Course Topics

EEE 598: Operations Research Applied to Electric Power Systems

Prerequisites: This advanced specialty topics course is designed as a course both for upper level graduate students in electric power engineering and upper level graduate students in industrial engineering. You must have a strong graduate level background in either electric power engineering (EEE 577 or EEE 598 (Electric Energy Markets)) or you must have a strong graduate background in optimization (IEE 574, IEE 620, or APM 523).

Catalog Course Description: Optimization models in power systems operations and planning; operations research

Course Topics:

Electric power engineering topics:
- Security constrained optimal power flow
- Security constrained unit commitment
- Reliability unit commitment
- Contingency analysis
- Hydro scheduling
- Transmission expansion planning
- Generation expansion planning
- Large-scale power systems optimization problems

Operations research topics:
- Valid inequalities
- Mixed integer programming
- Stochastic optimization
- Lagrangian relaxation
- Benders’ decomposition
- Progressive hedging

Classroom: SS 229, 9:00am – 10:15am Tuesdays and Thursdays  Credits: 3

Instructor: Dr. Kory W. Hedman
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Office Hours:
To be determined

Required Textbook: None (Class Notes & Papers)

There is no textbook for this course. The material will be based on notes from Dr. Hedman as well as journal papers.

Optional References:
- Power Generation, Operation, and Control, Wood & Wollenberg
- Introduction to Linear Optimization, Dimitris Bertsimas and John Tsitsiklis
- Linear and Nonlinear Programming, David Luenberger
- Integer and Combinatorial Optimization, Nemhauser & Wolsey

Offered: Spring semester every other year starting 2014

Prerequisites / co-requisites:
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Course Description: This course focuses on the various mathematical programs that are used within power systems planning and operations. This includes scheduling problems (e.g., unit commitment), investment planning (e.g., transmission expansion planning), and reliability analysis (e.g., contingency analysis). This class is designed as an extension of EEE 577. We will be formulating and solving medium-scale and large-scale optimization problems that exist in the power systems industry (we will be greatly extending a number of topics covered in EEE 577 as well as discussing various optimization algorithms to solve these problems). This class will teach you how to
characterize and formulate these problems as well as the corresponding algorithms that can be used to solve these complex mathematical programs.

We will (briefly) discuss tighter unit commitment formulations (facet defining valid inequalities) so that we can improve the computational performance. We will discuss various optimization algorithms to solve medium to large-scale versions of these mathematical programs. Such algorithms may include LaGrangian Relaxation, Progressive Hedging, Benders’ Decomposition, as well as other potential algorithms.

We will also study the difference between formulating deterministic optimization problems versus stochastic programming formulations. For instance, we will investigate the difference between formulating and solving a security constrained unit commitment problem (with reserve requirements) versus a two-stage stochastic unit commitment formulation where N-1 reliability standards (or wind scenarios) are explicitly enforced.

This course is designed to be a project oriented course. Students will be required to write multiple programs (see programming language requirements) throughout the semester.

This course is designed to be for advanced graduate level students in both the electric power engineering graduate program as well as for those in the industrial engineering graduate program. Those in EE will improve their skills in regards to how to formulate these problems as well as learn advanced algorithms that are needed to solve these complex problems. Those students in IE will be introduced to power systems operations and planning, learn about various power systems optimization problems, how to formulate these problems, and be exposed to advanced optimization algorithms.

**Topical Coverage (tentative):**
- Optimization
  - Mixed Integer Linear Programming
  - Deterministic versus stochastic programs
  - Lagrange Relaxation, Benders’ Decomposition, Progressive Hedging
  - These topics will be discussed based on the application
- Generation scheduling problems
  - Quick overview of: ACOPF, DCOPF, Unit Commitment
  - Security Constrained Optimal Power Flow
  - Security Constrained Unit Commitment
  - Hydro Scheduling
- Reliability Analysis
  - Contingency Analysis
  - Reliability assessment for planning (tentative)
- Investment Planning
  - Transmission expansion planning
  - Generation expansion planning (tentative)
- Maintenance Scheduling and Outage Coordination (tentative)
Grading (tentative – likely to change):
Projects: 80%
Final Exam: 20% (In class)

Projects: There will be multiple group projects. Each group project will include a technical report. Each group will be required to give a short presentation on their work at least one time in the semester.

Potential Project Topics:
- Security Constrained Unit Commitment / Optimal Power Flow
- Medium to Large-Scale Stochastic Unit Commitment / Optimal Power Flow
- Long-Term Transmission Expansion Planning
- Contingency Analysis
- Potential algorithms to be used are listed above.

Software: We will be using a variety of optimization software, depending on the application.

Programming Languages: Depending on the project, you may be required to program in AMPL, GAMS, C++, or JAVA. All students should already have the ability to program well at least in AMPL or Matlab.

Late Assignments: will not be accepted (unless there is a documented emergency).

Academic Integrity Policy at ASU: Every student is required to understand and know ASU’s Academic Integrity Policy: http://provost.asu.edu/academicintegrity. See Lecture 1 for more information on ASU’s AIP. If at any time you are not sure about what is allowed/acceptable, ask your professor. Students that are caught cheating will be reported to the Dean and will be penalized.

* Additional information regarding the class is provided in the first lecture.