ECE 4/546: Power Electronics Systems Design II

Catalog Description

Dynamic analysis of DC-to-DC converters is presented using state space techniques and the method of equivalent circuit modeling of the switching device. Different control techniques such as current programming and sliding mode control are introduced. Inverter and input current wave shaping rectifier circuits are also introduced.

Also offered for graduate-level credit as ECE 546 and may be taken only once for credit.

Credit hours: 4

Goals

Students build on the knowledge of electronic devices gained in ECE 445 to study more complex power electronic converters. We emphasize on using mathematical and analytical skills to understand and analyze various power electronic switching circuit topologies, develop their modeling as well as control approaches, and understand the design guidelines and performance metrics of several power electronic converter 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 445/545

Learning Outcomes

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

1. Understand and apply state space averaging small-signal modeling
2. Apply asymptotic Bode plots to converter controller design
3. Understand and apply algebra on the graph
4. Feedback loop design using lead, lead-lag, and PID compensation
5. Multi-loop feedback design
6. Prototype construction and software simulation

Topical Outline

- AC small signal modeling of switching power converters
- Circuit modeling
- Feedback design
- Bode plots
- Multi-loop control, current programming, droop control
- Upcoming power converter topologies and their modulation approaches including modular multilevel converters, matrix converters, and switched capacitor converters.
- Power electronics in the context of applications including power flow control, electric drives, and regulated DC power supplies.

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.

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