ECE 4/545: Power Electronics Systems Design I

Catalog Description

Basic DC-to-DC switching converter topologies are presented. Operation in various modes is examined. Steady state design is undertaken using state space techniques and equivalent circuit modeling. Design issues concerning semiconductor devices and magnetics design are also addressed.

Also offered for graduate-level credit as ECE 545 and may be taken only once for credit.

Credit hours: 4

Goals

Students build on the knowledge of electronic devices gained in ECE 321 and ECE 322 to understand the basic operation of dc power electronic converters. We emphasize on using mathematical tools to develop the analytical skills to analyze simple switching circuits and develop the capability to derive their modulation approaches. We also explore simple ac switching circuits and silicon-controlled rectifier circuits.

Course Coordinator and Committee

David C. Burnett (Coordinator)
Malgorzata Chrzanowska-Jeske
Mahima Gupta
Melinda Holtzman
Richard Tymerski

Textbooks

Power Electronics: A First Course, Ned Mohan, Wiley, 2011, ISBN 978-1-118-21526-5

Fundamentals of Power Electronics, R.W. Erickson and D. Maksimovic, Kluwer Academic Publishers, 2001, ISBN 0-7923-7270-0, 2nd.

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

Prerequisites

ECE 322

Learning Outcomes

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

1. Understand and apply Volt/sec. and charge balance for steady-state and ripple analysis
2. Understand and apply state space averaging modeling technique
3. Understand and apply equivalent circuit modeling of power conversion systems
4. Understand operating modes power conversion systems
5. Understand and identify power converter topologies including non-isolated and isolated DC-DC converters, DC to single-phase AC converters, DC to three-phase AC converters and SCR circuits.
6. Power converter prototype construction and software simulation

Topical Outline

- Basic high switching frequency power converter topologies
- Steady state and ripple analysis using volt-second and charge balance
- State space analysis, state space averaging dc model
- Power loss, component parasitics
- Averaged circuit modeling
- Converter operating modes
- Introduction to single feedback loop control for power regulators
- Analysis of DC-AC converters and SCR converters using the concepts from DC-DC converter analysis.

Course Structure

Two 110 minute lecture periods per week. Weekly reading and homework assignments.

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

(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: Richard Tymerski

Updated: 04/05/2023