Carnegie Mellon University

45977 “Management in Electric Power Systems and Electricity Markets”

Meeting Days, Times, Location: Monday, 18:30-22:00, TPR 2111

Semester: Spring/Mini 3**, Year:** 2019

Units: 6**, Section(s):** 1

Instructor information

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Office hours	(TBD)

Course Description

- Cyber-physical attacks to energy infrastructure, the climate change turmoil, the quest for utility-scale battery technology innovation, the burning matters of retiring nuclear and coal units that are hard to be properly replaced, and the ever-going discussion about the structure and organization of the recently deregulated electricity markets require leadership vision and robust management mind-set. All these current matters fall on top of the challenging nature of electricity itself (following highly variable demand, hardly stored efficiently and in bulk, catastrophic socioeconomic effects when black-outs occur, dependent on highly diverse primary sources of energy, etc). Multiple entities ranging from regulators implementing political decisions, operators handling day-to-day operation and all the way to customers’ associations require for multi-objective decision-making at many levels and facades of the industry, while considering the changing environment and planning for the adoption of innovation, standardization and upcoming policy. In this course all the aforementioned parameters and concerns as seen, developed and implemented by all stakeholders in the field, through both their actions and their interactions will be presented and discussed.
- Basic understanding of markets operation is required. Some prior knowledge of optimization theory will be helpful, but not required.

Learning Objectives

After completing this course, the students will be able to:

- Understand the roles of all major entities in the electricity markets, namely operators, regulators, load/generation aggregators/customers, and equipment/software manufacturers/suppliers.
- Prepare for and participate in electricity markets (energy and ancillary services) both online and forward ones.
- Review and recommend market (re)structures and regulations.
- Identify challenges for every stakeholder in the field and propose proper action, e.g. overcome capacity concerns for the case of a transmission system operator.
- Appraise investment/trading opportunities in the shorter (market) and longer (planning) terms.
- Qualify as an authority with all-round knowledge and wide know-how of the field and the intertwined relations among the multitude of actors involved.

Learning Resources

- Instructor's notes and power-point presentations
- Reading material from (indicatively) the following e-books available through institutional access (CMU library):
  - "Restructured Electric Power Systems: Analysis of Electricity Markets with Equilibrium Models" by Xiao-Ping
  - "Power Markets and Economics: Energy Costs, Trading, Emissions" by Barrie Murray
  - "New Power Markets: Corporate Strategies for Risk and Reward" by Robert Jameson
  - "Power Generation Investment in Electricity Markets" by the International Energy Agency,
  - "The Economics of Electricity Markets" by D. R. Biggar and M. R. Hesamzadeh,
  - "Electricity markets : pricing, structures and economics" by C. Harris, and
  - "Competitive electricity markets : design, implementation, performance" by F. P. Sioshansi
- Recent news, articles and scientific publications: On each of the course topics the mentioned material will be discussed in light of the recent advances on the respective subjects.

Assessments

The final course grade will be calculated using the following categories:

Assessment	Percentage of Final Grade
Final exam OR Project	FE or P score/100, varying weights (see following)
Turn-in Assignments	TI score/100, varying weights (see following)
Participation (short Quizzes)	Q score = 11% taking all of them, 16% "acing" all of them

FINAL GRADE FORMULA = MAX (FE*89%+Q, FE*47%+TI*41%+Q) [weights affected by attendance, see following]

- Final exam: Open notes exam of three parts. A) One quantitative problem to solve, B & C) One question answered either by a short argumentative or bullet-points, or multiple choice. All parts equally weighed.
- Project (personal & 'competitive'): Oral presentation (5' pitch of less than 10 slides) and an essay (500-800 words) describing a strategy and the procedures to implement an electricity market challenge. 50% for submitting a valid essay (identifying challenges and key stakeholders of the project) 50% from the pitch.
- Turn-in Assignments: Three equally weighed assignments (quantitative or short text), due on exam date.
- Participation (short Quizzes): At various times during class hours (in the middle or/and at the end to summarize main points and review previous material) and only available at that time, a (mostly) multiple-choice quiz will be handed out or published on Canvas. Answering correct at least half of the quiz is considered "acing" it. Quizzes not taken are graded zero.

Students will be assigned the following final letter grades:

Grade	Percentage Interval
A	≥90%
B	75-89.9%
C	60-74.9%
D	55-59.9%
F	≤54.9%

Grading Policies

- **Late-work policy**: Turn-in assignments may only be submitted by the final exam date; turn-in assignments that are not submitted by the due date are graded zero. The quizzes are only available at the time of the class that are published and graded online. Quizzes not taken at all are graded zero.
- **Make-up work policy**: Make-up work might be arranged according to the attendance policy following. It will be decided strictly in a case-by-case manner and should not be considered as a readily available option. With this work, the student may make-up for at most half of any attendance penalties that have not been properly justified (preferably documented).
- **Re-grade policy**: Regrading may be requested in person, on (date TBD) during office hours announced closer to that date.
- **Attendance and/or participation policy**: Attendance is taken by the participation in the quizzes of the day. One full day missed is excused; you only miss the quiz score of that day which is less than 1%. Every other full day missed leads to 5% being subtracted by the weight of the final exam or project score.

Course Policies

- **Attendance & Participation**: The content of the course is mostly descriptive and concerns structures and relations among stakeholders. The content is strictly connected to the nature of the studied subject (power system), hence, interacting with the instructor and among you will offer a more concrete understanding of the topics discussed. See grading policies for relevant details. Informing the instructor of your absence at least one day in advance, improves your make-up work prospects.
- **Academic Integrity & Collaboration**: Do not copy or borrow your classmates' works. Any act of cheating or plagiarism will be treated in accordance with Carnegie Mellon's Policy on Academic Integrity, which can be found here: http://www.cmu.edu/policies/student-and-studentlife/academic-integrity.html Depending upon the individual violation, students could face penalties ranging from failing the assignment to failing the class.
- **Late-work/Make-up work policy**: See grading policies for relevant details. Informing the instructor of absence at least one day in advance, improves your make-up work prospects.
- **Accommodations for students with disabilities**: If you have a disability and require accommodations, please contact Catherine Getchell, Director of Disability Resources, 412-268-6121, getchell@cmu.edu. If you have an accommodations letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate.
- **Statement on student wellness**: As a student, you may experience a range of challenges that can interfere with learning, such as strained relationships, increased anxiety, substance use, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may diminish your academic performance and/or reduce your ability to participate in daily activities. CMU services are available, and treatment does work. You can learn more about confidential mental health services available on campus at: http://www.cmu.edu/counseling Support is always available (24/7) from Counseling and Psychological Services: 412-268-2922.
- **Mobile Devices**: The use of mobile devices is encouraged in the framework of using Canvas resources. The use (but not abuse) of laptops for the same reason during the classes might be considered.

Course Schedule

1. **Leadership roles in electricity industry (0.5 week)**
    a. Electric Power system fundamentals
    b. Utility & generation companies
    c. Load customers & aggregators
    d. Operators
    e. Regulators
    f. Associations
2. **Electricity markets & deregulation (1 week)**
    a. Energy>Ancillary Services>Spot/balancing markets & structures-timelines
    b. Price makers/takers
    c. Economic Dispatch (ED) and environmentally constrained ED
    d. Network constraints and zonal/locational pricing
3. **Generation & Demand (1 week)**
    a. Incentives for Renewables and market irregularities
    b. Wind generation utilization factor, technical limits
    c. Conventional generation technical concerns (minimum thermal, water flows hydro, start times)
    d. Demand response
4. **Operators (1 week)**
    a. Grid investments (capacity concerns)
    b. Maintenance
    c. Operation (market clearance), Monitoring(state estimation) & Control (2ary control)
5. **Regulators (1 week)**
    a. Pricing mechanisms
    b. Market control
    c. Operators' auditing
6. **Cyber-Physical Security (1 week)**
    a. Classical security concerns
    b. Recent attacks to power system infrastructure
    c. Measures to counteract cyber-physical security and threats