Power System Dynamics & Control

POWER SYSTEM MODELLING AND CONTROL (EEEN40550)

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Contents

- Modelling and control of:
  - Synchronous machines
  - Transformers
  - FACTS and VSC devices
  - Induction machines
  - Wind turbines
- Unix terminal
- 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, DDSG, etc.)
- Maximum power point tracking (MPPT)
- Pitch control
- Voltage control
- Other controls (e.g., frequency control)

Introductory Laboratory Activities

- 1 introductory lab:
  - Intro Lab – Week 5 – October 12th: Introduction to Jupyter Notebook and Dome.

- No report is required for the introductory lab.

Laboratory Activities

- 4 lab activities:
  - Lab 1 – Week 6 – October 20th: Primary and secondary frequency regulations of synchronous machines.
  - Lab 2 – Week 9 – November 9th: Automatic voltage regulation of synchronous machines.
  - Lab 3 – Week 10 – November 16th: Under load tap changer, phase shifter and FACTS applications.
  - Lab 4 – Week 11 – November 23rd: CSWT and DFIG simulations.

- A report has to be prepared after each lab.

Worked Problems and Tutorials

- Worked problems will be presented at the end of each section.
- Extra tutorial on week 12, starting on November 26th.
- Examples of exam papers are available on the webpage of the course.

Evaluation

- Final Exam (40%)
- 4 Lab Reports (60%)
- Important remarks on lab reports:
  1. A report has to be prepared for each lab activity.
  2. Reports have to prepared **individually**, i.e., **NOT** in group. Reports prepared in group will be graded G-.
  3. Please read UCD and College plagiarism policies on *Blackboard*.
  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 e-mail lab reports **in PDF** to me or to the TA (Guðrún Margrét Jónsdóttir).

Questionnaire

- Laboratory activities are part of a long term project on didactic innovation.
- The students are invited to fulfill and submit a questionnaire on lab activities.
- The questionnaire can help improve future lab activities!

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

- Blackboard:

  https://elearning.ucd.ie