EEC 289O - Integrated Circuit Design for Power Electronics

Lecture: TR 9-10:20
Bainer 1134

Instructor: Rajeevan Amirtharajah
Professor
3173 Kemper Hall
(530) 341-2522
ramirtha@ucdavis.edu

Web Page: Access course webpage through UC Davis Canvas.

Office Hours: TBD

Prerequisites: EEC 210

Grading: Letter (A: 100-90%, B: 90-80%, C: 80-70%, D: 70-60%, F: below 60%)
Midterm 25%
Homework 10%
Design Project #1 15%
Design Project #2 20%
Final Exam 30%

There will be a few homework assignments, two design projects, one midterm exam, and one final exam. The midterm exam will be held in class on a date to be determined. The final exam will occur during the final exam period. Homework problems will be graded on a four-point effort scale: 1 point for an attempt or poor effort, 2 points for major errors or fair effort, 3 points for a nearly correct answer and strong effort, and 4 points for a correct answer.

Collaboration: You may discuss issues with other students on design projects, but you must design your own circuit and circuit test bench and perform your own simulations. Each student must turn in their own circuit design and project writeup. If you choose to discuss the project with other students, each student must list all of his/her colleagues who participated in any discussion(s) on the first page of their homework. Final projects will be done individually or in groups of at most two.

Late Design Projects: Design projects will be submitted via Canvas. Twenty-five percent of the total points are deducted for each day the submission is late, until the assignment is worth 0 points four days after the official due date.

Curves: No curves on design projects. Exams will be graded on a curve if the class performance warrants it, and the curve will only improve your grade.

Extra Credit: No individual extra credit. Instructor might offer an extra credit assignment to the entire class, but only if absolutely necessary.

MS Plan II Project Extension: Course projects can be extended into projects that can be used to satisfy MS Plan II degree requirements on a case-by-case basis, with approval by the instructor.

Course Description: IC design for power electronics. Linear and switching regulation. Integrated power management. DC/DC and AC/DC conversion. Applications in portable electronics and wireless sensors.

Course Outline:

I. Overview of Power Electronics

   A. Linear Regulation
   B. Switching Regulation
   C. Analysis Methods

II. Linear Regulators

   A. Simple Diode Regulator
   B. Low Dropout Regulator
   C. Shunt Regulator
   D. Series-Shunt Regulators

III. Switched-Capacitor DC/DC Converters

   A. Series-Parallel Architectures
   B. Charge Pumps
   C. Switched Capacitor Converter Optimization
   D. Application: Integrated Dynamic Voltage Scaling

IV. Inductor-Based DC/DC Switching Converters

   A. Buck Converter
   B. Boost Converter
   C. Buck-Boost Converter
   D. Switching Converter Optimization
   E. Analog and Digital Feedback Control
   F. Application: Photovoltaic and Thermoelectric Energy Harvesting

V. AC/DC Conversion

   A. Rectifiers
   B. Flyback Converters

C. Application: RF Energy Harvesting

VI. Power Devices

A. Thyristors

B. Insulated-Gate Bipolar Transistors

C. GaN Power FETs

Reading:

1. Most material will be from classic and recent research papers on power electronics design.

Reference Material:

1. Erickson, R. and Maksimovic, D., *Fundamentals of Power Electronics*, 2nd ed.
2. Kassakian, J., Schlecht, M., and Verghese, G., *Principles of Power Electronics*.

Lecture	Date	Title
1	01/08/19	Power Electronics Overview
2	01/10/19	Overview (cont.)
3	01/15/19	Linear Regulators Overview
4	01/17/19	Diode Regulator
5	01/22/19	Low Dropout Regulator 1
6	01/24/19	Low Dropout Regulator 2
7	01/29/19	Shunt and Series-Shunt Regulators
8	01/31/19	Switched-Capacitor Converters
9	02/05/19	Series-Parallel Converters
10	02/07/19	Charge Pumps
11	02/12/19	Switched-Capacitor Converter Optimization
	02/14/19	Midterm
12	02/19/19	Integrated Dynamic Voltage Scaling
13	02/21/19	Inductor-Based Switching Converters
14	02/26/19	Buck, Boost, and Buck-Boost Converters
15	02/28/19	Switching Converter Optimization
16	03/05/19	Feedback Control
18	03/07/19	Rectifiers and Flyback Converters
18	03/12/19	RF Energy Harvesting
19	03/14/19	Power Devices
20	Optional	Thermal Management
	03/20/19	Final Exam