

ECE511: Analog Electronics

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Course web page: <http://courses.ncsu.edu/ece511/>

*****Please use the course bulletin board** to ask questions about lectures, HW, projects, etc. It is the best way to broadcast questions that may be of interest to everyone.

Required text:

Paul R. Gray and Robert G. Meyer, *Analysis and Design of Analog Integrated Circuits*, 4th edition, Wiley.

Supplemental references (not required, but very helpful):

- Behzad Razavi. *Design of Analog CMOS Integrated Circuits*. McGraw-Hill. (on reserve at DH Hill Library)
- Phillip E. Allen and Douglas R. Holberg. *CMOS Analog Circuit Design*. 2nd Edition. Oxford University Press. (1st edition on reserve at DH Hill Library)
- David A. Johns and Ken Martin, *Analog Integrated Circuit Design*. Wiley.

Prerequisite: Senior-level undergraduate analog circuit course covering dc and small-signal analysis of simple bipolar (BJT and/or HBT) and CMOS amplifier circuits including two-stage amplifiers and op-amp compensation concepts.

Course objectives: After taking this course, the student should be able to analyze, simulate, and design single and multistage amplifiers. Design of single, multistage, and op-amp amplifier are covered in detail including analysis of biasing techniques, frequency response compensation, feedback, stability, noise, and nonlinearity. An introduction to advanced analog techniques is presented including topics on PLL, VCO, data converters (ADC/DAC), mixer/multipliers, and switch capacitor circuits.

Grading:

20% Midterm

20% Final exam

20% HW – Problems and SPICE simulation exercises

40% Design Project – Paper design with formal write up with simulation results

The following cutoffs (inclusive) will be used for letter grades: A+: 97%, A: 93%, A-: 90%, B+: 87%, B: 83%, B-:80%, C+: 77%, C: 73%, C-: 70%, D+: 67%, D: 63%, D-: 60%.

Audit Students: Students officially auditing this course are required to earn an average grade of B or higher on HW assignments and the design projects. Assignment due dates are the same schedule as the class (no exceptions). Audit students are not required to take the midterm and final exams.

Exams: There will be two major exams: a midterm and final exam. These will be closed book and closed notes. For the midterm, you are allowed to bring a single 8 ½" x 11" sheet with any information you wish on both the front and back of the page. For the final exam, you may bring no more than two 8 ½" x 11" sheets with any information you wish on both the front and back of the page.

Simulation: SPICE based circuit simulation will be used extensively in the homework and projects. Students are to use the Cadence design environment and the Spectre SPICE based circuit simulator. Course workspace will be set up for you to work on your simulations and project designs.

Design Project: The design project is an individual project where a circuit is designed to a set of specifications. Students are encouraged to discuss issues and ideas amongst each other, but each design must reflect the work of each individual. Project grading will come from both the *quality* and *content* of the report and the *performance of the design* against the specifications (additional details will be provided in the assignment).

Students with Disability: Reasonable accommodations will be made for students with verified disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 515-7653, http://www.ncsu.edu/provost/offices/affirm_action/dss. For more information on NC State's policy on working with students with disabilities, please see Appendix K of the Handbook for Advising and Teaching (<http://www.ncsu.edu/provost/hat/current/index.html>).

Academic Integrity: Students should refer to the University policy on academic integrity found in the Code of Student Conduct (found in Appendix L of the Handbook for Advising and Teaching). It is the instructor's understanding and expectation that the student's signature on any test or assignment means that the student neither gave nor received unauthorized aid. Unauthorized aid includes, but is not limited to, providing or receiving information in written or electronic format (email, file sharing, etc.), and will be treated as a violation of academic integrity.

Outline of ECE511: Analog Electronics

Topic	References
Introduction to Analog Design	Notes
Basic CMOS device physics, modeling, and technology (select material)	1.5 - 1.9 & 2.8 - 2.10
Current mirror biasing	4.2 (MOS)
Voltage and Current References	4.4
Single stage amplifiers, active loads, differential amps	3, 4.3
Output Stages	5.3 & 5.5
Amplifier frequency response	7.1 - 7.3
Op Amps: Single Ended, Fully Differential, CMFB	6 & 12
Stability, Compensation, Slew Rate	9.1 - 9.4, 9.6
Feedback Analysis and Circuits	8.1 - 8.5
Noise	11.1 - 11.5
Advanced Analog Concepts	Notes