
Classroom: COOR 184, 3:30pm – 4:45pm Mondays and Wednesdays

Instructor:
Dr. Kory W. Hedman
School of Electrical, Computer, and Energy Engineering
Arizona State University
PO Box 875706
Tempe, AZ 85287-5706

Office: Engineering Research Center 579

Email: kwhedman@asu.edu

Phone: 480-965-1276 Fax: 480-965-0745

Credits: 3

Required Textbook: None (Class Notes & Papers)

Useful References:
- Fundamentals of Power System Economics, Daniel Kirschen
  - On hold in Noble Library
- Power System Economics, Steven Stoft

Additional References:
- Power Generation, Operation, and Control, Wood & Wollenberg
- Intermediate Microeconomics, Hal R. Varian
- Introduction to Linear Optimization, Dimitris Bertsimas and John Tsitsiklis
- Linear and Nonlinear Programming, David Luenberger
- Market Operations in Electric Power Systems, Mohammad Shahidehpour
  - On hold in Noble Library
- Electricity Market Reform: An International Perspective, Fereidoon Sioshansi
  - On hold in Noble Library

Offered: Spring semester every year starting 2011

Prerequisites / co-requisites: graduate standing and a background in power engineering

Course Description: This course focuses on the market structures that exist within the electric energy industry. The course will provide a background on basic economic theory that is necessary to understand operational objectives, pricing and incentives, market power, etc. We will discuss the history of the electric power industry, regulation, and deregulation. We will discuss dispatch optimization problems that exist in the electric industry, approaches to solving these problems, and the corresponding markets. We will discuss different pricing methods, non-convex markets, uplift payments, etc. The final part of this class will deal with a discussion on current research problems in this field,
including the Extended-LMP proposal, changing the ISO’s objective from minimizing total system bid cost to minimizing the payment to suppliers, as well as other research topics.

Topical Coverage and Timeline:
- Review of Syllabus (week 1)
- Overview of the Electric Power Industry (week 1)
  - History of the Electric Power Industry
  - Deregulation Overview
  - Vertical Integration
  - Role of NERC & FERC
  - Market Structure in the USA
- Overview of Economic Theory (weeks 2-3)
  - Material Based On:
    - Ch 4, Power System Economics
    - Ch 2 & Ch 4 Fundamentals of Power System Economics
    - Ch 3 Restructured Electric Power Systems
  - Microeconomics
    - Supply & Demand
    - Consumer Surplus & Producer Surplus
    - Price Taking
    - Profit Maximization
    - Monopoly
  - Game Theory
  - Equilibrium Models (Reduce)
  - Market Power
    - Hockey Stick Bidding
    - Deck Game
    - Measurements of market power
  - Auctions (ADD)
  - Theory of Second Best
    - Transmission Expansion
    - Carbon Tax
- Optimization (weeks 4-6) (Reduce)
  - Material: Ch 1-5, 11 Introduction to Linear Optimization
  - Linear Programming
    - Convex sets
    - Primal and Dual
    - Proof of Optimality
    - Duality Theory
  - Mixed Integer Linear Programming (Reduce)
- Dispatch Optimization Models (week 6-7)
  - Material: Power Generation, Operation, and Control
  - Economic Dispatch
  - Direct Current Optimal Power Flow (DCOPF)
  - Unit Commitment
• MIDTERM EXAM 1: Monday, March 7\textsuperscript{th} (week 8) (tentative date)
  o Coverage of Material: until February 21\textsuperscript{st}
• Pricing (weeks 8-10)
  o Material: Papers will be posted on Blackboard
  o Uniform Market Clearing Prices (MCP) vs. Pay As Bid
  o Locational Marginal Pricing (LMPs)
• Objectives, Rents, Congestion (week 10-11)
  o Material: Papers will be posted on Blackboard
  o Dual of the DCOPF
    ▪ Load payment, Congestion Rent, Generation Rent
  o Congestion
• Non-convex markets (week 11-12)
  o Material: Papers will be posted on Blackboard
  o Make-whole Payments / Uplift
  o Centralized Unit Commitment vs. Decentralized
• Financial Transmission Rights (week 13) (?)
  o Material: Papers will be posted on Blackboard
  o Simultaneous Feasibility Test
  o Revenue inadequacy
• Capacity Markets (ADD)
• Ancillary Services Markets (ADD)
• Reliability Unit Commitment (ADD)
• SCE’s Proposed Objective: Minimize Payment to Generators vs. Minimize Total Cost (week 13) (Reduce)
  o Material: Papers will be posted on Blackboard
  o Overview
  o Presentations
• Extended-LMP (Convex Hull Pricing) (week 14) (Reduce)
  o Material: Papers will be posted on Blackboard
  o Overview
  o Presentations
• MIDTERM EXAM 2: Wednesday, April 20\textsuperscript{th} (week 14) (tentative date)
  o Coverage of Material: Until April 11\textsuperscript{th}
• Presentation Days 1 & 2 (week 15)
• Last Day of Class: Monday, May 5\textsuperscript{th}: Review for Final Exam
• Final Exam: Wednesday, May 11\textsuperscript{th}, 12:10pm – 2pm
  o Final Exam will be a take home exam due on Wednesday, May 11\textsuperscript{th} at 12pm

Grading:
Homework: 20%
Midterm 1: 20% (In class)
Midterm 2: 20% (In class)
Final Exam: 20% (Take home exam – Due on the schedule final exam date)
Project: 20% (15% Report, 5% Presentation)
Projects:
Information on the projects will be posted on Blackboard.

Software Requirements: AMPL. The software will be installed in the ERC 584/512 Lab. If you do not have access to this lab you will have to request access.

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

Academic Integrity Policy at ASU:
Every student is expected to understand and know ASU’s Academic Integrity Policy:
http://provost.asu.edu/academicintegrity
If at any time you are not sure about what is allowed/acceptable, ask your professor.