDENT-FACULTY EXPECTATION AGREEMENT: At Georgia Tech we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See https://policylibrary.gatech.edu/student-affairs/academic-honor-code an articulation of some basic expectation that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

IMPORTANT DATES FOR SEMESTER:

Topics Covered

Topic 1: EM and Statistical Mechanics Give Birth to Quantum Theory

Topic 2: de Broglie, Heisenberg, and Schrodinger Wave Mechanics

Topic 3: (1D) Barrier Scattering and Quantum Tunneling

Topic 4: Hilbert Vector Spaces, Hermitian Operators, Matrix Mechanics, and Dirac Notation

Topic 5: Approximation Methods in Quantum Theory

Topic 6: (3D) Hydrogen Atom, Spin, and Angular Momentum

Topic 7: Equilibrium Statistical Mechanics

Topic 8: Basis of Band Theory of Crystals

- Multiple electron atoms and systems semi-classical discussion
- Conductors, insulators, and semiconductors classifications
- Nearly free electron model
- Crystalline symmetries and Bloch's theorem
- Methods of band structure, tight binding, and Kronig-Penney
- Reciprocal lattices and Brillouin Zones
- Energy bands and charge carriers in semiconductors

Topic 9: Non-Equilibrium Statistical Mechanics and Current Flow in Crystals

- Electron and Hole Mobility
- Fick's Laws of Diffusion
- Drift-Diffusion Equation
- Boltzmann Transport Equation
- Superconductivity and Quantum Hall Effect (Optional)