Instructor: Prof. Yury Dvorkin (dvorkin@nyu.edu)
Office hours: TBA, or by email

Course audience: This is a graduate level course for students who are interested in electric power engineering and applications of control, optimization, and machine learning techniques in the area of smart grids and power grid cybersecurity. Please email me if you have any questions or concerns. The course will start with a thorough background review section that will help those who may lack necessary prerequisites. Please email me if you have any questions/concerns.

Course description: This course will teach fundamentals of smart grids that are anticipated to alter existing energy delivery principles. Basic concepts of traditional power system analysis will be introduced and placed in the context of emerging smart grid technologies (e.g., communication and information systems, demand-side participation, energy storage, physical and cyber security, renewable generation resources, uncertainty-aware decision support systems). These technologies and their impacts on power system operations will be discussed in the context of deregulation, modernization, operation and expansion, and policy of the power sector. Methodologically the course with focus on methods in linear and nonlinear optimization, Lyapunov stability, and machine learning. Students will gain theoretical and practical knowledge underlying smart grids and hands-on experience with modeling and CAD tools.

Tentative lecture schedule:

Week 1: Introduction. Structure of power grids. Key components (generators, transformers, substations, transmission lines). Operation, communication, control layers.

Week 2: Steady-state operations. Voltage/current phasors, active and reactive power, AC and DC power flows. Transmission and distribution grids. [Homework 1 is due].

Week 4: Disturbances and power system dynamics. Frequency and voltage control. Power swings. [Homework 2 is due].


Week 6: Security of power system operations. Value and cost of security. Cost/benefit analysis. [Homework 3 is due], [Midterm exam].

Week 7: Transition to Smart grids. Motivation, regulation, incentives. Enabling customer participation and emerging technologies.

Week 8: Smart grids and transmission networks. PMU and WAM. Enhanced communication and control. Large-scale renewables, energy storage.

Week 9: Smart grids and active distribution grids. Smart metering and consumers. Distributed energy resources (renewables, energy storage, EVs), their operations and value/renumeration. [Homework 4 is due].

Week 10: Advance control and communication systems: objectives, priorities and timescales. SCADA and EMS. Transmission and distribution coordination.


Week 13: CAD tools for smart grids: design principles. Open source and commercial packages: GridLAB-D, OpenDSS, Plexos, Voltron. [Homework 8 is due].


Week 15: [Group project presentation]. [Final exam].

Grades:
- Homework (biweekly assignments) – 25%
- Midterm (related to homework problems; 1-page cheat sheet is allowed) – 25%
- Group/individual project (List of topics available below) – 25%
- Final (related to homework problems; 1-page cheat sheet is allowed) – 25%

Dissemination of materials:
- All class materials are posted on NYU Classes
- Homework is posted biweekly after the 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)