UNIVERSITY OF UTAH
ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

ECE/CS 5720/6720: Analog Integrated Circuit Design

Spring 2008
Tuesday/Thursday 9:10 - 10:30 am
WEB 105

Instructor: Prof. Cameron Charles
Office: 4108 MEB
Office Hours: Wednesday 2:00-3:00 pm, Thursday 10:30 am - 12:00 noon, or by appointment
Phone: 587-9497
Email: ccharles at ece.utah.edu

Prerequisites: ECE 3110 or equivalent (see below)

Texts: David A. Johns and Ken Martin, *Analog Integrated Circuit Design*, Wiley, 1997
Supplemental notes at Copy Center in Union Building

Web Page: http://www.ece.utah.edu/~ccharles/ece5720/

TA: Ondrej Novak
Email: onovak at eng.utah.edu
Office: MEB 2270
Office hours: Tuesday 1:00 pm-2:30 pm, Friday 10:00 am - 11:30 am

General Description

This class will cover the design and implementation of modern analog integrated circuits (VLSI) in CMOS technology. We will cover aspects of circuit design from single transistor operation to complex amplifiers and data converters. The Cadence CAD tool suite will be used for mask-level layout, schematic entry, verification, and simulation. While CAD tools will be used extensively, the course will emphasize a basic understanding of circuit operation through analytical means.

The course will follow chapters from the textbook, *Analog Integrated Circuit Design*, and many homework problems will be assigned from this book. However, much supplementary material will be presented in lectures, so it is *essential* that you attend class regularly.

Prerequisite Knowledge

- It is assumed that students taking this class understand basic time-domain and frequency-domain linear circuit analysis.
- It is assumed that they are somewhat familiar with the basic structure of a MOSFET, and have analyzed circuits involving transistors at some point in their education.
- It is assumed that each student has some experience with circuit simulation.
- Some homework problems will require the use of MATLAB. If you have never used MATLAB before, there are introductory tutorials available on the web.

If you are an undergraduate taking this class, you *must* have taken ECE 3110, or its equivalent.

Homework & CAD Assignments

There will be a number of homework assignments in this course involving written problems, MATLAB assignments, and/or CAD assignments. CAD work will be performed in the CADE lab. All problem sets will be collected and graded. Homework assignments are due by 6:00 PM on the specified date in the class locker on the 3rd floor of MEB. Homework assignments turned in up to 24 hours late will be penalized 10% (i.e., multiply your score by 0.9). Assignments turned in more than 24 hours late will not be accepted. Your lowest homework grade will be dropped. Solutions will be posted after the problems are due.

Homework problems will be graded on a five-point scale (from 0-5), with credit being assigned as follows:

Answer	Method	Score
right	right	5
wrong	right; arithmetic mistake	4
-	close	3
-	not close	1
-	no attempt	0

Collaboration policy: While you are allowed to work with other students on the homework assignments, *everything you turn in should be your own work.* Dividing up the work between classmates and then sharing answers is considered cheating. Discussing possible solutions to problems together is not cheating. Copying answers from a solutions manual is considered cheating. Sharing files in CAD assignments is *not* permitted, but discussing assignments together in the CADE lab is encouraged.

Exams

There will be one 1.5-hour midterm exam given during class in March. No exam will be given during finals week. The exam will count 30% towards your final grade. The exam will cover material discussed in lectures as well as material from the sections of the book covered in reading assignments and homework assignments. The exam may also cover questions related to the CAD tools used in layout and simulation assignments.

Design Projects

After students have reached a basic proficiency with the CAD tools and have a good understanding of circuit design techniques, several (2-3) mini design projects will be assigned. Each miniproject will involve circuit design and simulation, and some layout and verification. The final design project will require students to design, simulate, layout, and verify an analog or mixed-signal integrated circuit of moderate complexity. Projects may be submitted for fabrication at the end of the class if desired. If a design is submitted, it may be tested in the fall semester for one credit (ECE 6722: Analog IC Testing).

Additional Assignments for 6720

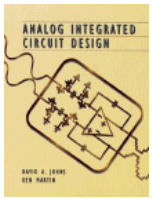
Those students enrolled in the 6000-level course will have two additional assignments: two written reports on journal articles. Journal articles from the *IEEE Journal of Solid-State Circuits* and other journals will be assigned to each student. A short written report summarizing the article will be turned in. This will expose students to current research in analog VLSI design. Also, the final design project must be larger in scope than the 5720 projects.

Grading

Final class grades will be "curved." That is, there is no numerical cutoff for various letter grades. (From experience with previous years, 90-100 *usually* corresponds to a grade of A or A-, and 80-89 *usually* corresponds to a grade between B+ and B-, etc.) Grades for students enrolled in the 5000-level course will be calculated separately from students enrolled in the 6000-level course. Following is a breakdown of how grades will be calculated:

	ECE/CS 5720	**ECE/CS 6720**
Midterm	30%	30%
Homework	15%	15%
CAD Assignments	15%	10%
Mini Design Projects	20%	20%
Written Reports	not required	5%
Final Design Project	20%	20%

Required Text

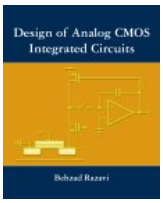


David A. Johns and Ken Martin, *Analog Integrated Circuit Design*, Wiley, 1997.

- Required text for this class. Reading assignments and many homework assignments will come from this book.

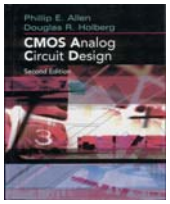
- Also, purchase the Supplemental Notes at the Copy Center in the Union Building.

Optional Reading



Behzad Razavi, *Design of Analog CMOS Integrated Circuits*, McGraw-Hill, 2001.

- Another good textbook with emphasis on CMOS circuits.

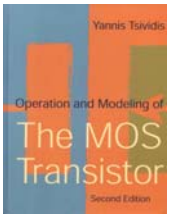


Phillip E. Allen and Douglas R. Holberg, *CMOS Analog Circuit Design, 2nd edition,* Oxford University Press, 2002

- Another good textbook with emphasis on CMOS circuits; in-depth circuit analysis.

Paul R. Gray and Robert G. Meyer, *Analysis and Design of Analog Integrated Circuits, 3rd edition,* Wiley, 1993.

- Older book; emphasis is on bipolar transistor circuits, but also contains CMOS circuits. A 4th edition has just been released.



Yannis Tsividis, *Operation and Modeling of the MOS Transistor, 2nd edition,* McGraw-Hill, 1999.

- Detailed explanation of MOS transistor behavior; links physics to device models.