ECE 4430: Analog Integrated Circuits
Fall 2023
Course Site: http://hasler.ece.gatech.edu/Courses/ECE4430/index.html
Time: T Th 2:00pm – 3:15pm
Professor Jennifer Hasler, jennifer.hasler@ece.gatech.edu
Office Hours: T Th 1:30p – 2:00pm, 3:15pm – 4:00pm

Course Objectives: Upon successful completion of this course, students should be able to

- demonstrate a mastery of transistor and circuit modeling understanding the design capabilities and constraints in an Integrated Circuit (IC) process.
- synthesize previous circuit knowledge towards design of analog and mixed-signal IC circuits with 1 to 100 transistors.
- design small to medium scale Analog and Mixed-Signal ICs that includes selecting circuit approaches, as well as simulating and laying out of that design.

Course Grading: Your grade will be determined using the following scheme:

	Projects (4)	Short Assignments
Option 1	95%	5%

Grades will be assigned on a curve; however, I will guarantee the following grades if you reach the following percentages: 89% for an A, 79% for a B, 60% for a C, and 50% for a D. Rarely does the line for a C or D move as a result of a curve; the curve for an A and B vary significantly between classes.

Textbook : **none** . There will be some reference materials available for those who feel more comfortable with a text. The material we need will be available on this site through on-line materials. I expect most in the class appreciate not having to buy yet another expensive textbook as well at this point.

Projects (Four): Projects are both analysis (earlier projects) as well as design (later projects), and can be based on experimental work, on experimentally measured results, on simulation (SPICE), and / or analysis.

IC Design Tools used throughout the semester: This course is an IC design course, focusing on the details of IC design. The impact of device parasitics on the overall system design is critical. You will be using open-source IC design tools for this course for the Skywater 130nm CMOS IC process. I will not be explicitly teaching these tools as part of the class, although I will point out tutorials and there will occasionally be some additional information.

Simulation Model: You will be building up your simulation model in your first project, and potentially improving it throughout the semester. You must use the EKV model (for MOSFETs) available in SPICE; other models will not be acceptable. Other models will often give incorrect results. If you use another model you will get no credit for that part of the assignment; this policy is firm, so don't test whether you will get away with an option.

Working in groups of two: You will work on your projects in groups of two. To form these groups, I give you two options. First, you can choose grouping on your own. Second, I can choose a partner for you. You may change partners between projects, but not during an individual project. I will probably change partner groups sometime, at least once. You may discuss the questions in large groups, but each group must independently perform and write-up the required work. I reserve the right to increase the number in a group if I see a need. Any such points will be clearly communicated during class.

Each Student has a Laptop: Remember GT policy is that everyone has a laptop of a given capability. You will need it throughout this semester.

- **Project Analysis:** will be done in MATLAB or equivalent (e.g. Scilab) type language for data analysis and plots (not excel). We do not need to see your MATLAB code, unless explicitly asked for. Circuits must be drawn and presented in a way that is clear to see (e.g. no Cadence schematics, xschem would be acceptable). If you are not sure, you must ask me before the submission is due. Each group might be somewhat different in terms of their particular project, which enables everyone in the class to see some different situations / cases.

Project submission: we will require the following procedure that we will use to grade projects:

- **Deadlines are hard**: You need to complete all required items for the project, which will include analysis, experimental measurements, some system level modeling, and data analysis. Projects handed in after this deadline will not be accepted.
- **Project Writeup** : You will have one writeup, which must be word-processed, two-column IEEE format with data figures integrated into the text. You may not have your data figures added to the end of the writeup. You will submit the writeup as a .pdf file, and only as a .pdf file. You should integrate data and analysis together on your submitted plots. For example, if you perform a curve fit, I expect the curve fit and the data to be on the same graph, where the data points would be in point markers (e.g. "o"), and the curve fit would be a straight line. The plots need to be MATLAB style plots (MATLAB, scilab, python MATLAB), and not other non-technical forms (e.g. Excel). Do not submit your MATLAB code to generate the plot. Your writeup is limited to 9 pages including references and figures. Submit only one writeup per group of two individuals. **Make sure both names are on the document**.
- *Extensions on due dates will not be granted unless there is a very compelling reason* (e.g., a medical problem by everyone in the team). To get an extension, you must talk with me before the due date.

Short Assignments: There will be a few short assignments throughout the semester. One purpose of these assignments is making sure everyone is mastering the material due to group projects. One purpose of these in-class assignments is to verify everyone will have completed the video watching and/or reading assignments before the class they are assigned. The questions could be a wide range of things, including working out an example problem in class, answering some simple objective questions, etc, and could happen anytime during class. Obviously, this approach means you want to be at the start of every class. Part of this item will help evaluate general class participation as part of your grade.

Class Schedule: Projects will consist of analytical problems, design problems, as well as our final design project. Lectures will closely correspond to the projects that we are working on that week.

Key Schedule Elements	Date Due
Project #1: MOSFET device modeling & SPICE & layout parasitics	Sept 10
Project #2: MOSFET Transistor Circuits and Transconductance Amplifiers	Oct 6
Project #3:Stability, programmability, references, and further amplifier design	Nov 3
Project #4: Analog System Design	Dec 1

Days off: Sept 4, Fall Break (Oct 9, 10), Nov 24-26
Last Day of Normal Class: Dec 2

Attendance: Students are responsible for all material covered in class, including changes in project schedules announced in class. The easiest way to do poorly in my class is to skip class or not pay attention while in class; conversely, paying attention to class material strongly correlates with higher grades. Further, I will not take up class time to review information that students have missed because of being excessively late.

No photography, filming, or recording in class: I wish to minimize distractions in the class, as well as make the class an open place for discussion. I will take pictures of all whiteboards and put them on-line for you. Any other visuals used in class I will also make available electronically.

Academic Honesty: Although students are encouraged strongly to work together to learn the course material, all students are expected to complete projects (in the respective groups) individually, following all instructions. You may discuss project questions in large groups, but each group must independently perform and write-up the required work for each project.

All conduct in this course will be governed by the Georgia Tech honor code. Additionally, it is expected that students will respect their peers and the instructor such that no one takes unfair advantage of anyone else associated with the course. Any suspected cases of academic dishonesty will be reported to the Dean of Students for further action.

Student Outcomes: Primary and Moderate outcomes of course components

1. (Primary) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. (Primary) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
3. (Primary) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
4. (Moderate) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
5. (Moderate) an ability to communicate effectively with a range of audiences
6. (Moderate) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

I want to make sure my health related policies are clear, and aspects might change depending on how health issues progress throughout the semester:

- If you are sick, DO NOT COME to class. Seriously, just don't do it.
- If you can not come to class, please email me so we know everyone in the community is safe.
- Each person should do what you need to do for your own physical health.
- There are recorded lectures to watch before class. I will not record our sessions. I plan to record shorter versions of what we cover during class time and make those available.