Georgia Institute of Technology
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
ECE 4430: Analog Integrated Circuits – Fall 2008
1:00 – 2:00 pm, Mon, Wed, Fri, Van Leer C341
http://www.ece.gatech.edu/academic/courses/ece4430/F08

Instructor: Maysam Ghovanloo, Ph.D. (mghovan@ece.gatech.edu), Phone: (404) 385-7048

Office Hours: Fridays 2:00-4:00 pm, other times with prior appointment

TA: N/A


Other References: (recommended)
1. CMOS Analog Circuit Design
   P.E. Allen and D.R. Holberg
2. Design of Analog CMOS Integrated Circuits
   B. Razavi
3. The Art of Analog Layout
   A. Hastings
4. Analog Integrated Circuit Design
   D.A. Johns and K. Martin

Prerequisites: Analog Electronics (ECE-3040 and 3050 or equivalent), Co-requisites: None

It is assumed that you are familiar with the following topics:
1. Circuit theory, frequency response, small signal analysis.
2. Solid-state devices and microelectronic circuits: P-type and N-type semiconductors, diodes, bipolar junction transistors, and MOS field-effect transistors (MOSFET).
3. Basic knowledge of MATLAB and available CAD tools such as SPICE or Cadence.

Course Description:
Analysis and design of the analog integrated circuits (ICs) using analytic techniques and CAD tools. This course emphasizes on circuit design and intuitive understanding of circuits, particularly those topics used in analog ASIC design.

Topical Outline:
Introduction, MOS Technology
CMOS and BJT Technologies, Layout and Design Rules
MOS models: dc, ac, capacitive effects, regions of operation, short channel effects, measurements
BJT models: diodes, high frequency, measurement
MOS analysis: large signal, small signal
SPICE simulations - MOS and BJT models
Switches and active resistors
Current sinks and sources
Current mirrors and amplifiers
Voltage and current reference generators
MOS inverting amplifiers
BJT inverting amplifiers, cascode amplifiers
Differential amplifiers
Output stage
MOS and BJT operational amplifiers

Course Projects:
Three to five projects will be assigned to you during this semester. The projects will sometimes include computer simulation problems using SPICE or MATLAB. You must use the transistor models associated with that specific project. Some projects need to be done individually and some need to be done in groups of two. The last project will be more comprehensive and has a higher grade percentage. We will be using CADENCE for IC layout, and will have tutorials to learn to use CADENCE layout.

Here are some further important details about the projects:

- You may discuss the questions in large groups, but each person must independently perform and write-up the required work unless indicated otherwise.

- MATLAB: We will use the computer program MATLAB for analyzing data; therefore your projects will require a simple understanding of MATLAB. We will use only a small fraction of MATLAB capability in this class.

- Format: For each project, you are required to develop a set of PowerPoint slides (or some other set of slides that can be viewed through a pdf viewer) that describe your methods, experimental results, simulation results, and regression data, and answers and solutions and explanations for the questions. One should use fonts that can be visible when projected. One should keep the number of slides to 15 or less. One should minimize the number of slides with only text (I would strongly prefer 0 slides in this case, other than a conclusion slide at the end). Results should be word-processed (no hand drawn / hand written materials / none scanned in).

- Your group will present to the class your results from this slide deck submitted to me. Clearly, after the first 1-2 presentations, it does not become as important to cover the problem statement (since others have), but rather look at the results, and differing approaches.

- Slides are due by email to me (mghovan@ece.gatech.edu) at 8 am on the day that they are due. This rule gives me time to organize the presentations on my laptop so we can be efficient for the presentations, as well as gives me a chance to take an early look at the
presentations to efficiently ask key questions. In the e-mail please identify your name (of all people in the project), as well as on the first slide, so I know who should get credit for the project. Projects handed in after this deadline and before the beginning of the class on the same day will be graded from 50% of the full grade. After the beginning of the class, no project will be accepted. This policy is firm, so do not fall behind! The work load will not get any lighter later in the semester.

- Only one set of slides / one presentation will be accepted per group. To help me archive the presentation files, please use this naming convention: LastName1_LastName2_ECE4430_F08.ppt
- There is no need to show any MATLAB code unless the project explicitly asks for it.
- Try to add a relevant title for each slide and add a brief description so that your slides would be self explanatory. Also try to add one or two slides at the end as a conclusion and what you have learnt out of that specific project.

**Reading Assignments:**

Reading assignments include sections of the textbooks, supplementary notes, and online articles that are relevant to the course topics. Class notes and supplementary notes, which topics may or may not be included in the textbook, will be posted on the class webpage and it is your responsibility to print them out and bring to the class with you. These materials will not be handed out during lectures. Students are responsible for both lecture material and reading assignments for the midterm, project, and final examinations.

**Homework:**

Homework will be assigned, as seen on the course webpage. The homework will include designs, hand calculations, and computer simulation problems using SPICE. The homework will not be collected, but you are expected and highly encouraged to complete the problems.

**Exams:**

- There will be three, closed book midterm examinations each of 50 minute duration.
- Rules of exam: One sheet of notes, last exam's sheet of notes, and a calculator.
- Each exam is basically cumulative: Every unit builds on all the previous units.
- Expect the unexpected: The exam will be over material covered in lectures (primarily), handouts, and in the textbook, but I reserve the right to make any / all problems not look like homework problems. I expect that you get the intuition of the key concepts from the homework. In the exam, you should be able to apply these concepts to slightly different problems.
- All grades become final one week after they are returned in class.

**Missed Exam:**

If you miss midterm exam or do not attend your project presentation without a certified medical excuse or my prior approval, a zero will be averaged into your grade. Certified excuses and prior approval will be dealt with individually. Generally, only one makeup exam will be held at a
designated time near the end of the semester and before the final exam. This means that there will be only one make-up test, independently from which exam/presentation you miss. Thus, the make-up test will be comprehensive. To request an excused absence, 1- write a formal letter to me (typeset), dated and signed, stating your specific request and the reason you are asking for an excused absence; 2- provide documentation supporting your request; 3- bring this letter and the documentation to me in person before the requested date (if an absence is foreseeable) or within one week after the absence (if it is of unforeseeable nature), at which time your request will be discussed. Special cases will be dealt individually.

**Academic Integrity:**

It is the responsibility of the instructor to encourage an environment where you can learn and your accomplishments will be rewarded fairly. Any behavior which compromises the basic rules of academic honesty as described in the General Catalog will not be tolerated. It is the instructor’s understanding that the student’s signature on any test or assignment means that the student neither gave nor received unauthorized aid. For more information: http://www.deanofstudents.gatech.edu/integrity/

**Disabilities:**

Reasonable accommodations will be made for students with verifiable disabilities. To qualify for these accommodations, students must register with Access Disabled Assistance Program for Tech Students (ADAPTS). For more information: http://www.adapts.gatech.edu/

**Grading Policy:**

- Midterms (3)  30%
- Projects (3)  40%
- Final  30%

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<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>A</td>
<td>90.0 – 100.0</td>
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<tr>
<td>B</td>
<td>80.0 – 89.9</td>
</tr>
<tr>
<td>C</td>
<td>60.0 – 79.9</td>
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<tr>
<td>D</td>
<td>50.0 – 69.9</td>
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<tr>
<td>F</td>
<td>0.0 – 49.9</td>
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**Auditing Criteria:**

To audit this course you will need to:

1- Attend all sessions
2- Do the projects

Basically you just do not need to participate in any of the exams. Everything else would be the same as taking the course for credit.
Course Schedule (Tentative):

<table>
<thead>
<tr>
<th>Exam/Project</th>
<th>Date</th>
<th>Time</th>
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</thead>
<tbody>
<tr>
<td>Evaluation Quiz</td>
<td>Friday 8/22/08</td>
<td>In class</td>
</tr>
<tr>
<td>Midterm 1</td>
<td>Monday 9/22/08</td>
<td>In class</td>
</tr>
<tr>
<td>Midterm 2</td>
<td>Friday 10/24/08</td>
<td>In class</td>
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<tr>
<td>Midterm 3</td>
<td>Monday 11/10/08</td>
<td>In class</td>
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<tr>
<td>Final</td>
<td>Tuesday 12/9/08</td>
<td>2:50 - 5:40pm</td>
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Notes: