



Power System Dynamics & Control

POWER SYSTEM MODELLING AND CONTROL (EEEN40550)

Prof. Federico Milano

Email: federico.milano@ucd.ie

Tel.: 01 716 1844

Room 157a – Engineering & Materials Science Centre

School of Electrical & Electronic Engineering

University College Dublin

Dublin, Ireland



Contents

- **Modelling and control** of:
 - Synchronous machines
 - Transformers
 - FACTS and VSC devices
 - Induction machines
 - Wind turbines
- **Jupyter Notebooks**
- **Power system software tool “Dome”**



Synchronous Machines

- Park's model of synchronous machines
- Primary regulations (frequency, voltage)
- Secondary regulations (AGC, voltage)
- Other controllers and limiters (PSS, OEL, UEL)
- Synchronization



Transformers

- Dynamic model of the transformer
- Under-load tap changer
- Phase shifting transformer
- Other controlled series devices (e.g., HVDC)



FACTS and VSC Devices

- Thyristor-based FACTS devices
 - SVC
 - TCSC
- Voltage source converter (VSC)
- VSC-based FACTS devices
 - StatCom
 - SSSC
 - UPFC
- Applications
 - Photo-voltaic panels
 - Energy storage devices



Induction Machines

- Dynamic model of the induction machine
- Start-up
- Speed regulation



Wind Turbines

- Wind turbine figures (DFIG, DFIG, etc.)
- Maximum power point tracking (MPPT)
- Pitch control
- Voltage control
- Other controls (e.g., frequency control)



Introductory Laboratory Activities

- 2 introductory labs:
 - **Intro Labs – Weeks 3 and 4:** Introduction to Jupyter Notebook and Dome.

- No report is required for the introductory labs.



Laboratory Activities

- 4 lab activities:
 - Lab 1 – Week 6: Primary and secondary frequency regulations of synchronous machines.
 - Lab 2 – Week 7: Automatic voltage regulation of synchronous machines.
 - Lab 3 – Week 9: Under load tap changer, phase shifter and FACTS applications.
 - Lab 4 – Week 12: CSWT and DFIG simulations.
- A report has to be prepared after each lab
- There is an additional lab slot on week 10 available for questions.



Worked Problems and Tutorials

- Worked problems will be presented at the end of each section.
- Week 12: solution of exam scripts of previous years.
- Examples of exam papers are available on the webpage of the course.



In-Class Examinations

- First in-class examination ([21st of October – Week 6](#)): topics: Park transform, synchronous machine, frequency control.
- Second in-class examination ([2nd of December – Week 12](#)): topics: Voltage control, regulating transformers, FACTS devices and wind generation.



Evaluation

- 1st in-class examination (20%)
- 2nd in-class examination (20%)
- 4 Lab Reports (15% each report, 60% in total)
- Important remarks on lab reports:
 1. A report has to be prepared for each lab activity.
 2. Reports have to be prepared **individually**, i.e., **NOT** in group. Reports prepared in group will be graded G-.
 3. Please read UCD and College plagiarism policies (also available on the website of the module).
 4. Lab-based reports have to be submitted within **10 days** after the lab activity. One grade will be taken out per each day of delay.
 5. Please submit reports **in PDF** through Brightspace (see section “Assignments”).



Bibliography

- Slides of the module
- P. Kundur, **Power System Stability and Control**, McGraw-Hill, 1994
- P. M. Anderson and A. A. Fouad, **Power System Control and Stability**, Wiley, 2003
- P. W. Sauer and M. A. Pai, **Power System Dynamics and Stability**, Prentice Hall, 1998
- F. Milano, **Power System Modelling and Scripting**, Springer, 2010
- X.-P. Zhang, C. Rehtanz, B. Pal, **Flexible AC Transmission Systems: Modelling and Control**, Springer, 2006
- S.-K. Sul, **Control of Electric Machine Drive Systems**, Wiley, 2011
- T. Ackermann, **Wind Power in Power Systems**, Wiley, 2005



Links

- Web page of the course:

<http://faraday1.ucd.ie/modules/control.html>

- Web page of the software tool:

<http://faraday1.ucd.ie/dome.html>

- Brightspace:

<https://brightspace.ucd.ie>