Introduction

- **INSTRUCTOR:** Kenneth R. Laker
  - Email: laker@seas.upenn.edu
  - Office: 203D Moore Complex
  - Office hours: M & W 5:00 to 6:00 PM; Th 2:00 to 3:00 PM or by appointment

- **CLASS:** M, W & F 11:00 AM – 12:00 N, 305 Towne

- **LAB:** Th 12:00 – 3:00 PM or F 1:00 – 4:00 PM, RCA Lab

- **TA:** TBD
  - Email: TBD
  - Office: TBD
  - Office hours: TBD

- **TEXT:** Sedra/Smith *Microelectronic Circuits* – 5th Ed.

- **COURSE WEBSITE:** [http://www.seas.upenn.edu/~ese319/](http://www.seas.upenn.edu/~ese319/) + Blackboard

- **SOFTWARE:** NI Multisim on all RCA Lab PCs (Student Edition available)
Course Outcomes

• Theory and Analysis
  • a1. Apply principles of component-insensitive design of semiconductor systems.
  • a2. Apply concepts of common and differential mode voltages and currents.
  • a3. Apply principles of differential amplifier analysis.
  • a4. Apply High frequency models of BJT circuits.
  • a5. Apply concepts of feedback, including stability, instability and oscillators.
  • a6. Apply MOS inverter principles.
  • a7. Apply principles of monostable, bistable, and astable circuit operations.
  • a8. Apply basic analog filter concepts.
  • a9. Apply principles of Class A, B, and AB power amplifiers.
  • a10. Design an op amp to specs and experimentally evaluate its performance.

• Design and Practice
  • c1. Design, simulate, construct and test of semiconductor systems covered in class to relevant specs.
  • c2. Develop awareness of the causes of discrepancies between theoretical and practical circuit performance, and learn when these discrepancy causes are significant and when they are not.

• Use of Computer Tools
  • k1. Apply circuit CAD tools used to each of the design tasks in Outcomes c1 & c2 above.
Analog Electronic Circuit Design

- Preliminary design inherently a pencil and paper exercise.
- Followed by simulation using theoretical models for “real” components.
- If simulations show adequate performance, the designs are “breadboarded” and tested in the laboratory.
- The design process is usually iterative.
- We will follow this approach in the course.
**Design Cycle**

- Develop/Revise Design Specs
- Analysis/Simulation
- Design/Synthesis
- Simulation/Analysis
- Evaluation Design Specs
- Construction/Implementation/Fabrication
- Test
- Evaluation Design Specs

---

2008 Kenneth R. Laker, University of Pennsylvania (updated KRL 02Sep08)
Analog Circuit Design II

- **Real-world circuit designers**
  1. Minimize the use of expensive components.
  2. Maximize circuit robustness making it.
     - I. Insensitive to component selection.
     - II. Insensitive to its operating environment.
  3. Recognize that semiconductor devices.
     - I. Are highly nonlinear in their behavior.
     - II. Are sensitive to temperature.
     - III. Vary widely in their performance characteristics.
The Design Experience

- Took many engineers many years to develop the design techniques we will learn.
- These techniques
  1. Amenable to pencil and paper solutions.
  2. Compensate for transistor temperature sensitivity and inherent variability.
  3. Give analytical results reasonably close to practice.
Overall Course Grading Policies

- 2 Mid-term exams 15 points each
- Final exam 30 points
- Homework 10 points
  1. See slide 9 for Homework Policy.
- Laboratory 30 points
  1. See slides 10 - 12 for Lab Policy.
Lecture Style

- Primarily Adobe Acrobat slides
- Classroom blackboard augmentation
- Student handouts
  - Download slides from ESE 319 website.
  - Suggestion: Print slides and bring to class for note-taking.
Homework Policy

1. Assigned by Friday of each week.
2. Due on Wednesday, the week after assigned.
3. Up to 2 late turn-ins (by Friday the week after assigned) permitted with no penalty.
4. All HW not turned in on-time, according to 2 & 3, will receive “0” grade.
5. Graded homework returned by Monday or 5 days after turned in.
6. Copying or plagiarism of homework is a violation of the Code of Academic Integrity and can result in a “0” grade for the course.
Lab Policy - General

1. Each lab session lasts 3 hours and starts promptly.
   I. Lab sessions missed due to legitimate absences must be made up.

2. Student Groups: A lab group is 2 or 1 students.
   I. Pre-lab and Lab Notebook – individual.
   II. Lab Report - group.

3. Collaboration is OK, copying and plagiarism is NOT OK.
   I. Any violation of the Code of Academic Integrity may result in zero grade for the course.
      a) Copying of pre-lab, data or report content from other lab groups.
      b) Submitting contrived or altered data.
      c) Copying material (other than schematics) from lab handouts or other sources into Lab Reports.

4. Lab Report Turn-in Policy.
   I. All Lab Reports are due the next lab session (usually 1 week).
   II. Up to 2 excused late Turn-Ins will be permitted without penalty.
      a) Late Lab Reports are due 1 week after original deadline.
   III. Lab Reports violating I. & II. will receive “0” grade.
Lab Policy – Pre-Lab Prep & Notebooks

1. Individual Pre-Lab Preparation is very important.
   I. Read lab assignment in advance.
   II. Read text sections relevant to the experiment.
   III. Do pre-lab assignment prior to the lab. Pre-Lab work will be spot checked in lab.
      a) Pencil and paper circuit design.
      b) Circuit simulation(s).

2. Individual Lab Notebook for recording experimental data and observations is essential to preparing accurate Lab Reports.
   I. Lab Notebooks will be kept as in ESE 206
      http://www.seas.upenn.edu/~ese206/#NOTEBOOK.
   II. Lab Notebooks will be spot checked in lab and collected for instructor review at the end of the course.
Lab Policy - Reports

5. Group Lab Reports (Reports due at start of next lab)
   I. Lab reports are to be clearly written and wordprocessor prepared.
   II. Schematics may be computer drawn or neatly hand-drawn or copied/printed and pasted from circuit simulator created graphics.
   III. Tables and graphs of measured data may be copied/printed and pasted from spreadsheet or some other math software.
   IV. Each report is to be organized as follows:
      a) **Heading**: Date, Title of Experiment, Authors Names and Lab Section.
      b) **Introduction**: *very brief* summary description of experiment objectives.
      c) **Theory**: ideal circuit behavior, pencil-and-paper design, relevant equations.
      d) **Experimental Setup**: descriptions/schematics of actual circuit(s) tested, instrumentation used and setups for each test.
      e) **Experimental Data**: present data results, including experimental and simulation data.
      f) **Discussion**: discuss results and explain inconsistencies between design assumptions, theory, experimental results and simulation results.
Next Class/Lab Assignments

- Topic to be covered Friday, 5 Sept.
- MOS Properties Review
  - S&S pages 248-260, 290-293, 322-324
- Don't forget to download the handouts!
- No lab this first week of class.
- First Lab Meetings: Th 18Sep., F 19Sep. (3rd week of class)
Explore and Have Fun!

RCA LAB