EAEE E4220: Energy System Economics and Optimization – Fall 2021

Learning Outcomes:
Upon completing this course, the student should be able to:

- Define and discuss the major problems in power system economics
- Formulate these problems as optimization problems
- Solve simple power system optimization problem by hand
- Use optimization packages to solve more complex problems
- Describe the various types of electricity markets and discuss their purposes
- Discuss bidding strategies in electricity markets with perfect and imperfect competition
- Explain and calculate locational marginal prices
- Explain and the economic pros and cons of different energy resources
- Discuss the factors that affect energy system investments

Time: Mon, Wed 1:00 pm – 2:30 pm; **Classroom:** 602 Hamilton Hall

Zoom Meeting ID: See Courseworks.

Instructor: Bolun Xu
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Office hours: Thu 9:30 am – 11:00 am (in office & zoom)

Teaching Assistant: Zhuoran Zhang
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Grader: Shizheng "JJ" Tie
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Grading:		
	Homework:	30%
	Midterm:	30%
	Final project:	30%
	Participation:	10%

Website: https://courseworks2.columbia.edu/courses/109788 (Courseworks)

All group communications will take place through Courseworks, use it to

- Check for announcements
- Get lecture slides and other material
- Get homework and project assignments
- Submit your homework
- Get your grades
- Ask questions

Textbooks [All Available Online via Columbia Library]:

Required**:** **K&S:** Kirschen & Strbac: Fundamentals of Power System Economics, Second Edition, Wiley, 2018

Supplemental: **M:** Masters: Renewable and Efficient Electric Power Systems, Wiley 2004
C&B: Conejo & Baringo: Power System Operations, Springer 2018

Tentative timetable of topics:

Week 1	9/6	Labor day	
	9/8	No class	
Week 2	9/13	Introduction	M Ch3.1-3.2, D&S Ch1
	9/15	Basic concepts from economics	D&S Ch2.1-2.3
Week 3	9/20	Risks, markets, and contracts	D&S Ch2.4-2.6
	9/22	Organization of electricity markets	D&S Ch3
Week 4	9/27	Centralized and bilateral markets	
	9/29	Market experiment I	
Week 5	10/4	Economic dispatch	C&B Ch7
	10/6	Linear programming	
Week 6	10/11	Solution algorithms for economic dispatch	
	10/13	Unit commitment	
Week 7	10/18	Mixed-integer linear programming	
	10/20	Transmission in electricity markets	D&S Ch5.1-Ch5.3.4
Week 8	10/25	Security constrained economic dispatch	
	10/27	**Midterm**	
Week 7	11/1	No class	
	11/3	Financial transmission rights	D&S Ch5.3.5
Week 8	11/8	Participating electricity markets	D&S Ch4
	11/10	Power system operation	D&S Ch6
Week 9	11/15	Ancillary services markets	
	11/17	Renewable and storage	M6.1-6.5,6.11,8.5,9.4-9.6
Week 10	11/22	Market experiment II	
	11/24	No class	
Week 11	11/29	Power system expansion	D&S Ch8
	12/1	Planning under uncertainties	
Week 12	12/6	Decomposition methods	
	12/8	Project presentation	
Week 13	12/13	Project presentation	

Homework

Due Thursdays at 11:59 PM ET. Submission by file upload via Courseworks Assignment, only PDF files are accepted. MS Word or LATEX (www.overleaf.com) or Jupyter Notebook is highly recommended.

Homework submitted after the due date will be charged 10% late penalty; no homework accepted after Friday.

Market experiments

Participation of market experiments counts towards 10% of the total course credit as participation. Market experiment results will be recorded and the top 3 will receive 3% extra total course credits.

Project

The presentation video for the project is due on Sunday, December 12th. The final project is due on **Monday, December 20th**. No later submission will be accepted.
Grading:

- Presentation 20%
- Formulation 30%
- Code format 20%
- Result analysis 30%

Optimization Software

Students can use any languages and optimization packages for homework and the project. The recommended set-up in this course is Jupyter Notebook + Python + CVXPY. Please check on Courseworks -> Files -> Optimization_Setup_Guides for set-up instructions.