

EE 656: Electronic Transport in Semiconductors

Course Description This course is about how charge flows in semiconductors with an emphasis on transport in nanoscale devices. The objective is to develop a broad understanding of basic concepts. The course is designed for those who work on electronic materials and devices – whether they are experimentalists, device physicists, or computational experts. The course is intended to be accessible to students with a general, introductory background in semiconductors.

The course consists of three parts. Part 1 reviews advanced semiconductor fundamentals reviewing concepts covered in 453/595 and 606 and addressing new topics such as carrier scattering. Part 2 addresses 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. Finally, Part 3 examines high-field transport in bulk semiconductors and so-called “non-local” transport in nanoscale devices. Both semiclassical and quantum transport effects are discussed.

Instructor: M.S. Lundstrom (lundstro at purdue.edu)
TA: Xufeng Wang (wang159 at purdue.edu)

Class meetings: Mon, Wed, Fri 1:30 – 2:20 PM EE-005

Office Hours: Tuesdays and Thursdays, 8:30-10:00 AM, EE-334C
(or make an appointment for a different time by e-mail.)

Prerequisites: ECE 453/595 and 606 or equivalent (basic introduction to semiconductor materials and devices, solid-state physics, and quantum mechanics).

Texts: *Near-equilibrium Transport: Fundamentals and Applications* (NET)
Mark Lundstrom, World Scientific (2012).
(a draft copy of this text will be distributed to 656 students)

Fundamentals of Carrier Transport, 2nd Edition (FCT)
Mark Lundstrom, Cambridge University Press (2000)
ISBN-13: 9780521637244 (paperback)

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

Course Web Page: All course materials will be available from the course web page
http://nanohub.org/groups/ece656_f13

The schedule of lectures, reading assignments, HW assignments and solutions, practice exams, and other course-related information will be posted on the course web-page. Check it frequently.

ECE 656 Fall 2013 (continued):

Course Format: This course will be taught in a “flipped” format. Students will view lectures online – before class sessions, and class sessions will be used to amplify upon (not repeat) the lectures, to answer questions, and to work problems. More information on the course format and tips for taking the course are posted on the course web page.

Lecture Quizzes: There will be a quiz for each of the online lectures. The questions will be multiple choice and will focus on the few, key points that you should take away from the lecture. You will also be asked to ask a question relating to the lecture. You must **hand in the quizzes** for the lectures assigned each week **in class on Friday**. Answers to quizzes will be posted Friday evenings. Quizzes will be graded pass/fail **and up to two may be dropped when determining the final quizzes grade.**

Homework Assignments: Working homework problems is essential for understanding a course like this. Homework will not be graded, but solutions will be posted and discussed in class.

Exams: Frequent exams will test your understanding of the material, so it will be important to keep up. Six (6) exams will be given and you must take all 6. Exams will be conducted on Weeks 3, 6, 9, 12, 14 and during Finals Week. Your exam score will be determined by the highest 5 of the exams. You will have an opportunity to re-take two exams, and the highest of the first and second taking will be your score for that exam.

Grading:

Lecture quizzes and questions: 25%

Exams (highest 5 of 6 at 15% each) 75%

The quiz score is computed as $\text{Score} = x/\text{total times } 25\%$, where x is the number of quizzes you turned in and passed and total is the total number of lectures in the course.

The exam score is computed as $\text{Score} = \text{average of the percentage scores of the 5/6 best exams scores including any retakes.}$

Approximate curve:

- A: 91 – 100%
- B: 81 – 90%
- C: 71 – 80%
- D: 61 – 70%
- F: 60% or less

Academic Dishonesty Any case of academic dishonesty will result in a grade of F in this course.

Class Attendance: Class attendance is important. If you must miss class, you are responsible for any material, information, handouts, announcements, etc. that you missed.

Campus Closing / Disruption of Classes: 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. In such an event, information about changes will be posted on the course web page and available from lundstro@purdue.edu

Course announcements posted on the course web page supersede prior written information.