ECE 5227: Fundamentals of Power Management Integrated Circuits for VLSI Systems

Course Description

Theory, design and applications of integrated power management integrated circuits in VLSI systems. This includes: system and circuit architectures, performance metrics, practical implementations, design considerations in VLSI systems in advanced CMOS processes, and design techniques for integrated power regulators and battery chargers. Background in basic analog design is strongly recommended.

Transcript Abbreviation: Power Mangmnt ICs
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Undergrad, Graduate
Student Ranks: Senior, Masters, Doctoral
Course Offerings: Spring
Flex Scheduled Course: Never
Course Frequency: Every Year
Course Length: 14 Week
Credits: 4.0
Repeatable: No
Time Distribution: 3.0 hr Lec, 2.0 hr Lab
Expected out-of-class hours per week: 7.0
Graded Component: Lecture
Credit by Examination: No
Admission Condition: No
Off Campus: Never
Campus Locations: Columbus
Prerequisites and Co-requisites: Prereq: 4021 or 5021, or permission of instructor.
Exclusions:
Cross-Listings:

Course Rationale: Address the pressing demand for engineers with solid knowledge and understanding of

power management integrated circuits for VLSI systems.

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: Doctoral Course

Programs

Abbreviation	Description
CpE	Computer Engineering
EE	Electrical Engineering

Course Goals

Learn the various power conversion and regulation schemes in VLSI systems and mixed-signal SoCs and the latest industrial trends and challenges pertaining to integration and silicon technologies.

Learn power management integrated circuits specifications and performance metrics.
Learn the fundamental design techniques and performance tradeoffs of integrated power regulators in VLSI systems.
Apply the acquired theoretical knowledge to perform a class project that involves the implementation of an integrated power regulator in a selected CMOS technology.
Learn how to perform lab characterization of various power management integrated circuits.

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Basic definitions, main tasks of power management systems, challenges facing the implementation of power management circuits in VLSI systems, power distribution schemes in mixed-signal SoCs, typical load types.	3.0							
Performance metrics of power management circuits.	4.5							
Steady-state operation of step-down power regulators.	3.0							
Voltage-mode control techniques of step-down power regulators.	1.5							
Small-signal modeling and compensation techniques for step-down power regulators.	5.5							
Current-mode and other control techniques for step-down power regulators.	4.5							
Loss mechanisms and modeling in power regulators.	4.0							
Implementation examples of step-down power regulators.	1.5							
Steady-state operation and small-signal modelling of step-up (boost) power regulators.	4.0							
Buck-boost, forward, and fly-back power regulators.	3.0							
Battery chargers	4.5							
Introduction to lab characterization of power management integrated circuits			8.0					
Lab characterization of integrated linear regulators			6.0					
Lab characterization of step-down switching regulators			6.0					
Lab characterization of step-up switching regulators			6.0					

Representative Assignments

Homeworks
Midterms
Lab Report
Final Design Project

Grades

Aspect	Percent
Homeworks	20%
Midterms	40%
Lab Report	10%
Final Design Project	30%

Representative Textbooks and Other Course Materials

Title	Author
Fundamentals of Power Electronics	Robert Erickson and Dragan Maksimovic
Switch-Mode Power Supplies: Spice Simulations and Practical Designs	Christophe Basso
Designing Control Loops for Linear and Switching Power Supplies	Christophe Basso

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.

Additional Notes or Comments

Updated text info, 12/9/15, ced.

Edited text info, 5/10/17, CED

Updated the pre-req and corrected the title

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