ECE 529: Utility Applications of Power Electronics
Class Project

The ECE529 class project will consist of a 5-7 page paper (with an appendix if needed) describing an aspect of utility applications of power electronics. The paper can be either single or double column (IEEE format) with single spacing, 12 point font (if you’re not sure of the IEEE format, you can go to http://www.ieee-pes.org/publications/information-for-authors and look at the Sample Template for a PES Technical Paper under either transactions or conference papers). I can help provide references to help you get the background information for your paper. If you do a simulation project, describe your simulation model, and also hand in the input data files.

You can work individually or in groups of two or three. The project must be larger and accomplish if it is a group project.

Possible topics include:

1. Overview of control and operation of multiterminal HVDC systems or HVDC grids (with or without simulations)
2. Develop and demonstrate more complete models of FACTS, VSC HVDC converter, wind turbines, photovoltaics, etc in a transients program. Document model and show results.
3. Develop and demonstrate more complete power flow or stability models of FACTS, VSC HVDC converter, wind turbines, photovoltaics, etc. Document your model and show results.
4. Impact of FACTS devices, VSC HVDC, Wind Turbines, or Photovoltaics on ac system protection
5. HVDC protection schemes or HVDC circuit breakers
6. Power electronic transformers or high power HVDC DC/DC converters
7. Modeling and analysis of power electronic interface for microturbines, fuel cells, photovoltaics, etc.
8. Modeling and analysis of power electronic interface and an energy storage system (battery, SMES, flywheel, ultracapacitor).
9. Many additional topics are also possible, but they need to be cleared with me first.

DUE DATES

Part 1: Choose topic and write a brief abstract and outline. Due Session 30 (March 29). Worth 6% of the project grade.

Part 2: Final paper is due May 7 at 3:00pm Pacific time. Copies of the papers will be sent to your classmates.

Part 3: Perform a review at least 2 papers submitted by others in the class and provide to instructor. Due by 11:59 pm Pacific time on Friday May 14.
- Two control options discussed
  - ch 4 - Space Phaser (two axis)

4.5, 4.6
↑   ↑
α, β d, q

stationary ref frame
synchronous ref frame

& ch 8 - Rep tracking/side synchronized control
Control loops

PI controller to set \( m_d \), \( m_q \)

\[ \frac{1}{s} \] cancels the \( \frac{1}{s} \) response

Cancels the cross coupling terms

Some gains

\[ 5 \times \frac{b}{T} \]

\[ \frac{1}{s} + \frac{1}{s} \text{ and } \frac{1}{s} \text{ (and more)} \]

\[ (\Theta + \omega L - \omega L + V_d) \]

\[ (e^{\omega_1} + e^{\omega_2} + e^{\omega_3}) \]
P and Q output from VSC and Applying Transformations

- Averaged Mode: Circuit

- Only a single current source on each rail in the DC bus -- take sum in TACS
Alpha-Beta-Zero Transformation
Synchronous DQ Transform

\[ e(t) = (v_{sA} + jv_{sB}) e^{j\alpha} \]

Voltage at PCC measured in current

\[ (v_{sA} + jv_{sB}) e^{j\alpha} \]
Calculate P and Q at PCC

PC power
Convert MD and MQ alpha-beta and then to ABC domain

\[(m_d + jm_q)e^{-j\Theta_{nt}}\]

\[\mathcal{P} \left( \frac{\sigma_d}{\sigma_q} \right) \rightarrow 0\]

- \(I_{dref}, I_{qref}, I_q\)

![Graph showing the transition from alpha-beta to ABC domain with a schematic diagram and a graph illustrating the behavior of the system over time.](file:C:\Users\User\Documents\ECE529\Utility Applications of Power Electronics\Session 17\Page 6/13)
- Pand Q

P has small change when q changes
Q - changed when q changed
Positive change in q

Positive change in id, positive P
P 2 changed when id changed

- M_d and M_q

\[ V_{T_{eq}} = \nu (V_{x\theta} + jV_{xq}) \]
(from PPT)
- $V_{TA}$ and $V_{SA}$

Reactive power change

Real power change

$\Theta_{V+}$ is $90^\circ$ rel to $\Theta_{V-}$