ECE/CS 5720: Analog Integrated Circuit Design

Credits and Contact Hours: 3.0 Credit Hours
15 weeks: Two 80-minute lectures per week

Instructor’s Name: Ross Walker

Text Book(s) and/or Required Material:

Catalog Description: Design of analog and mixed-signal CMOS integrated circuits. Fundamental building blocks for analog circuits, including the basic principles of op amp, current mirror, and comparator design. The basics of sample-and-hold circuits. Students complete integrated circuit design, simulation, layout, and verification using computer-aided design tools.

Prerequisites:
- C- or better in ECE 3110: Engineering Electronics II; and
- Full major status in Computer Engineering

Designation: Elective

Contribution of Course to Meeting the Requirements of ABET Criterion 5: This course teaches electrical engineering analysis, design, simulation, and some electrical engineering science.

Specific Outcomes of Instruction: The course seeks to cultivate proficiency in using elementary single- and two-transistor stages commonly used in amplifiers, comparators, sample-and-hold circuits, etc. Students should learn the fundamentals of feedback and electronic noise, and the basics of $g_m/I_D$ design methodology. The course seeks to bridge the gap between analysis and design through “design-oriented analysis techniques”. Students should learn to perform simulation, design, and optimization using Cadence and MATLAB (no layout or verification).

Relationship of the Course to the Program Outcomes:
(a) An ability to apply knowledge of mathematics, science, and engineering. Students apply fundamental concepts learned earlier, including circuit analysis, small-signal models of nonlinear elements, and Bode plots. Students apply this background knowledge and material learned in the course, especially when solving homework problems.

(b) An ability to design and conduct experiments, to analyze and interpret data, and to debug and analyze software. Circuit design projects require students to design and conduct simulation experiments to prove their circuit meets specifications. They must analyze and
interpret the data returned by the circuit simulator. They must also propose a method for testing their final design project.

(c) An ability to design a system, component, process or software package to meet desired needs. The course culminates in a 3-week design project where students must design a transistor-level circuit to meet provided specifications. The students optimize their designs to minimize power consumption of the circuitry.

(e) An ability to identify, formulate, and solve engineering problems. Both standard homework assignments and the final design project require problem solving. We spend ~33% of class time solving example problems, taking quizzes, and doing in-class exercises.

(g) An ability to communicate effectively in written and oral form. The design project requires a written report in IEEE 2-column format.

(i) A recognition of the need for, and an ability to engage in life-long learning. The course exposes students to the scale and complexity of modern integrated circuits, and professional options in the areas of design, test, and manufacturing are discussed to motivate the need for continued education.

(j) A knowledge of contemporary issues. We invite a guest speaker from a local integrated circuit design company to give a class lecture on “real world” engineering.

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. Students make extensive use of the Cadence CAD tool suite. They use Cadence and MATLAB for analog circuit design and simulation, through the homeworks as well as the final design project.

Topics Covered in the Course:
- Elementary single- and two-transistor stages commonly used in amplifiers, comparators, sample-and-hold circuits, etc.
- Fundamentals of feedback and electronic noise
- Basics of gm/ID design methodology
- Design-oriented analysis techniques
- Simulation, design, and optimization
- Cadence tools
- MATLAB