University of Idaho

ECE 529
Utility Applications of Power Electronics

Session 1

ECE 529 L 1/3

ECE 529: Utility Applications of Power Electronics

Spring 2023: Syllabus

DESCRIPTION	Study operation and modeling of power electronic devices applied in power transmission and distribution systems. Applications include: HVDC transmission, static VAR compensators, FACTS devices, energy storage systems, Custom Power devices, and issues related to power quality.
PREREQUISITES	Power Systems Analysis (UI ECE 422 or equiv.) or permission.
INSTRUCTOR	Brian K. Johnson
CLASS TIME	MWF 1:30pm-2:30pm (Pacific Time), JEB 26
CONTACT INFO	Phone: 208-885-6902 (800-824-2889, ext. 6902) Fax: 208-885-6165 e-mail: bjohnson@uidaho.edu
OFFICE HOURS (may change)	M, W: 2:30-3:30 Th: 2:00-3:00 or anytime my door is open. We can also schedule Zoom meetings
RECITATION	Wednesday, 5:00pm Pacific time. Zoom information will be provided.
WEB SITE	http://www.ece.uidaho.edu/ee/power/ECE529/
TEXT	Required: A. Yazdani and R. Iravani, *Voltage-Sourced Converters in Power Systems,* Wiley-IEEE Press, 2010. ISBN 9780470521564. This book available for free download through UI library on IEEEXplore for registered UI students. Optional: D. Jovcic and K. Ahmed, *High Voltage Direct Current Transmission: Converters, Systems and DC Grids 1st Edition*. Wiley, 2016. Available through the UI library
REFERENCES	1. M.J. Gibbard, P. Pourbeik and D.J. Vowles, *Small-signal stability, control and dynamic performance of power systems*, University of Adelaide Press, Adelaide, 2015. Available for free through authors at: (https://www.adelaide.edu.au/press/titles/small-signal/) 2. N.G. Hingorani and L. Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems. IEEE Press, 2000. ISBN: 0-7803-3455-8. Note that this book is available for free download for IEEE members from IEEEXplore (log in as yourself, go to Books, select tab for Classics. Also available through UI library. 3. Chapters: 8, 7, and 10 of: Juan A. Martinez-Velasco, *Transient Analysis of Power Systems : A Practical Approach.* Wiley-IEEE Press, 2020. Available online through library. Log in with student credentials. Search on the title.
SOFTWARE	1. You may want to use MathCAD for homework during this course. 2. We will be using an electromagnetic transient simulation tool for many of the examples in the course and for assignments/projects.

Powerworld (or other Power flow)

Time Domain

- ATP - free
- PSCAD / EMTDC
- EMTP-RV

L1 2/3

COURSE OUTLINE

We will cover most of these topics, but won't have time for all.

Lecture Topic
Introduction
Power Electronics
• Fundamentals
• Converter Topologies
• High voltage - High Power
Modeling and Simulation of Power Converters for Power System Studies
• Modeling needs for: power flow, stability studies, fault analysis, harmonics, transients, etc.
○ Ideal versus non-ideal behavior
• The importance of modeling converter controls - Voltage Source Converters
○ Grid Following Control ←
○ Grid Forming Control
AC Transmission Applications
• Power Electronic Interfaces for Large Scale Wind Turbines and Photovoltaics
• Large Scale Storage with Power Electronic Interface
• Steady-State Versus Dynamic Reactive Compensation
• Shunt Reactive Compensation
• Enhancing Stability
• Short Circuit Behavior of Grid Power Converters
• Series Compensation
• Combined Series/Shunt Compensators
• Converter Controls and Control Interactions
• Solid-State Transformers
Distribution Applications
• Power and Voltage Quality
• Single phase and three phase distributed generation and storage
• Distribution Shunt Compensation
• Static Series Compensators for Voltage Sag Correction
• Static Transfer Switches and Solid-State Circuit Breakers
• Active Filters
HVDC Transmission
• Classic HVDC
• VSC HVDC
• Configurations: Back-to-Back, Point-to-Point, and Multiterminal
• Onshore, Submarine and Offshore Generation Applications
• DC/DC Converters for HVDC and MVDC Systems
• DC System Protection and Control

1. Exams will be given as "take homes"
2. Note: homework assignments and projects will require software tools, such as a transient simulation tool.

LI 3/3

Outreach Students:

1. This is not a self-paced class. Engineering Outreach students are expected to finish the course at the same time as the on campus students.
2. Please include either "ECE 529" in the subject line of e-mail correspondence for this course.
3. Due dates for homework and projects will generally be specified the same as the due date for on-campus students. This is the date when your assignment reaches Moscow. Assignments will be worth a maximum of 50% after the due date. However, I will allow extensions if you consult with me in advance and if you have a major schedule conflict.
4. Please put your name and the course number on top of the first page of each exam and homework, especially if submitting by FAX or e-mail. It would be best if your name was in the header of each page. E-mail submission of assignments is ok, as long as compatible file formats are used. Allowable formats for electronic submission are Adobe Portable Document Format (PDF), Microsoft Word (*.doc or *.docx), Rich Text Format (*.rtf) or MathCAD 15 (or earlier) or Prime 8.0 (or earlier). Limit to one or two attached files. We don't want a large number of files with no documentation on what order to use them. Make sure you number your pages as: 1/4, 2/4, etc., so we know whether or not we have a complete set. Also make sure writing is dark and clear on the FAX or a scan.
5. When submitting homework assignments, please send copies to Brian Johnson (bjohnson@uidaho.edu) and Mataz Alanzi (alan5214@vandals.uidaho.edu)
6. Phone calls or the use of e-mail for asking questions is encouraged. You are welcome to call outside of office hours. The Engineering Outreach 800 line is available 24 hours a day so you can reach me outside of their hours. I have a link to my Google calendar posted on the course web page. Please refer to that to check my availability, especially if you want to schedule a meeting.
7. Library Resources: As a UI student, you not only have access to valuable print and electronic resources from the university's library, such as access to IEEEXplore, but you also have the access to personalized assistance from the librarians. If you have assignments or research questions and aren't sure how to make the most of library resources from off campus, you do one of the following:
   a. As a UI student you can also download a VPN client from the ITS Help Desk: https://support.uidaho.edu/TDClient/KB/ArticleDet?ID=231 You will need to log in using your UI student account.
   b. You can visit the Off-Campus Access information page on the library's website at: https://libanswers.uidaho.edu/faq/227988 ieeexplore.ieee.org
      i. For IEEEXplore papers, it appears that you may now need to go to the UI library web page (https://www.lib.uidaho.edu/), put the paper title in the search box.
8. University of Idaho is committed to creating a safe learning environment for all students. Consistent with this, UI policy and Title IX prohibit sexual misconduct, which includes sex or gender-based harassment, sexual assault, intimate partner violence, stalking, and retaliation. If you have experienced any form of sexual misconduct, know that help and support are available. Please be aware that all University of Idaho employees are mandatory reporters and are required to report any information they receive about sexual misconduct to the university's Title IX Coordinator within 24 hours (Idaho State Board Policy, Section I, I.T.). Visit http://www.uidaho.edu/ocri/title-nine/resources to learn more about which resources on campus and within our community are confidential. If you would like to report an incident, you may do so anonymously by visiting www.uidaho.edu/vandalcare or you can directly contact the Office of Civil Rights and Investigations at 208-885-4285 or ocri@uidaho.edu.
9. Running Mathcad remotely on UI computers:

   There university remote computer access lab is available through the following web page: https://remoteaccess.labstats.com/University-of-Idaho-RALab