EE 582
Power System Applications of Power Electronics

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School of Electrical Engineering and Computer Science
Tuesday, August 21, 2012
Course Information

**Lectures**
- Tuesdays and Thursdays from 12:05 PM to 1:20 PM

**Office Hours**
- Wednesdays from 10:00 AM to 11:00 AM

**Course Website**
- [http://eecs.wsu.edu/~mehrizi/ee582](http://eecs.wsu.edu/~mehrizi/ee582)
Course Overview

- **Instructor**: Prof. Ali Mehrizi-Sari
- **Email**: mehrizi@eecs.wsu.edu
- **Office**: EME 35
- **Phone**: (509) 335-6249
- **Fax**: (509) 335-3818
- **Lecture Room**: SLOA 163
- **Lecture Hours**: Tuesdays and Thursdays from 12:05 pm to 1:20 pm (note we start 5 minutes after the hour to allow you sit through Tuesday seminars)
- **Course Website**: [http://eecs.wsu.edu/~mehrizi/ee582](http://eecs.wsu.edu/~mehrizi/ee582)
- **Office Hours**: 
  - Wednesdays from 10:00 am to 11:00 am; or
  - Email me for an appointment with "EE 582" in the subject line.

This course discusses the applications of power electronics for the smart grid focusing on the flexible AC transmission system (FACTS devices). EE 582, in general, discusses HVDC transmission, static compensation, and series and shunt filters. This course will also discuss modeling and control of such devices. The goals of this course are to introduce you to (i) power electronics converter used in high power applications, (ii) applications of power electronics in the smart grid; and (iii) study analysis, modeling, and control methods employed for power electronics.

Course Outline

All information about the course, including the marking scheme and textbook, are included in the following PDF file: [here](#).

Course Documents

- **Course Outline**: [here](#)
Required Background

- **EE 486 Power Electronics**
  - Basics of analysis techniques for power electronic converters. I will do a quick review of EE 486 at the beginning of the semester

- **EE 491 Power Systems**
  - Basics of power system analysis including power flow and VAr compensation

- **PSCAD/EMTDC**

- **MATLAB/SIMULINK**
Textbook

References


My Name

Ali MEHRIZI-SANI

Second

High

From an area called Mehriz, named in honor of the daughter of one of the emperors of Persia.
Power Electronics for Smart Grid

S. Filizadeh, et al, Power system transients, J. Martinez, ed., Chapt. 9
Microgrids and Integration

Building Block of Smart Grid

R. Erickson, PESC'09
Converter Classification

Grand Unification Theory of Power Electronics

- **DC-DC Conversion**
  - Change voltage magnitude
- **AC-DC Rectification**
  - Produce dc voltage from an ac source
- **DC-AC Inversion**
  - Produce a sinusoidal voltage with controllable magnitude and frequency
- **AC-AC Conversion**
  - Change voltage magnitude and frequency

Fundamentals of Power Electronics, Erickson and Maksimovic
Why Power Electronics

To improve overall energy efficiency, power electronics is needed.

US (and Canada) is worse than most of the world:

- World average: 72 MBTU/capita
- US: 334 MBTU/capital
- Europe: 150 MBTU/capita

Source: US DOE
Energy Efficiency

Impact of activity, structure, service level, weather, and energy efficiency on change in energy use, 1990--2007

Potential Impact of PWRE

Scope

EE 486 (Steady-state)

EE xxx (Dynamic modeling and control)

EE 582 System applications

Switching converter

Power input

Control input

Reference

Power output

feedforward

feedback
DC-DC Converter Example

- **Input:** 100 V
- **Output:** 50 V, 10 A, 500 W
Realization of a DC-DC Converter

Resistive Voltage Divider

\[ P_{\text{loss}} = 500 \text{W} \]

\[ P_{in} = 1000 \text{W} \]

\[ P_{out} = 500 \text{W} \]
Realization of a DC-DC Converter

Power Electronics

\[ V_g \]
100 V

\[ V_s(t) \]

\[ v(t) \]
50 V

\[ I \]
10 A

\[ R \]

\[ DT_s \]

\[ (1-D)T_s \]

\[ t \]

\[ V_s = DV_g \]

Switch position:

1 2 1
Power Electronics Research

- Power conversion efficiency: $\eta = \frac{P_{out}}{P_{in}}$
- Control techniques
- System-level optimization
Course Topics

- Review of steady-state power flow
- Review of power electronics
- Applications of converters for compensation of transmission systems
  - STATCOM, SVC, TCR, TCSC, TSSC, SSSC, UPFC, IPFC
- High-voltage direct current (HVDC) systems
- Wind power systems (time permitting)
- Converter dynamic model and control, reference frames
- Microgrids and integration of distributed energy resource (DER) units
Mark Distribution

40% ~4 Homeworks
- 40%, submit electronically as PDF
  IEEE two-column format
- Bonus, including 5% for LaTeX

30% Final Project
- Proposals due Oct. 1, 2012
- Final reports due Dec. 3, 2012
- Maximum of two people
- See course syllabus for details

30% Final Exam
- Two-hour comprehensive
- Wed., Dec. 12, 2012
Simulation Software

- PSCAD/EMTDC and MATLAB
Questions?

EE 582

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