ECEN326: Electronic Circuits
Fall 2017

Lecture 1: Introduction

Sam Palermo
Analog & Mixed-Signal Center
Texas A&M University
Analog Circuit Sequence

- Electronics I
  - Operational Amplifiers
    - Solid-State Devices
      - Data Converters
    - Advanced Mixed-Signal Interfaces
  - VLSI Circuit Design
    - Advanced Analog Circuit Design
      - Integrated CMOS RF Circuits and Systems
    - MM-Wave Integrated Circuits
  - Active Filter Analysis and Design
    - Active Network Synthesis
    - Broadband Circuits
    - High Frequency GaAs/SiGe Analog IC Design
  - High-Speed Links Circuits & Systems
Why is Analog Important?

- Naturally occurring signals are analog
- Analog circuits are required to amplify and condition the signal for further processing
- Performance of analog circuits often determine whether the chip works or not
- Examples
  - Sensors and actuators ( imagers, MEMS)
  - RF transceivers
  - Microprocessor circuits (PLL, high-speed I/O, thermal sensor)
Integrated Circuits

- 4-core Microprocessor (45nm CMOS)
  - Mostly Digital
  - Noteable analog blocks
    - PLL, I/O circuits, thermal sensor

- Cellular Transceiver (0.13μm CMOS)
  - Considerable analog & digital

- Instrumentation Amplifier (0.5μm CMOS)
  - Mostly Analog
  - Some Digital Control Logic

[Bohr ISSCC 2009]

[Sowlati ISSCC 2009]

[Perijs ISSCC 2009]
The Power of CMOS Scaling

- Scaling transistor dimensions allows for improved performance, reduced power, and reduced cost/transistor

- Assuming you can afford to build the fab
  - 32nm CMOS fab ~3-4 BILLION dollars
Course Topics

• BJT & MOSFET Review
  • Large signal model
  • Small signal model

• Differential Amplifiers
  • Large & small-signal analysis
  • Common-mode rejection

• Current Mirrors
  • Allows for accurate current sources
  • Output resistance & compliance voltage
Course Topics

• Active Loads
  • Allows for higher gain
  • Useful in IC design

• Frequency Response
  • What limits the bandwidth of our circuits
  • High-frequency transistor model

• Feedback
  • Allows for accurate gain

• Stability
  • In this class, we want to build amplifiers (not oscillators)
  • Phase & gain margin
Course Goals

• Learn how to analyze and simulate multi-transistor analog circuits
  • Large & small-signal analysis
  • Nodal impedance estimation
  • Develop “inspection-based” analysis capabilities
  • Extensive use of PSpice

• Understand fundamental analog building blocks
  • Differential amplifiers, current mirrors, active loads

• Understand fundamental analog design concepts
  • Frequency response, feedback, stability

• Use circuit building blocks and design concepts to construct moderately complex analog circuits
  • “Build” component is emphasized in lab
Administrative

• Instructor:
  • Sam Palermo
  • 315E WERC Bldg., 845-4114, spalermo@tamu.edu
  • Office hours: TR 2:30pm-4:00pm

• Lectures: MWF 9:10am-10:00pm, ETB 1035

• Class web page
  • http://www.ece.tamu.edu/~spalermo/ecen326.html

• Prerequisite
  • ECEN 314 and 325
Class Material


- References
  - *Class Notes*, A. Karsilayan. *(Excellent Condensed Notes)*
  - Material is posted on website

- Lab
  - Lab kit is required (MSC Bookstore – same as 325)
  - Lab start date is third week (9/17 & 9/18)
    - Prelab 1 is due at beginning of first lab
  - Recommend buying personal breadboard and one lab kit per person

- Lectures
  - ~50% slides and ~50% delivered on whiteboard
Grading

• Exams (60%)
  • Three midterm exams (20% each)

• Homework (20%)
  • Collaboration is allowed, but independent simulations and write-ups
  • Need to install PSPICE on your laptop/computer
  • Due in my mailbox near WERC 315E by 5PM of due date
  • No late homework will be graded

• Laboratory (20% + 2%)
  • Lab 11 is extra credit, with the total lab grade computed as a sum of the 11 lab grades divided by 10
# Preliminary Schedule

<table>
<thead>
<tr>
<th>Topic</th>
<th>Week</th>
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<tbody>
<tr>
<td>I. Introduction/Amplifier review</td>
<td>Week 1-6</td>
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<tr>
<td>II. Differential amplifiers</td>
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<tr>
<td>Review session (30 min.)</td>
<td>Oct. 6</td>
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<tr>
<td>1st MIDTERM</td>
<td>Oct. 9</td>
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<tr>
<td>III. Current mirrors</td>
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<tr>
<td>IV. Active loads</td>
<td>Week 7-10</td>
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<tr>
<td>V. Frequency response</td>
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<tr>
<td>Review session (30 min.)</td>
<td>Nov. 3</td>
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<tr>
<td>2nd MIDTERM</td>
<td>Nov. 6</td>
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<tr>
<td>VI. Stability</td>
<td>Week 11-15</td>
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<td>VII. Output stages</td>
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<tr>
<td>Review session (30 min.)</td>
<td>Dec. 6</td>
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<tr>
<td>3rd MIDTERM</td>
<td>Dec. 11 (8:00AM-10:00AM)</td>
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*Exam dates are approximate and subject to change with reasonable notice.

- **Dates may change with reasonable notice**
Reading

• Razavi Chapter 5 & 7
  • The majority of this material should be 325 review