ECEN326: Electronic Circuits
Spring 2022

Lecture 1: Introduction

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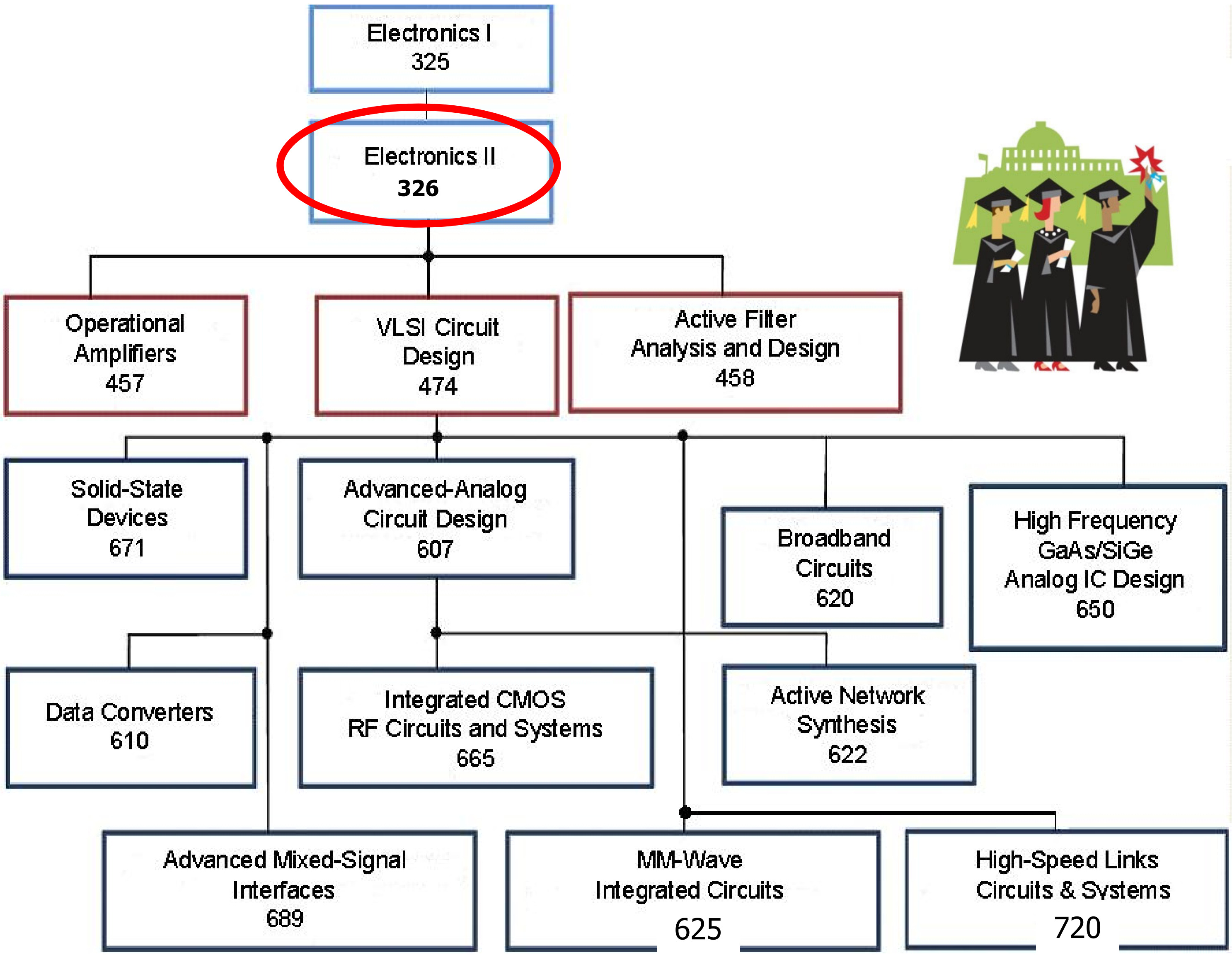
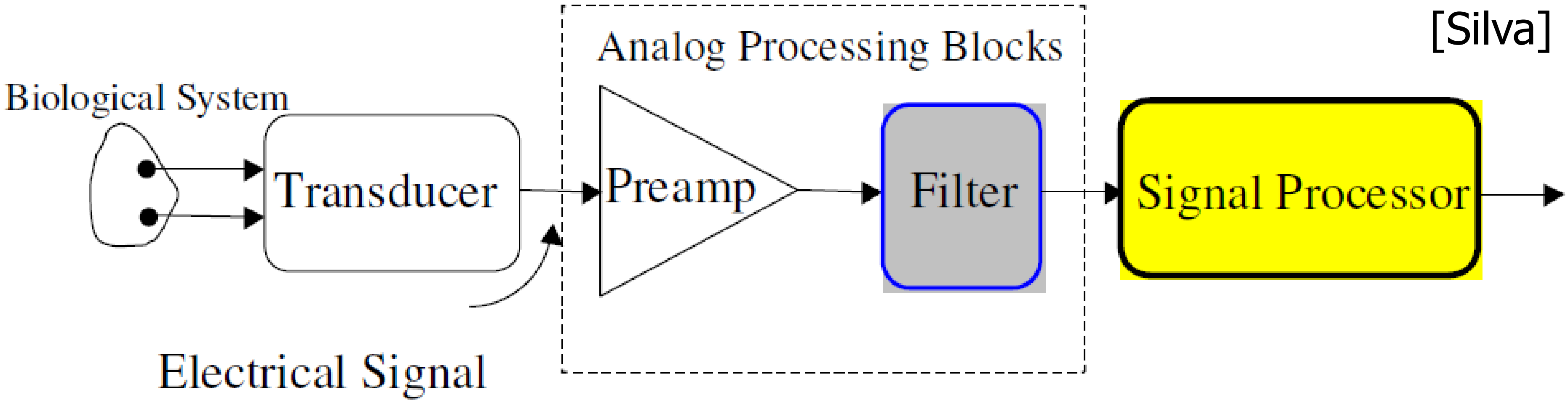
Texas A&M University

Analog Circuit Sequence



Why is Analog Important?

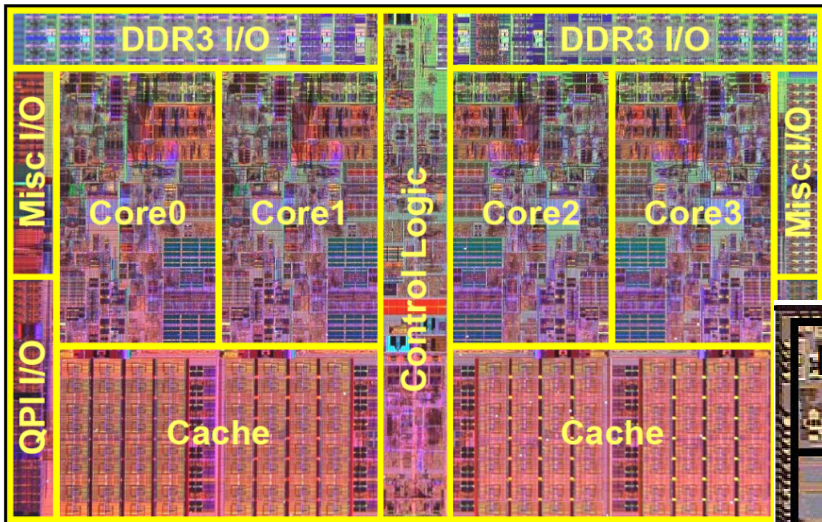
[Silva]



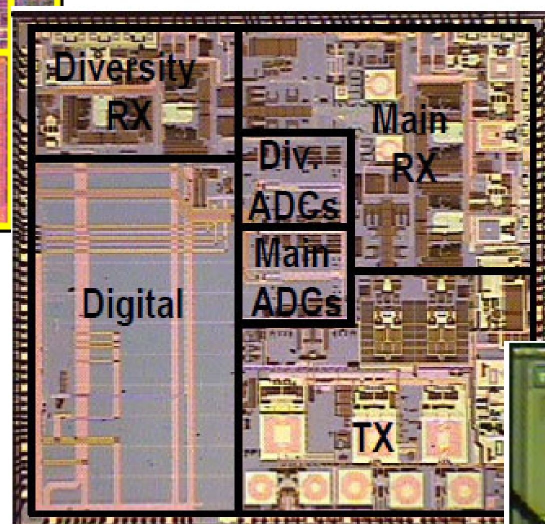
- Naturally occurring signals are analog
- Analog circuits are required to amplify and condition the signal for further processing
- Performance of analog circuits often determine whether the chip works or not
- Examples
  - Sensors and actuators (imagers, MEMS)
  - RF transceivers
  - Microprocessor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

Integrated Circuits

[Bohr ISSCC 2009]



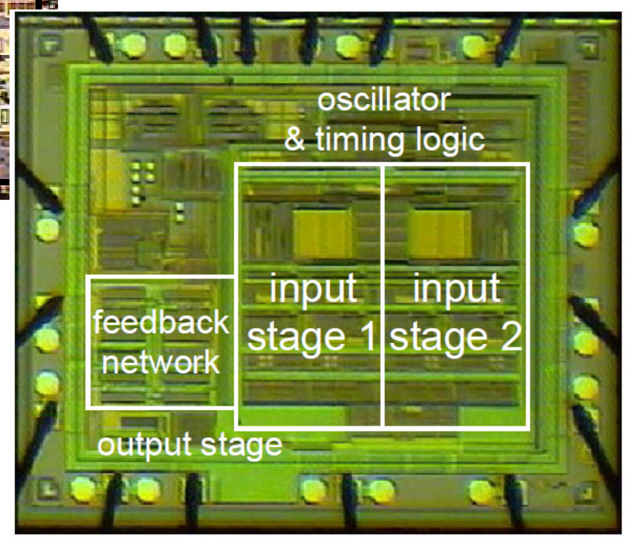
- 4-core Microprocessor (45nm CMOS)
  - Mostly Digital
  - Noteable analog blocks
    - PLL, I/O circuits, thermal sensor



[Sowlati ISSCC 2009]

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

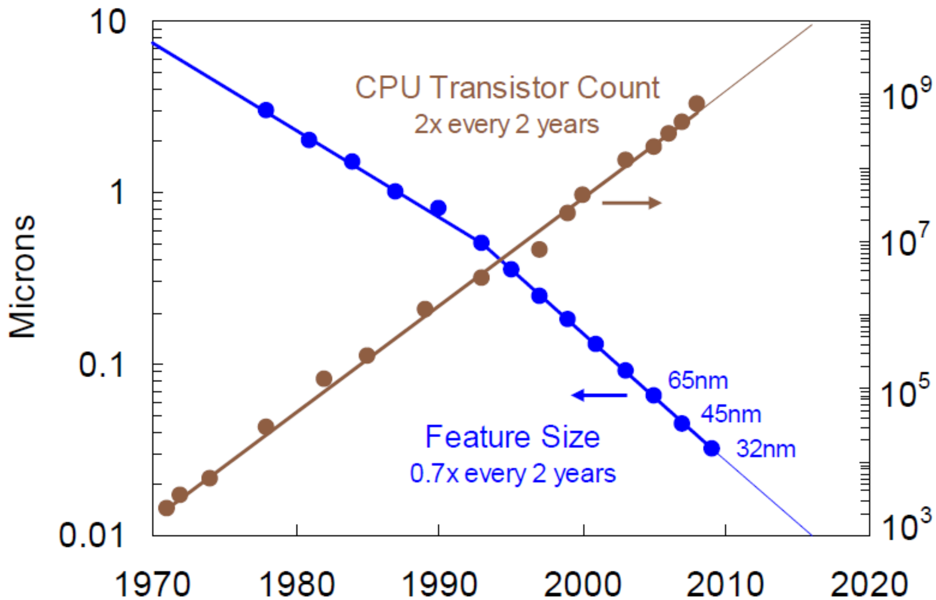
[Pertijs ISSCC 2009]

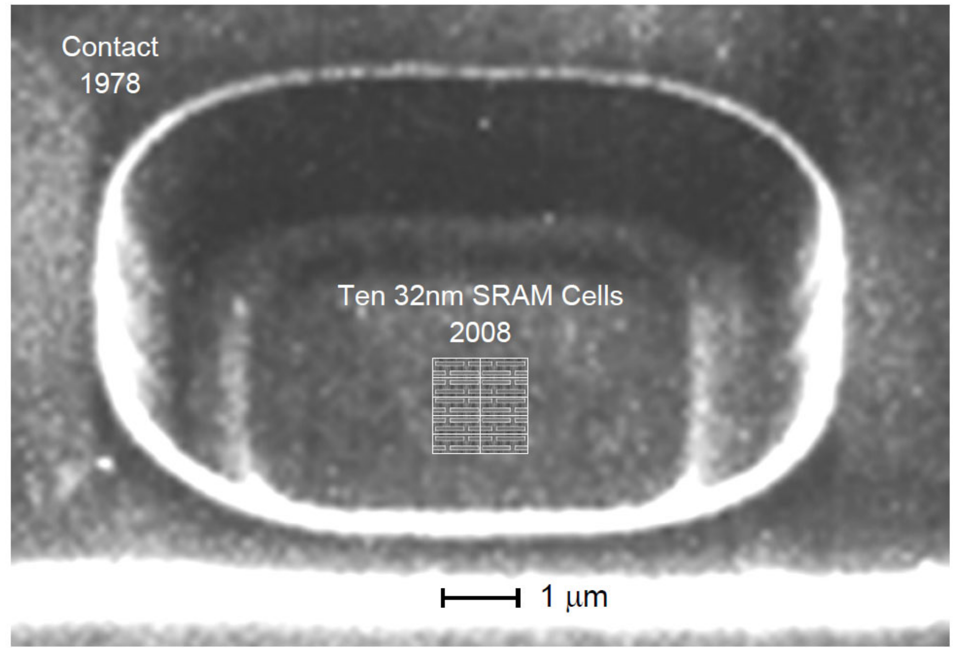


- Instrumentation Amplifier (0.5μm CMOS)
  - Mostly Analog
  - Some Digital Control Logic

The Power of CMOS Scaling

[Bohr ISSCC 2009]





- 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 MultiSim
- 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., 979-458-4114, spalermo@tamu.edu
  - Office hours: M 10:00AM-11:30AM & F 1:00PM-2:30PM
    - Online via Zoom
- Lectures: TR 9:35AM-10:50AM, ETB 1037
- Class web page
  - https://people.engr.tamu.edu/spalermo/ecen326.html
- Prerequisite
  - ECEN 314 and 325

Class Material

- Textbook: *Fundamentals of Microelectronics, 2nd Edition*, B. Razavi, Wiley, 2014.

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

- Lectures
  - ~100% slides, with previous semester's notes posted on website

Lab

- Some details are TDB
- Lab kit details TBD
  - Use your 325 lab kit for now
- Preliminary plan is to use Analog Discovery 2, like in 325?
  - How many people have an AD2?
  - Tentative plan is for the department to supply them
- Primary circuit simulator is MultiSim
  - Follow instructions on website to get started
- Lab starts on Jan 26-27 with an orientation session
- Lab 1 is due on Feb 2-3

Grading

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

- Homework (20%)
  - Collaboration is allowed, but independent simulations and write-ups
  - Need to install MultiSim on your laptop/computer
  - Turn in via Canvas
  - 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

Topic		Week
I.	Introduction/Amplifier review	Week 1-6
II.	Differential amplifiers	
	Review session (30 min.)	**Feb. 22**
	1st MIDTERM	**Feb. 24**
III.	Current mirrors	Week 7-10
IV.	Active loads	
V.	Frequency response	
	Review session (30 min.)	**Mar. 29**
	2nd MIDTERM	**Mar. 31**
VI.	Stability	Week 11-15
VII.	Output stages	
	Review session (30 min.)	**Apr. 28**
	3rd MIDTERM	**May 5 (12:30PM-2:30PM)**

- Dates may change with reasonable notice

Reading

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