

Course No.: 09720NEMS580100

Fundamental Analog Circuits for MEMS

Spring 2009

Instructor:

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Office Hours: TBD

Lecture:

Rm. 212, Engineering Bldg. I, Thursday 9:00am – 12:00pm

Teaching assistant:

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Course Description :

Micro Electro Mechanical Systems (MEMS) are miniaturized devices that are created using various techniques including many similar to those used to manufacture integrated circuits, and are capable of performing many tasks and functions that involve mechanical, electrical, optical, fluidic, and other types of signals. MEMS Sensors and actuators allow us to interface our electronic systems to the non-electronic world. They provide analog information on the system being monitored through signal conditioning circuits to a microprocessor-based controller. MEMS and integrated Microsystems are increasingly finding applications in many areas including automotive, health care, industrial processing, environmental monitoring, biomedical systems, chemical analysis, energy sources, telecommunication, aerospace systems, consumer appliances, and many others. Among those systems, integrated readout or sustaining circuits play important roles for connecting the MEMS devices and their corresponding data-processed units.

This is an introductory and analysis course of CMOS analog circuits for MEMS devices with class lectures and hands-on design labs based on Cadence or SPICE. This course begins with the introduction of the start-of-the-art MEMS devices integrated with circuits, and then covers the review of MOS transistor basics, small signal analysis, single stage and differential amplifiers, CMOS opamps, stability, and frequency compensation.

Tentative Outline:

Week	Lecture Date	Lecture
1	2/26	MEMS Devices Integrated with Circuits
2	3/5	MEMS Input/Output Modeling
3	3/12	Review of Transistor Basics – Basic MOS Physics
4	3/19	Single Stage Amplifiers I – Common Source
5	3/26	Single Stage Amplifiers II – Common Drain/Gate
6	4/2	Single Stage Amplifiers III – Cascoding, Folded Cascode
7	4/9	Frequency Domain Analysis I – Poles, Zeros, Bode/Phase...
8	4/16	Frequency Domain Analysis II – CS/CD/CG Amplifiers
9	4/23	Differential Amplifiers
10	4/30	Midterm Exam
11	5/7	Current Mirrors
12	5/14	Feedback Analysis
13	5/21	Stability and Compensation I
14	6/4	Stability and Compensation II
15	6/11	More About OP Amps
16	6/18	Micromechanical Resonator Oscillator Design
17	6/25	Final Exam

Textbook:

- (1) Behzad Razavi, *Design of Analog CMOS Integrated Circuits*, 1st Edition, McGraw Hill, 2001
- (2) Class Notes.

References – Books:

- (1) Gray, Hurst, Lewis, Meyer, *Analysis and Design of Analog Integrated Circuits*, 4th Edition, John Wiley & Sons, 2001
- (2) P. E. Allen, D. R. Holberg, *CMOS Analog Circuit Design*, Holt, Reinhart, and Winston, Inc., 1987

Prerequisite:

This course is intended for undergraduate seniors and graduate students. It is a fundamental and introductory circuit course designed for those students who are not very familiar with CMOS analog circuits. Therefore, the course prerequisites are selected to allow students from MANY engineering and science disciplines, including mechanical, electrical, chemical, aerospace, biomedical, and material engineering to take the course. The course is organized into lectures and design labs. The lectures present material that ALL students need to learn

and the labs are intended to teach students how to use simulators to facilitate the CMOS circuit design procedure. The following academic background is required for this course: (a) KVL, KCL, Laplace domain, and basic circuits; (b) transistor operation, processing, cross-section.

Grading Policy: (subject to revision)

Homework 25%, Midterm 20%, Design Project 20%, Final Exam 25%, Class Participation 10%