Fall 2009

ECE 656: ELECTRONIC TRANSPORT IN SEMICONDUCTORS

Instructor: M.S. Lundstrom (lundstro@purdue.edu)

Office Hours: Tues, Thurs, 5:00-6:00PM, EE-310
(or make an appointment for a different time by e-mail.)

Prerequisite: EE 606

Text: *Fundamentals of Carrier Transport*, 2nd Edition
Mark Lundstrom, Cambridge University Press
ISBN-13: 9780521637244 (paperback)

Advanced Semiconductor Fundamentals, 2nd Edition
R.F. Pierret, Prentice Hall, ISBN 0-13-061792-X

Handouts and class notes will also be distributed from time to time

Course Web Page: All handout materials and course announcements will be available from the course web page http://cobweb.ecn.purdue.edu/~ee656

Grading: Exam 1: 30% Exam 2: 30% Final: 40%

Homework will be assigned regularly. It will but collected, but solutions will be posted. Every two weeks or so, homework and applications of the course material to current research will be discussed.

Course Description: This is a course about how charge flows in semiconductors with an emphasis on transport in nanoscale devices. The course consists of three main parts. Part 1 focuses on near-equilibrium transport in the presence of small gradients in the electrochemical potential or temperature, with or without the application of a small magnetic field. The emphasis in Part 2 is on the physics of carrier scattering and how the microscopic scattering processes are related to macroscopic relaxation times and mean-free-paths. Part three examines high-field transport in bulk semiconductors and so-called "non-local" transport in sub-micron devices. The course concludes with a brief introduction to quantum transport. The objective of the course is to develop a broad understanding of the basic concepts needed to understand modern electronic devices. It is designed for those who work on electronic devices – whether they are experimentalists, device theorists, or computationalists. The course is intended to be accessible to students with a general, introductory background in semiconductors, such as that obtained by taking EE-606 at Purdue University.

Academic Dishonesty: Cheating is unacceptable and may result in a grade of zero on the exam, or the entire course – depending on the severity of the incident as determined by me.

Campus Emergency Policies: In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. Information about changes will be posted on the course web page and available from lundstro@purdue.edu

ECE-656: Course Outline Fall 2009

Course Introduction	1 lecture
Part 1: Near-equilibrium transport:	
Low bias transport –the Landauer approach	3 weeks
Low bias transport – the Boltzmann equation	2 weeks
Percolative transport	1 week
Part 2: Carrier scattering	
Relaxation times and lengths	1 week
Carrier scattering in semiconductors	4 weeks
Part 3: High-field and non-local transport	
Balance equations	1 week
Monte Carlo simulation	1 week
Off-equilibrium transport in bulk semiconductors and devices	1 week
Quantum transport	1 week

Connection to *Fundamentals of Carrier Transport* by Lundstrom

Introduction:	Chapter 1
Near –equilibrium transport:	Chapters 3, 4, and Sec. 9.9
Carrier scattering:	Chapter 2
High-field and non-local transport:	Chapters 5, 6, 7, and 8
Quantum transport:	Secs. 1.5, 9.7, 9.8, and 9.12