**Course Number and Title**

ECE/ENRGYEGR 431/531: Power Electronic Circuits for Energy Conversion

**Classes**

Spring 2020; Time: TTh 03:05 – 04:20 pm; Location: Fitzpatrick 1411

**Instructor**

Angel V. Peterchev, PhD
E-mail: angel.peterchev@duke.edu

**Description**

Efficient conversion and conditioning of electrical energy is a critical enabling element in modern electronic systems spanning portables (smart phones, tablets, and laptops), medical devices (implants, prostheses, imaging scanners, non-invasive stimulation systems), servers and data centers, electric and hybrid vehicles, alternative energy generation (wind and solar), as well as the electrical power grid and microgrids.

This course provides an introduction to circuit analysis and design of switched-mode power converters for advanced undergraduate and graduate students. The first part of the course treats basic circuit operation, including steady-state converter modeling and analysis, switch realization, and transformer-isolated converters. Next, converter control systems are covered, including ac modeling of converters using averaged methods, small-signal transfer functions, and feedback control design. Finally, magnetics design for switched-mode applications is discussed, including: basic magnetics, the skin and proximity effects, inductor design, and transformer design.

The 531 course shares lectures with 431, but has extended content of some assignments and the exams.

**Prerequisites**

ECE 230L or EGR 224L or graduate student standing.

**Grading**

40% Homework
25% Midterm
35% Final

**Text**

**Required**

Erickson, R. W. and Maksimovic, D. *Fundamentals of Power Electronics*. Second Edition. Springer, 2001. ISBN: 9780792372707.

**Website**

Duke Sakai: https://sakai.duke.edu/portal/site/ce7d30fc-97ce-4489-a003-4780aec5544b

**Material Outline**

I. Converters in Equilibrium
   1) Principles of Steady State Converter Analysis
   2) Steady-State Equivalent Circuit Modeling, Losses, and Efficiency
   3) Switch Realization
   4) The Discontinuous Conduction Mode
   5) Converter Circuits

II. Converter Dynamics and Control
   1) AC Equivalent Circuit Modeling
   2) Converter Transfer Functions
   3) Controller Design

III. Magnetics
   1) Basic Magnetics Theory
   2) Inductor Design
   3) Transformer Design