Tips on how to take;

A Primer on Semiconductor Fundamentals

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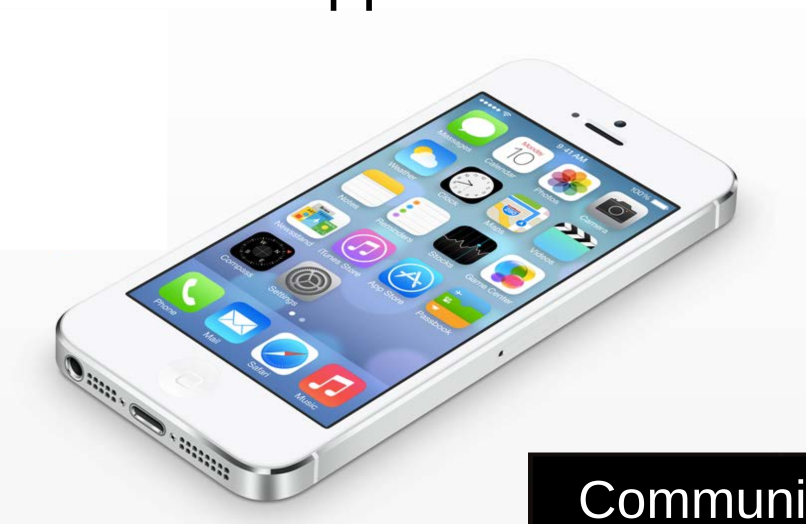
PURDUE UNIVERSITY

21^{st} Century electronics

Apple 2007

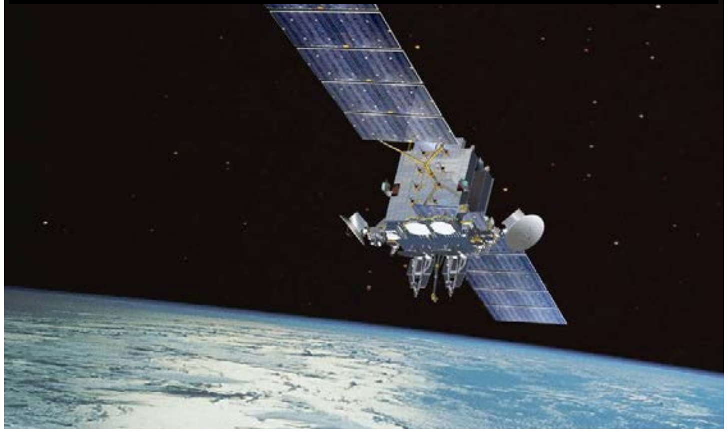


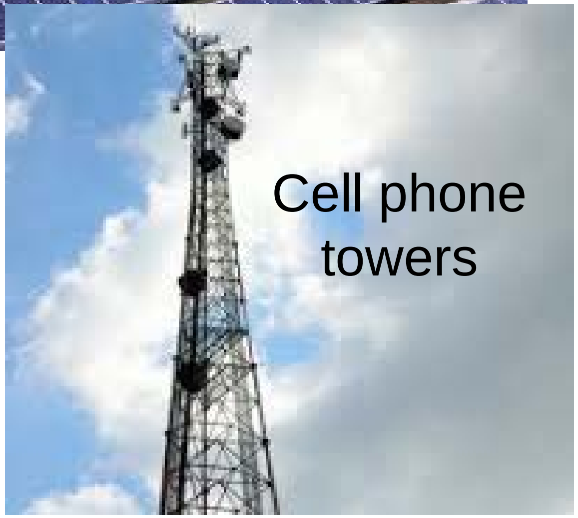
- Transistors
- Memory cells
- CMOS imagers

LEDs and lasers

Solar cell arrays

Communications satellites





Cell phone towers

This is a course about semiconductors

Not about semiconductor devices

It is about the semiconductor fundamentals needed to understand how devices operate.

- chemistry
- materials science
- solid-state physics
- electrical engineering

Approach

The emphasis is on developing a sound physical and intuitive understanding important, key concepts in semiconductors.

Developing an ability to perform some simple, key calculations is another goal.

By the end of the course, you will be prepared to take courses on semiconductor **devices**.

Example: The Fermi function

$$f_0(E) = \frac{1}{1 + e^{(E - E_F)/k_B T}}$$

(Fermi function)

We will describe this function and learn how to use it, but we will not derive it.

In general, long, mathematical derivations will be avoided.

General Reference

R.F. Pierret, *Advanced Semiconductor Fundamentals,* 2nd ed., Pearson Education, Inc., 2003. (ISBN-0-13-061792-X (paperback)).

Course outline

Unit 1: Materials properties and doping

Unit 2: Rudiments of quantum mechanics

Unit 3: Equilibrium carrier concentrations

Unit 4: Carrier transport, generation, and recombination

Unit 5: The semiconductor equations

Unit 1

Unit 1: Materials properties and doping

L1.1: Energy levels to energy bands
L1.2: Crystalline, polycrystalline, and amorphous semiconductors
L1.3: Miller indices
L1.4: Properties of common semiconductors
L1.5: Free carriers in semiconductors
L1.6: Doping
L1.7: Unit 1 recap

HW Problems
Homework solutions
Unit 1 Exam

Unit 1

Unit 1: Materials properties and doping

L1.1: Energy levels to energy bands

- Lecture quiz: 5 multiple choice questions
- 1 short problem
- No solutions to short problems will be posted. You are encouraged to discuss these problems with your classmates.

Unit 1

Unit 1: Materials properties and doping

HW Problems
Homework solutions
Unit 1 Online Test (based on HW)

- HW is assigned but not graded
- Short (2 question) Unit Tests are based on the HW.
- Numerical answers will be required – **bring a calculator.**
- Exams are closed book – a formula sheet will be provided.
- You **must take all five unit exams**.

Grading (online students pursuing a certificate)

- A short Lecture Quiz will follow each lecture to assess your understanding of the material covered.
- Lecture Quizzes are TIMED. You will have 15 minutes to answer 5 multiple choice questions.
- A maximum of 120 Lecture Quiz points is possible. You will receive all of the points if you average at least 70%.
- Each unit is followed by a short online “Unit Test” based on the homework problems.
- Unit Tests are TIMED. You will have 40 minutes to answer 2 multiple choice questions.
- There will be 5 Unit Tests with a maximum of 40 points on each. Your lowest score on Units 1-4 will be dropped; the Unit 5 exam may not be dropped, so there are maximum of 160 point possible.

Grading (online students pursuing a certificate)

Grades will be based on the combination of the timed, Lecture Quizzes and the timed Unit Tests.

- A maximum of 280 points is possible (120 for the Lecture Quizzes and 160 for the Unit Tests).
- A minimum 70% overall score will be required to pass the course and earn a certificate.

Grading (Purdue students)

Grades will be based on the combination of the timed, Lecture Quizzes and the timed Unit Tests **and timed and proctored Unit Tests.**

- A maximum of 440 points is possible (120 for the Lecture Quizzes and 160 for the online Unit Tests and 160 for the proctored Unit Tests).

- For the online Lecture Quizzes and Lecture Unit Tests, the same policies apply.

- All 5 proctored Exams must be taken. The lowest of the first 4 proctored tests will be dropped. The Unit 5 Test may not be dropped.

Summary

This course will give you the background needed to understand the operation of *any* semiconductor device.

It also provides a starting point, a basic framework that can be filled in by self-study.

It is a summary of the way electrical engineers have learned to think about semiconductors over the years, but it is also informed by recent advances in nanoscience.

We will move fast and cover a lot of ground, so dive right in, ask questions, do the work and you'll learn a lot about semiconductors!