EEE598 ST: Power Electronics Applications in Power Systems

Spring 2008

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Class: SCOB 105 (also on internet) MW 10:40 – 11:55 AM

Description: Power electronics applications in power systems are growing very rapidly and promise to change the landscape of future power systems in terms of generation, operation and control. This course focuses on three important application areas – renewable and distributed generation (DG), flexible AC transmission systems (FACTS) and custom power/power quality. It is widely accepted that distributed generation is a very important energy option in the near future. Most of the distributed energy resources, including all the renewable resources, require a power electronic converter to interface with the load and utility. FACTS are important to precisely control power flow along transmission lines and to significantly increase power flow in existing lines without violating stability limits. In power distribution systems, power electronic converter based solutions are critical in meeting the power quality and reliability demanded by digital age loads. This course will focus on the operating principles, models, control and design of power electronic systems used in these applications.

Pre-requisite: Open to electrical engineering graduate students. Basic understanding of power conversion, power systems analysis and familiarity with either MATLAB/Simulink or PSpice are assumed.

Textbook: None. Lecture notes will be provided for selected topics.

Reference: Research papers in Power Electronics and Power Systems journals.
N.G. Hingorani, L. Gyugyi, "Understanding FACTS: Concepts and technology of flexible AC transmission systems," Wiley-IEEE press, 1999

Major topics:

- **High power converters**
  Topologies including multi level and matrix converters, PWM techniques including space vector PWM, modeling and control techniques, high power devices, design methods
- **Distributed Generation (DG)**
  Power electronic inverters for interfacing PV, fuel cells and micro turbines with utility, power converters for wind energy systems, PWM and control techniques, interconnect issues and standards, effect of DG on power distribution systems
- **Flexible AC Transmission Systems (FACTS)**
  Concepts of power flow control and power system stability, PWM converter based FACTS devices - STATCOM, static phase shifters, SSSC and UPFC, modeling and simulation of FACTS devices
- **Applications in Power Distribution Systems: Power Quality, Reliability and Security**
  Concept of custom power, Dynamic voltage restorers (DVR), D-STATCOM, uninterruptible power supplies, active filters, solid state circuit breakers.

Student Project: Students take up a specific DG interface, FACTS or custom power device, perform literature search, complete analysis, model and design, and finally validate in a detailed simulation of a simple system. Students may choose to concentrate more on power electronics or power systems aspects depending on their background and interests. Two project reports (midterm and final) are required.

Grading:
Project 50%, Homework 20%, Final exam 20% and Class/online participation 10%