

EE105 – Spring 2008 Microelectronic Devices and Circuits

<http://www-inst.eecs.berkeley.edu/~ee105>

Prof. Ming C. Wu
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Teaching Assistants

- Eudean Sun (eudeansun@berkeley.edu)
- Sung Hwan Kim (shpkim@eecs.berkeley.edu)
- Abhinav Gupta (agupta@eecs.berkeley.edu)
- Office Hours will be announced on the web

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Course Overview, Slide 2

What is this class all about?

- Basic semiconductor device physics and analog integrated circuits.
- What will you learn?
 - Electrical behavior and applications of transistors
 - Analog integrated circuit analysis and design

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Course Overview, Slide 3

Schedule

- Lectures:
 - TuTh 3:40-5:00 PM (102 Moffitt)
- Discussion Sections (beginning Monday 1/28):
 - Sec. 102 (293 Cory): Mon. 4-5PM, Eudean Sun
 - Sec. 103 (2305 Tolman): Wed. 10-11AM, Abhinav Gupta
 - Sec. 104 (293 Cory): Fri. 10-11AM, Sung Hwan Kim

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Lab Schedule

- **Laboratory Sections (beginning Monday 1/28):**
 - Section 10 (353 Cory): Monday 9AM-12PM; Wilson Ko
 - Section 11 (353 Cory): **Wednesday 5-8PM**; Eudean Sun
 - Section 12 (353 Cory): Wednesday 2-5PM; Abhinav Gupta
 - Section 13 (353 Cory): **Thursday 5-8PM**; Sung Hwan Kim
- **Students must sign up for one lab section outside 353 Cory by 5PM Friday 1/25**, and regularly attend this lab section.
- **Switching lab needs consent from both TAs**
- All of the lab assignments (and tutorials) are posted online at <http://inst.eecs.berkeley.edu/~ee105/sp08/#labs>
- Each pre-lab assignment is due at the beginning of the corresponding lab session. Post-lab assignments are due at the beginning of the following lab section.

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Relation to Other Courses

- **Prerequisite:**
 - EECS40: KVL and KCL, Thevenin and Norton equivalent circuits, impedance, frequency response (Bode plots), semiconductor basics, simple pn-junction diode and MOSFET theory and circuit applications, analog vs. digital signals.
- **Relation to other courses:**
 - EE105 is a prerequisite for EE113 (Power Electronics) and EE140 (Linear Integrated Circuits).
 - It is also helpful (but not required) for EE141 (Introduction to Digital Integrated Circuits).

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Class Materials

- **Textbook:**
 - *Fundamentals of Microelectronics* by Behzad Razavi, Wiley Press, January 2008
- Lecture Notes will be posted on the class website, but it is important that you read the corresponding sections in the textbook
- Lectures will be recorded and webcasted, however, this is not intended to replace attendance

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Homework

- Weekly assignments will be posted online on Tuesdays
- Due the following Tuesday at 5:10 PM @EE105 Drop box in Undergraduate Lounge, Cory Hall).
- Late homework will not be accepted.
- Students are encouraged to discuss homework problems. However, the work which you submit for grading must be your own.

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Grading

- **Homework** (posted online)
 - due Tu (5:10PM at Drop Box in Undergrad Lounge)
 - late homeworks not accepted
- **Laboratory assignments**
 - Prelab due at beginning of lab session
 - Report due at the beginning of the following lab
- **2 midterm exams**
 - 80 minutes each
 - closed book
 - (3 pages of notes allowed)
- **Final exam**
 - Th 5/22 from 12:30-3:30PM
 - closed book
 - (7 pages of notes allowed)
 - bring calculator

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Miscellany

- **Special accommodations:**
 - Students may request accommodation of religious creed, disabilities, and other special circumstances. Please make an appointment to discuss your request, in advance.
- **Academic (dis)honesty**
 - Departmental policy will be strictly followed
 - Collaboration (not cheating!) is encouraged
- **Classroom etiquette:**
 - Arrive in class on time!
 - Bring your own copy of the lecture notes.
 - Turn off cell phones, pagers, MP3 players, etc.
 - **No distracting conversations**

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Some Important Announcements

- Please don't bring food/drinks to 353 Cory
- Lab experiments will be done in pairs. Each person should turn in his/her individual reports.
- Homework should be done individually.
- Cheating on an exam will result in an automatic F course grade.

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Getting Started

- **Assignment 1:**
 - To be posted later today
 - Due 1/29 (Tuesday) at 5 PM
- **NO discussion sessions, labs, or office hours this week.**

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Course Overview

(refer to detailed syllabus)

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Course Overview, Slide 13

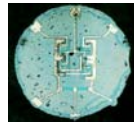
Introduction

The Integrated Circuit (IC)

- An IC consists of interconnected electronic components in a single piece ("chip") of semiconductor material.
- In 1958, Jack S. Kilby (*Texas Instruments*) showed that it was possible to fabricate a simple IC in germanium.
- In 1959, Robert Noyce (*Fairchild Semiconductor*) demonstrated an IC made in silicon using SiO_2 as the insulator and Al for the metallic interconnects.



Kilby's first integrated circuit in germanium.



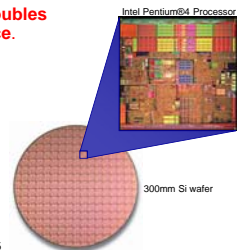
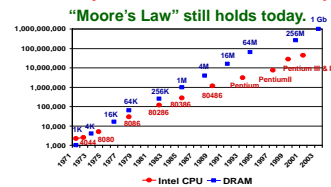
The first planar IC (actual size: 0.06 in. diameter)

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From a Few, to Billions

- By connecting a large number of components, each performing simple operations, an IC that performs very complex tasks can be built.
- The degree of integration has increased at an exponential pace over the past ~40 years.
 - » The number of devices on a chip doubles every ~18 months, for the same price.

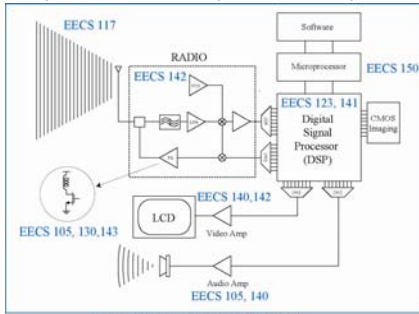


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EECS 105 in the Grand Scheme

- Example electronic system: cell phone



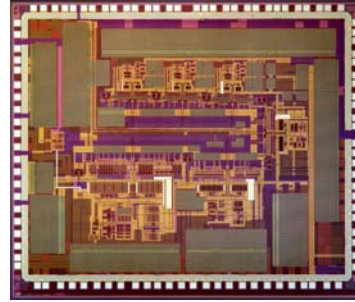
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EECS 105: Emphasis on Analog IC's

- Example: 14-bit analog-to-digital converter

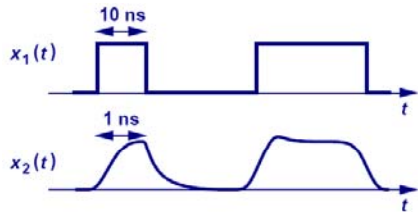
– Y. Chiu, *IEEE Int'l Solid-State Circuits Conference*, 2004.



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Digital or Analog Signal?



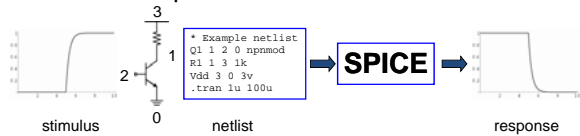
- $x_1(t)$ is operating at 100Mb/s and $x_2(t)$ is operating at 1Gb/s.
- A digital signal operating at very high frequency is very "analog".

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Circuit Simulation using SPICE

- Read tutorial posted on EE105 lab website!



- SPICE = Simulation Program with IC Emphasis
- Invented at Berkeley (released in 1972)
- .DC: Find the DC operating point of a circuit
- .TRAN: Solve the *transient* response of a circuit (solve a system of generally non-linear ordinary differential equations via adaptive time-step solver)
- .AC: Find steady-state response of circuit to a sinusoidal excitation

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