ECE832: Analog Integrated Circuit Design

Lecture: Mon Wed, 3:00-4:20, 1225 Engineering Bldg

Instructor: Dr. Shantanu Chakrabartty, shantanu@msu.edu

Office Hours: Any time in EB 3530 or EB3222

Course Website: http://www.egr.msu.edu/~shantanu/ece832-09.html

Prerequisite: Knowledge of transistor operation, operational amplifiers and Pspice

Reference Text:

Topics Covered:
This is a project oriented course that focuses on current state-of-art low power techniques used in designing CMOS data converters, imagers and biomedical signal processing systems. Several practical aspects of mixed-signal design, simulation, layout and testing will be covered in this course and will be used for implementing a VLSI prototype. It is expected that the students complete the design, simulation and layout of the prototype by the end of the course.

Topics Covered:
The following is a tentative schedule of topics that will be covered during the course:

Lecture 0 Introduction to analog circuits and analog signal processing.
Lecture 1 MOSFET modeling and mixed-signal layout
Lecture 2 Analog building blocks
Lecture 3 Digital building blocks
Lecture 4 Analog computational blocks
Lecture 5 Introduction to dynamic analog techniques
Lecture 6 Analysis and design of dynamic analog circuits
Lecture 7 Noise analysis
Lecture 8 Power estimation and optimization
Lecture 9 Introduction to data converters
Lecture 10 Sigma-Delta converters I
Lecture 11 Filters
Lecture 12 Sigma-Delta converters II
Case Studies: Popular Integrated Circuit Designs
Attendance and Conduct in Class:
Students are expected to attend classes and be attentive and responsive to all class discussions. It is the student’s responsibility to get notes and handouts for any missed class.

Grading:
The grades will be assigned according to the following credit table. Students have the option of selecting any one of the following option for their grade.

<table>
<thead>
<tr>
<th>Option</th>
<th>Credit Assignment</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Class participation (20% )</td>
</tr>
<tr>
<td>2</td>
<td>Presentation I (20%)</td>
</tr>
<tr>
<td>3</td>
<td>Presentation II (20%)</td>
</tr>
<tr>
<td>4</td>
<td>Final Project (40%)</td>
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Class project:
Each student will choose a topic of his/her interest which is related to analog circuit design. Possible project topics are:

- Programmable Precision Voltage Reference Generators
- Programmable Current Generators
- DC-DC converters
- High-voltage pulse generators
- Programmable Ultra-low current reference generator
- Sigma-Delta Analog-to-Digital Converters
- Sigma-Delta Digital-to-Analog Converters
- Phase-locked loops (PLL)
- Programmable Filters
- Analog-to-Information Converters (LPDC decoder, Sigma-delta learners)
- Energy harvesting circuits
- Other Instrumentation Circuits

The students are encouraged to schedule weekly meetings with the instructor to discuss the progress of the project. The student will be responsible in maintaining all design documentation related to the project which needs to be turned in for final submission. It is expected that the prototype designed by the students be fabricated through MOSIS.

Presentation I:
The first presentation should cover a brief survey of the students project topic and should include the following slides:
1) Topic of the project
2) Applications of the project
3) Are there any commercial products in the market related to the project?
4) Is there any research being done in this area and by which research groups?
5) What specifications have been achieved by other groups?
6) What do you expect to improve the design?
7) What are the specifications you are targeting for?
8) Project schedule.

**Presentation II:**
The second presentation should cover the preliminary design, MATLAB and spectre simulations of the proposed approach:
   1) Proposed architecture
   2) System level simulations in matlab.
   3) Potential problems and remedy
   4) Preliminary circuit level simulations.
   5) Project schedule.

**Final project:**
The final project submission should include a project describing the following:
   1) Complete system level schematic
   2) Complete system simulations using spectre.
   3) Complete system layout and extracted level simulations.

**Cadence:**
The simulations and design for this class will require the use of Cadence design tools. A tutorial will be provided on the class web-site to help you get started with the use of Cadence. Since the students will be designing complex and complete systems students are urged to make themselves familiar with the simulation tools as soon as possible. Detailed information on accessing and using Cadence on a UNIX platform will be provided.