Lecture 1: Introduction

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

- Electronics I
  - Electronics II
  - Operational Amplifiers
    - Solid-State Devices
      - Data Converters
        - Advanced Mixed-Signal Interfaces
      - Advanced Analog Circuit Design
        - Integrated CMOS RF Circuits and Systems
      - Broadband Circuits
      - Active Network Synthesis
      - High Frequency GaAs/SiGe Analog IC Design
    - MM-Wave Integrated Circuits
    - 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

[Bohr ISSCC 2009]

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

[Sowlati ISSCC 2009]

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

[Pertijs ISSCC 2009]

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

• Linear circuit analysis
  • Laplace transform basics
  • Bode Plots

• OpAmp Circuits
  • Opamp Properties
  • Amplifiers and basic filters

• Non-linear circuits
  • Large signal model
  • Small signal model
  • Diodes, BJTs, MOSFETs
Course Goals

• Learn how to analyze and simulate linear and non-linear circuits
  • Linear analysis → Laplace transforms, Bode plots
  • Nonlinear analysis → Linearize about a DC operating point to find AC small-signal response
  • Circuit simulation basics (MultiSim)

• Understand fundamental analog device properties
  • OpAmps, Diodes, BJTs, MOSFETs

• Learn amplifier properties and how to analyze/build multi-stage amplifier circuits
  • “Build” component is emphasized in lab and project
Administrative

- Instructor:
  - Sam Palermo
  - 315E WEB, 845-4114, spalermo@tamu.edu
  - Office hours: MW 2:30pm-4:00pm

- Lectures: MWF 10:00am-11:15am, ETB 1020

- Recitation: R 4:45pm-5:45pm, ETB 1020
  - Recitation begins first week
  - Attendance required

- Class web page
  - [http://www.ece.tamu.edu/~spalermo/ecen325.html](http://www.ece.tamu.edu/~spalermo/ecen325.html)

- Prerequisite
  - ECEN 314 (co-registration)
Class Material


- **References**
  - *Class Notes*, J. Silva-Martinez
  - *Class Notes*, A. Karsilayan
  - Material is posted on website

- **Lectures**
  - ~25% slides, with previous semester’s notes posted on website
  - ~75% delivered on whiteboard
Lab

• Lab kit is required
  • See Jeanne Prestwood in WEB 301

• Need to purchase Analog Discovery 2

• Primary circuit simulator is MultiSim
  • Follow instructions on
    http://www.ece.tamu.edu/~spalermo/ecen325/ms-ad2.pdf
to get started

• Lab starts on June 5 with an orientation session
• Lab 1 is due on June 12
Grading

• Exams (75%)
  • Three midterm exams (25% each)

• Homework/Quizzes (10%)
  • Collaboration is allowed, but independent simulations and write-ups
  • Need to install MultiSim on your laptop/computer
  • Due in my mailbox near WEB 315E by 5PM of due date
  • No late homework will be graded
  • Quizzes will be given in recitation and weighted equally with homework

• Laboratory (15%)
# Preliminary Schedule

<table>
<thead>
<tr>
<th>Topic</th>
<th>Week</th>
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<tbody>
<tr>
<td>I. Introduction to electronics</td>
<td>Week 1-4</td>
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<tr>
<td>II. Circuit analysis and bode plots</td>
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<tr>
<td>III. Operational amplifiers and circuit analysis</td>
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<tr>
<td><strong>Review session (Recitation)</strong></td>
<td>June 28</td>
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<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; MIDTERM</td>
<td>June 29</td>
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<td>IV. Diode and bipolar device models</td>
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<td>V. Concepts on input and output impedances and transmission gain</td>
<td>Week 5-7</td>
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<td>VI. Basic and multi-stage amplifiers</td>
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<tr>
<td><strong>Review session (Recitation)</strong></td>
<td>July 19</td>
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<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; MIDTERM</td>
<td>July 20</td>
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<tr>
<td>VII. Field-effect (MOS) transistors</td>
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<td>VIII. Basic and multi-stage amplifiers</td>
<td>Week 8-10</td>
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<td>IX. Differential amplifiers</td>
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<tr>
<td><strong>Review Session</strong></td>
<td>Aug 6</td>
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<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; MIDTERM</td>
<td>Aug 7 (10:30AM-12:30PM)</td>
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- Dates may change with reasonable notice
Reading & Homework

- Chapter 1 (Razavi)
- Fundamentals of Circuit Analysis (Dr. Silva)
- Homework 1 is posted on website and due June 8