ECE 4/521: Analog Integrated Circuit Design I

Catalog Description

Modeling of IC devices: transistors, capacitors, resistors. Temperature and device parameter variation effects. Building blocks of analog integrated circuits: current sources and mirrors, gain stages, level shifters, and output stages. Design of supply and temperature independent biasing schemes. CAD tools for circuit design and testing. Also offered for graduate-level credit as ECE 521 and may be taken only once for credit.

Credit hours: 4

Goals

To learn and be able to apply modern methods and tools for analog integrated circuit design.

Prerequisites

ECE 323

Course Coordinator and Committee

Branimir Pejčinović (coordinator)
David C. Burnett
Malgorzata Chrzanowska-Jeske
Yuchen Huang
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Textbooks

Analysis and Design of Analog Integrated Circuits, Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, J. Wiley and Sons, 2009, ISBN 978-0470245996, 5th Ed.

The course instructor may choose to use a different textbook. Please check with your instructor before purchasing.

Other References

The Art of Electronics, 3rd Edition, Paul Horowitz and Winfield Hill, Cambridge, 2015, ISBN 978-0521809269.

Reference materials may vary with instructor.

Learning Outcomes

At the end of this course, students will be able to:

1. Analyze and design integrated circuits such as differential amplifiers, two-stage opamps, voltage references, and oscillators.
2. Analyze the operation of BJT and/or MOSFET transistors.
3. Describe the simulation models and parameters for BJT and/or MOSFET transistors.
4. Analyze and design multi-device gain stages in bipolar and/or MOS technologies. Demonstrate the ability to analyze and design current sources and active loads in bipolar and/or MOS technologies.
5. Analyze and design and build an individual analog project reference circuit.
6. Present a circuit design project in a written report.

Topical Outline

- Opamp design, modeling, and applications. Opamp characteristics; opamp models; Basic configurations; Active filters; Nonlinear applications; Balanced differential applications.
- CAD simulation tools. The SPICE environment and modification of models.
- IC device models. Junction characteristics; Bipolar transistors: physics, modeling and BJT SPICE parameters; MOSFET transistors: physics, modeling and SPICE parameters; Passive components in integrated circuits.
- Gain stages. Basic gain stages; differential gain stages; differential and common-mode characteristics; gain stages with active loads; frequency response.
- Current sources and active loads. Current sources; Active loads; Supply-independent biasing; Temperature-independent biasing.

Course Structure

The class meets for four hours of lecture each week. The grade is based on a quizzes, a project, and exams. For details of the grading criteria, please see the syllabus provided by your instructor.

Relevant Student Outcomes

The following program outcomes are supported by this course:

(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

(3) An ability to communicate effectively with a range of audiences

(4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

(5) 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

(6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

(7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Prepared By: David Burnett

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