

## ECE 5/411 CMOS Analog IC Design

#### **Course Introduction**

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## **Course Outline**

- Instructor : <u>Vishal Saxena</u>
- **Time** : Tue/Thu 6:00-7:15 PM
- **Course dates** : Jan 21 May 8, 2014
- Location : MEC 307
- Office Hours : Tue/Thu 4:00-5:00 p.m.
- **Holidays** : March 25 & 27.
- Final Exam time: Thursday, May 15, 2014, 5:00-7:00 p.m.
- Website : <u>http://lumerink.com/courses/ece5411/s14/ECE5411.htm</u>



- Analog models of MOSFETs
- Voltage references
- Current mirrors and Bias circuits
- Amplifiers, frequency compensation, Opamps.
- Negative feedback systems and stability
- Bandgap references and voltage regulators
- Pre-requisite
  - ECE 5/410
  - Brush-up concepts from ECE 310 (Microelectronics)



## **Textbook and References**

- B. Razavi, "Design of Analog CMOS Integrated Circuits," McGraw-Hill, 2002.
  - Circuit theory and analysis
- <u>CMOS Circuit Design, Layout and Simulation</u> R. J. Baker, 3rd Ed., Wiley-IEEE, 2010.
  - Circuit design and simulation examples
  - Cadence examples available on the server
- For detailed references and handouts see this <u>page</u>.







### **EDISE STATE UNIVERSITY** Course Pedagogy, Grading and Policies

- Combination of lecture notes, slides and simulation
  - Lecture notes will be posted online (with some delay)
  - Additional slides and Matlab code will be posted.
- Workload (Grading)
  - Homeworks (20%): Weekly assignments.
  - Midterm Exam 1: (20%)
  - Midterm Exam 2: (20%)
  - Project (20%): Opamp design and characterization
  - Final (20%)
- Policies
  - No late work.
  - Neither the final exam nor final project will be returned at the end of the semester.

- Plagiarism is not acceptable. Look at the BSU student code of conduct.

http://www.boisestate.edu/policy/policy\_docs/2020\_studentcodeofconduct.pdf



## Why Analog? – The Myths



















# Why Analog Circuits?



- Real world is analog.
- Digital world: Discrete-time, discrete-amplitude signal representation.
  - Interface circuits: ADC and DACs.
- High speed signal processing circuits are analog (Serial IOs, 60 GHz RF)

### BOISE STATE UNIVERSITY Analog Circuits in Modern VLSI Systems

- Analog to digital conversion (ADCs)
- Digital to analog conversion (DACs)
- Amplification and filtering
- Signal processing circuits at high frequencies
  RFICs, Serial I/O, optical transceivers, etc.
- Power management-voltage references, voltage regulators
- Clock generation circuits (PLLs/CDRs)
  - The last two are found even on many "digital" ICs



## **Analog Circuits in Action**



BCM 4330 – Mobile Wireless Single-band 2.4 GHz 802.11 b/g/n or dual-band 2.4 GHz and 5Ghz 802.11 a/b/g/n Integrated ARM<sup>®</sup> Cortex<sup>™</sup>-M3 processor and onchip memory.



XC3028 TV Tuner Chip

Single-chip analog and digital TV tuner showing the fully integrated RF-to-baseband functional blocks.



# Analog Courses at BSU

#### ECE 511

- CMOS Analog IC Design
- ECE 518
- Memory and PLL IC Design

ECE 614

Advanced Analog IC Design

ECE 615

- Mixed-Signal IC Design
- ECE 613 (tentative)
- Wireless IC Design
- ECE 697-X
- Advncd Topics in IC Design





### System Level View – RF Receiver



- Top-down approach is used in system design.
- Scope:
  - □ MS Thesis/ PhD Dissertation





#### □ Scope:

- Advanced Analog IC Design (ECE 614)
- □ Mixed-Signal IC Design (ECE 615)

### Circuit Level View – A Loop-Filter







### Transistor Level View – An Opamp



#### □ Scope:

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- **ECE 511 and ECE 614**
- □ In this course, we will learn the basics of transistor-level analog design.





