Syllabus

ECE 542, Physical Electronics Fall 2008

Overview The goal of this course is to develop an understanding of the physical mechanisms governing semiconductor device behavior. We will discuss the electronic properties of semiconductors, and how we can take advantage of these properties to create basic semiconductor device components (pn diodes, photodiodes and transistors) . A thorough appreciation of these concepts will provide a basis for further study in electronic circuit design, materials characterization, electrical measurements, and advanced device design and characterization.

Textbook Ben G. Streetman and Sanjay Banerjee, *Solid State Electronic Devices, 6th edition*, Prentice Hall, 2006. This textbook is *required* for the course, as it will be the source of homework and reading assignments. The 6th edition has substantially changed from previous editions.

Course outline The course material is divided into 3 parts, each of which is allotted approximately 8 classes:

1. ***Electronic properties of semiconductors*** (S&B, chapters 1-3): semiconductor materials, free electron energy spectrum, semiconductor band structure, Fermi distribution, electron and hole charge carriers, doping to produce charge carriers, carrier motion in electric and magnetic fields.
2. ***Semiconductor junctions*** (S&B, chapters 4 and 5) Electron-hole recombination, carrier diffusion, p-n junctions, metal-semiconductor junctions, reverse bias breakdown
3. ***Semiconductor electronic devices*** (S&B, chapters 6 and 7) Junction Field Effect Transistor, MOS Field Effect Transistor, Bipolar Junction Transistor.

Course Learning Outcomes: Students who complete this course will be able to:

1) Draw band diagrams for doped and undoped semiconductors.
2) Calculate carrier concentrations using the Fermi distribution function.
3) Calculate current density, mobility and conductivity.
4) Use Hall effect measurement results to determine mobility, carrier concentration and carrier type.
5) Describe band diagrams, charge density, electric field and potential distribution for a pn junction.
6) Describe pn-junction current-voltage characteristics and variation of pn junction parameters with bias.
7) Calculate junction breakdown voltages for pn junctions.
8) Describe JFET and MOSFET operation.

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Textbook Ben G. Streetman and Sanjay Banerjee, *Solid State Electronic Devices, 5th edition*, Prentice Hall, 2000. This textbook is *required* for the course, as it will be the source of homework and reading assignments.

Supplementary reading S.M. Sze, *Physics of Semiconductor Devices,* New York, Wiley, 1981. R. S. Muller and T.I. Kamins, *Device Electronics for Integrated Circuits,* New York, Wiley, 1986.

Exams There will be three, one hour, closed book exams, one following the completion of each part of the course. Exam dates to be determined.

Homework Assignments There will be approximately ten homework assignments. Typically, homework assignments will be handed out one week before they are due. 10% will be taken off for late homework. A late assignment can still be turned in for partial credit as long as it is received prior to the day that the graded assignments are returned. After this point, the assignment can no longer be turned in for credit. There is often a long delay in the grading of a late assignment. Please expect this if you turn in your assignment late.

Grader: (Person to be determined) If you have a question or complaint on the grading of the HW, contact the grader first before contacting the instructor. This feedback is essential to ensure that the grading quality remains satisfactory.

Evaluation Grades will be calculated from the average of the homework assignment grades (worth 25%) plus the three exam grades (each worth 25%).