ECE 4021: Analog Integrated Circuits I

Course Description

Fundamentals of analog integrated circuits. CMOS transistors and diodes large-signal and small-signal operation and modeling. On-chip passive components operation and modeling. Simple and advanced current mirrors, single-ended and differential CMOS amplifiers, CMOS OTAs and Op-Amps. Integrated Circuits Fabrication, Packaging, and Testing.

Transcript Abbreviation: Analogs ICs 1
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Undergrad
Student Ranks: Junior, Senior
Course Offerings: Autumn
Flex Scheduled Course: Never
Course Frequency: Every Year
Course Length: 14 Week
Credits: 3.0
Repeatable: No
Time Distribution: 3.0 hr Lec
Expected out-of-class hours per week: 6.0
Graded Component: Lecture
Credit by Examination: No
Admission Condition: No
Off Campus: Never
Campus Locations: Columbus
Prerequisites and Co-requisites: Prereq: 3020.
Exclusions: Not open to students with credit for 5021.
Cross-Listings:

Course Rationale: This course is essential for filling in the huge topic coverage gap between 3020 (block level electronics) and 5021 (analog integrated circuits).

The course is required for this unit's degrees, majors, and/or minors: No
The course is a GEC: No
The course is an elective (for this or other units) or is a service course for other units: Yes

Subject/CIP Code: 14.1001
Subsidy Level: Baccalaureate Course

Programs

Abbreviation	Description
CpE	Computer Engineering
EE	Electrical Engineering

General Information

Our undergraduate students suffer from lack of exposure to analog integrated circuits until 5021. Analog integrated circuits is quite extensive and a single grad/undergrad course is insufficient for adequate coverage of the topic. 3020 focuses mainly on block level electronics without any integrated circuits component. Therefore, 4021 id designed to fill in the huge gap between 3020 and 5021.

Course Goals

Master the voltage and current characteristics of on-chipresistors, capacitors, and transistors
Master conducting large-signal and small-signal analysis of integrated CMOS transistors, current mirrors, and amplifiers
Be competent in the design and analysis of various classes of current mirrors and amplifiers
Be competent in the use of modern integrated circuit design CAD tools, such as CADENCE
Be competent in performing AC, DC, and Transient analog circuit simulations
Be competent in writing design reports
Be familiar with the integrated circuit physical structure, fabrication flow, and layout

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Introduction to analog signal processing and analog integrated circuits technology	2.0							
Integrated circuits physical structure and interconnects	3.0							
Integrated Circuits layout and CAD flows	2.0							
Diodes operation and modeling	2.0							
CMOS transistors large-signal operation and modeling	3.0							
CMOS transistor small-signal operation and modeling	5.0							
CMOS current sources and mirrors	4.0							
CMOS single-ended amplifiers	6.0							
CMOS differential pairs	2.0							
CMOS Single-ended OTAs and Opamps	4.0							
On-chip passive components in integrated circuits	3.0							
Integrated circuits fabrication flow, packaging, and testing	3.0							

Representative Assignments

HWs and HW-based short quizzes
Cadence design/simulation final project of CMOS current mirrors and amplifiers
Comprehensive written report on the assigned design project

Grades

Aspect	Percent
HWs and/or HW-based quizzes	10%
Two Midterm Exams	60%
Final Project/Report	30%

Representative Textbooks and Other Course Materials

Title	Author
Analog Integrated Circuit Design	T. Carusone, D. Johns, and K. Martin
CMOS Circuit Design, Layout, and Simulation (Recommended)	R. J. Baker

ABET-EAC Criterion 3 Outcomes

Course Contribution		College Outcome
**	a	An ability to apply knowledge of mathematics, science, and engineering.
**	b	An ability to design and conduct experiments, as well as to analyze and interpret data.
**	c	An ability to design a system, component, or process to meet desired needs.
*	d	An ability to function on multi-disciplinary teams.
**	e	An ability to identify, formulate, and solve engineering problems.
*	f	An understanding of professional and ethical responsibility.
*	g	An ability to communicate effectively.
*	h	The broad education necessary to understand the impact of engineering solutions in a global and societal context.
*	i	A recognition of the need for, and an ability to engage in life-long learning.
*	j	A knowledge of contemporary issues.
**	k	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

CpE ABET-EAC Criterion 9 Program Criteria Outcomes

Course Contribution		Program Outcome
**	1	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
*	2	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
*	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

EE ABET-EAC Criterion 9 Program Criteria Outcomes

Course Contribution		Program Outcome
**	1	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
*	2	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
*	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

Course Contribution		Program Outcome
**	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

Additional Notes or Comments

Created this course with the original coverage of 5021, and updated 5021 to advanced analog coverage.

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