ECEN325: Electronics
Spring 2024

Lecture 1: Introduction

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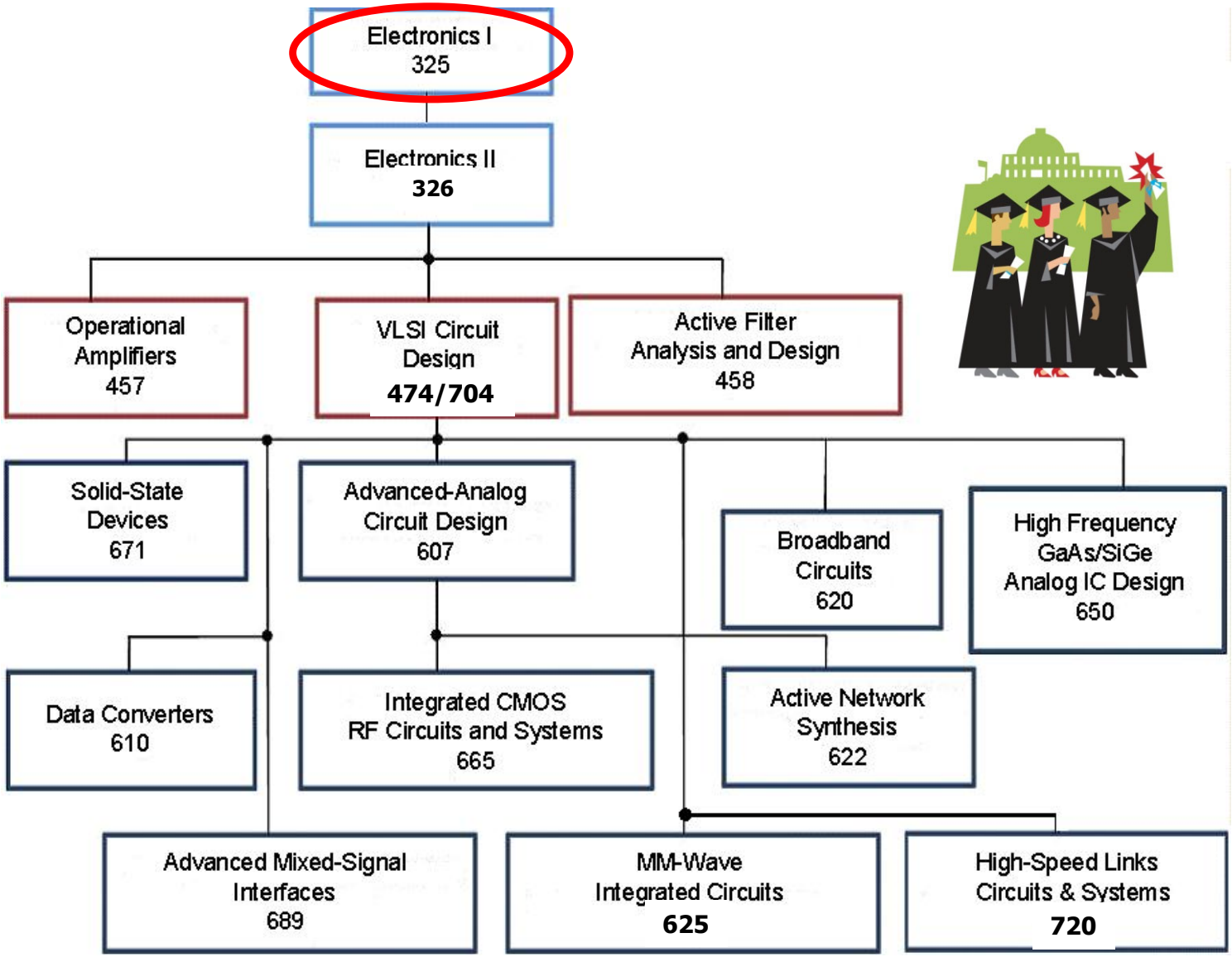
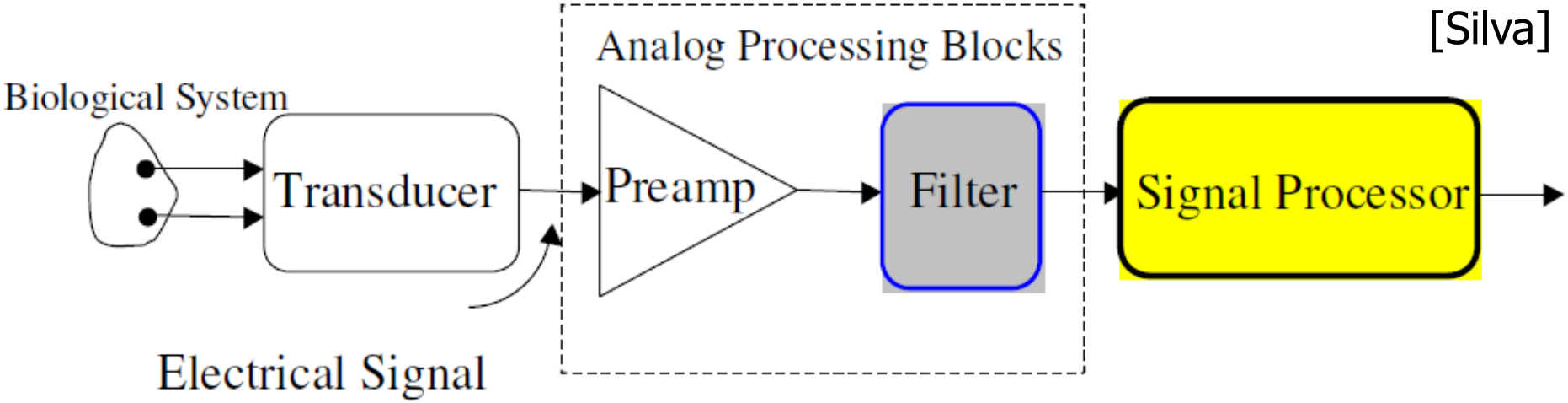
Analog Circuit Sequence



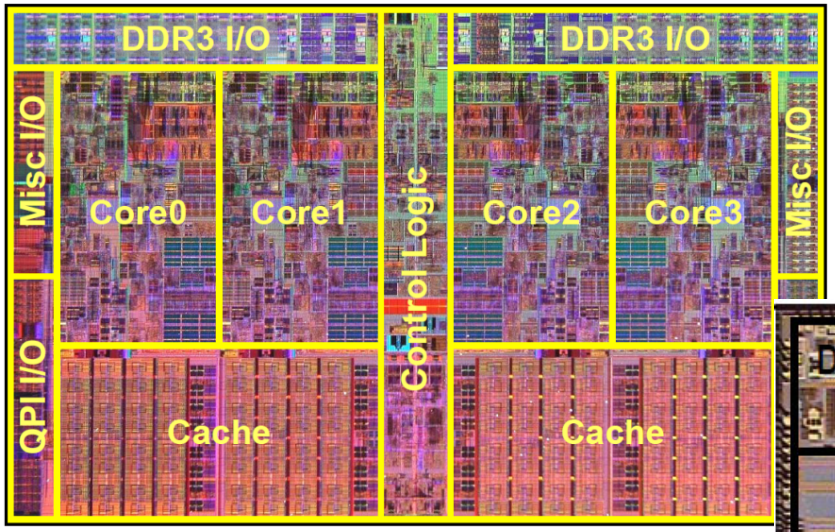
Why is Analog Important?



- 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)

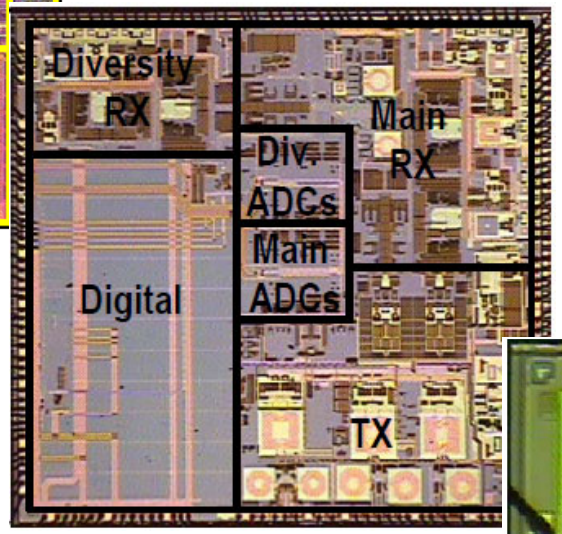
Integrated Circuits

[Bohr ISSCC 2009]



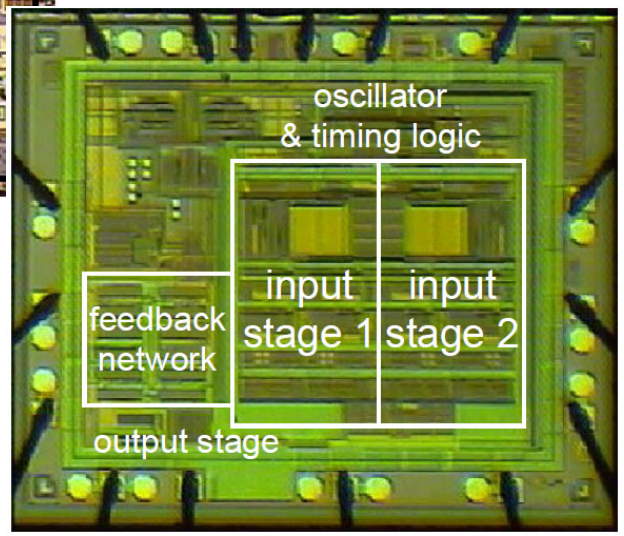
- 4-core Microprocessor (45nm CMOS)
  - Mostly Digital
  - Noteable analog blocks
    - PLL, I/O circuits, thermal sensor

[Sowlati ISSCC 2009]



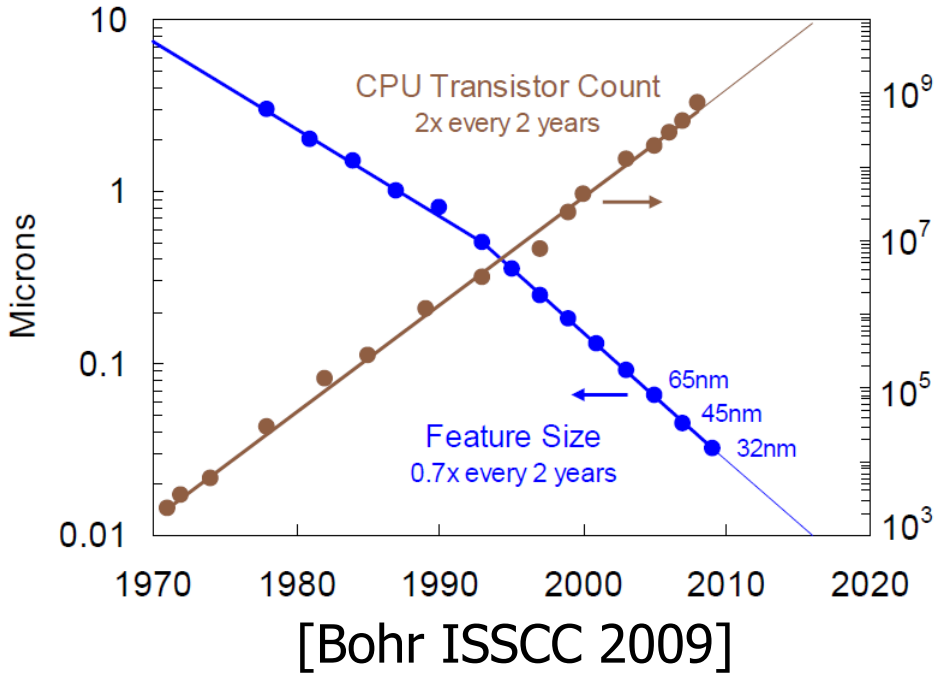
- Cellular Transceiver (0.13μm CMOS)
  - Considerable analog & digital

[Pertijs ISSCC 2009]

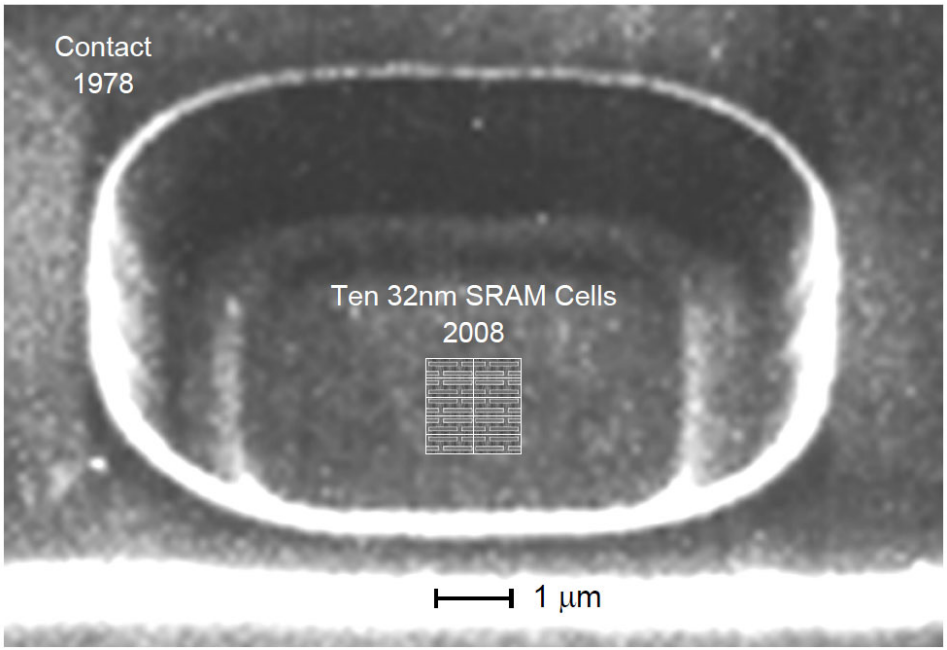


- Instrumentation Amplifier (0.5μm CMOS)
  - Mostly Analog
  - Some Digital Control Logic

The Power of CMOS Scaling



[Bohr ISSCC 2009]



- Scaling transistor dimensions allows for improved performance, reduced power, and reduced cost/transistor
- Assuming you can afford to build the fab

TSMC says 3nm plant could cost it more than $20bn

Comapny founder warns that Taiwan fab will cost a record amount

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 $\rightarrow$ Laplace transforms, Bode plots
  - Nonlinear analysis $\rightarrow$ 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: M 2:30PM-4:00PM & W 2:00PM-3:30PM
- Lectures
  - TR 2:20PM-3:35PM
- Class web page
  - https://people.engr.tamu.edu/spalermo/ecen325.html
  - Will use Canvas for turning in assignments
- Prerequisite
  - ECEN 314 (co-registration)

Class Material

- Textbook: *Fundamentals of Microelectronics, 3rd Edition*, B. Razavi, Wiley, 2021.

- 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 equivalent

Lab

- Lab starts on 1/22 – 1/26 with an orientation session

- Prelab 1 due in lab the week of 1/29 - 2/2

Grading

- Exams (75%)
  - Three midterm exams (25% each)
- Homework (10%)
  - Collaboration is allowed, but independent simulations and write-ups
  - Need to install MultiSim on your laptop/computer or access via VOAL
  - Turn in via Canvas
  - No late homework will be graded
- Laboratory (15%)

Preliminary Schedule

	Topic	Week
I.	Introduction to electronics	Week 1-4
II.	Circuit analysis and bode plots	
III.	Operational amplifiers and circuit analysis	
	Review session (30 min.)	**Feb. 27**
	1st MIDTERM	**Feb. 29**
IV.	Diode and bipolar device models	Week 5-8
V.	Concepts on input and output impedances and transmission gain	
VI.	Basic and multi-stage amplifiers	
	Review session (30 min.)	**Apr. 2**
	2nd MIDTERM	**Apr. 4**
VII.	Field-effect (MOS) transistors	Week 9-12
VIII.	Basic and multi-stage amplifiers	
IX.	Differential amplifiers	
	Review session (30 min.)	**Apr. 25**
	3rd MIDTERM (1PM-3PM)	**May 7**

- Dates may change with reasonable notice

Reading & Homework

- Chapter 1 (Razavi)
- Fundamentals of Circuit Analysis (Dr. Silva)

- HW 1 is posted on the website and due Feb 1