EL-GY 6653 Power System Stability

Instructor: Prof. Yury Dvorkin (dvorkin@nyu.edu)
Lecture: see at NYU Classes
Office hours: TBA, or by email

Course description: This course will focus on teaching fundamentals of power system stability and control applicable to existing and future power systems with renewable generation resources and emerging smart grid technologies. This class will cover aspects of steady-state and emergency voltage and frequency control mechanisms. These mechanisms will be considered in the context of operating/planning uncertainty and existing modeling methods. This class will also teach how to use existing CAD simulation tools. The class is suitable for undergraduate students upon meeting all prerequisites and approval of the instructor.

Figure 1. An illustration of the event sequence for the Western US blackout on July 2, 1996 (from [10]). The sequence jumps across hundreds of kilometers at several points, such as from 3-4 and from 7-8. See Hines et al, “Cascading Power Outages Propagate Locally in an Influence Graph that is not the Actual Grid Topology”, IEEE Trans. on Power Systems, early access, 2017.

Prerequisites:
I will try to make the course as self-contained as possible. For those who lack necessary background in power engineering, the class will start with a comprehensive review. The students are, however, expected to have basic electrical engineering background (circuits, KVL, KCL, energy conservation, etc), familiarity with linear algebra and with very basic control theory. This class will require basic programming in Matlab/Python/etc.
Tentative lecture schedule:

- **Topic 1:** Course Introduction. Power Engineering Review. Introduction to Power System Stability Problems
- **Topic 2:** Introduction to Power System Stability Problems
- **Topic 3:** Fundamentals of AC and DC power transmission
- **Topic 4:** Synchronous Machines
- **Topic 5:** Small Signal Stability
- **Topic 6:** Frequency Stability and Control
- **Topic 7:** Transient Stability
- **Topic 8:** Voltage Stability
- **Topic 9:** Stability in Optimal Power Flow and Unit Commitment
- **Topic 10:** N-K security and transmission system cascades
- **Topic 11:** Online cascade control

Books/Reading

- **[Main; HW]** State-of-the-art papers in IEEE Transactions on Power Systems

Learning goals:

- Analyze characteristics/limitations/advantages of the AC and DC power transmission lines
- Analyze power generation and transmission in complex power networks
- Explain the fundamental principles of the power system stability (steady-state, small signal, transient, voltage)
- Understanding of frequency and voltage control
- Model stability constraints in Optimal Power Flow and Unit Commitment tools
- Understanding of transmission cascades and their prevention/mitigation

Grades:

- Homework (4 multi-week assignments) – 40%
- Midterm (related to homework problems + theory; 1-page cheat sheet is allowed) – 20%
- Group project – 20%
  - **Bonus:** +50% for submitting a peer-reviewed paper based on the class project
- Final Exam – 20%
- Curve might be applied

Late submissions will only be accepted within the 24 hours after the deadline; the penalty for late submission is -25%.

Dissemination of materials:

- All class materials are posted online after the lecture
- Homework is posted biweekly after the lecture

Project:
- Students must self-organize in teams with 3-5 members and propose the title and abstract of the intended project no later than Lecture 6
- More details will be provided during the first lecture

**Important Resources:**
- NYU Tandon Policy on Academic Integrity: [http://engineering.nyu.edu/online-asynchronous-orientation/academic-integrity.php](http://engineering.nyu.edu/online-asynchronous-orientation/academic-integrity.php)
- If you require reasonable accommodation due to documented disability, please email me and check the following NYU resource: [http://www.nyu.edu/students/communities-and-groups/students-with-disabilities.html](http://www.nyu.edu/students/communities-and-groups/students-with-disabilities.html)