EE 295 - Power Distribution Systems Engineering and Analysis Course Syllabus/policy

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1 Overview and Prerequisites

This course is an in-depth study of power distribution systems engineering and analysis. By power distribution systems we are referring to the "medium" and "low" voltage systems that utilities use to connect home and businesses to the "high voltage" transmission substation and thus the bulk power grid. Due to the rapid adoption of distributed solar PV systems, batteries, and other new technologies, this portion of the power system is in a period of rapid change. This course will focus on understanding these changes as well as the fundamental physics and engineering that one needs to understand in order to contribute to solving engineering problems that occur in the midst of those changes.

The prerequisites for this course are either EE 113 (a first course in electrical power and energy conversion) and/or graduate student standing. Because power system operations requires at least a basic understanding of economics, if have not previously taken a course in microeconomics, you should do some background work: https://www.khanacademy.org/economics-finance-domain/microeconomics. The course will make extensive use of software for course projects, including Julia/JuMP, Python, Docker, and/or MATLAB. Students are encouraged to become familiar with these tools if they are not already.

2 Text and readings

The textbook for this class is "Distribution System Modeling and Analysis 4th Edition" by WH Kersting (4th edition). We will supplement with additional readings as the class proceeds.

Note that many of the readings will be journal articles, which can only be accessed from an on-campus address. To get these readings from off-campus use the UVM VPN, which can be accessed from https://sslvpn.uvm.edu.

3 Objectives

This course has five primary objectives.

1. Demonstrate a qualitative and quantitative understanding of how modern power distribution systems operate from a physics/engineering perspective, including the following elements covered in the text book
   (a) Load modeling
   (b) Distribution (overhead and underground) line modeling
   (c) Methods for voltage management in distribution systems
   (d) Three phase transformer modeling
   (e) Distribution feeder analysis methods
2. Demonstrate a qualitative and quantitative understanding of emerging topics in distribution systems engineering including the following
   (a) Integrating rooftop (behind-the-meter) solar PV into distribution systems
   (b) Integrating grid-scale solar PV into distribution systems
   (c) Advanced Metering Infrastructure (AMI)
   (d) microPMUs
   (e) Systems for behind the meter and grid scale battery management
   (f) Microgrid operations
   (g) Outage management, reliability and resilience
3. Demonstrate an ability to use software tools such as Julia/JuMP to solve simple distribution system optimization problems, such as battery schedule optimization
4. Demonstrate an ability to use software tools such as GridLab-D to solve three-phase unbalanced power flow analysis problems given distribution circuit data

4 Schedule

The precise schedule for this class will be developed throughout the semester.

5 Grading

Grades will be recorded on the course blackboard site (bb.uvm.edu) so check this often. Letter grades will be assigned at the end of the course, based on the standard breakdown:

Score	93%+	90%+	87%+	83%+	80%+	77%+	73%+	70%+	60%+	<60%
Grade	A	A-	B+	B	B-	C+	C	C-	D	F

I typically adjust grades up from the above scheme, though grades will not be adjusted in the other direction. A 93.1% guarantees you an A no matter what. Note that graduate students may be assigned an F for grades that are below 70%.

The following components will form final grades in this class:

- Mid-term (25%) and final (30%) exams. Exams may be take-home.
- Regular out-of-class challenges and mini-projects (40%). Challenges (aka, homework) should be submitted electronically via blackboard. Scanned copies of neatly handwritten work are fine as long as the submission as a whole is in the form of a single pdf (get a scanning tool, such as "camscanner"). Late Challenges may be accepted, at the discretion of the instructor, for no more than 50% credit. Challenges may include:

  - A short set of quantitative problems.
  - A reading assignment (typically journal articles), and a written response.
  - Computer programming assignments, including elements of a microgrid design project (stay tuned)

  - You are welcome to work collaboratively with your classmates on the homework assignments, but you are responsible to turn in your own work (which should not be identical to that of a classmate).
  - Note that we do not generally want to see your computer code unless explicitly requested. In general, if you used computer code to solve the problem, use some text and equations to explain how you got the answers that you did and then use tables or figures to display your results (like a conference or journal paper)

- Final project (15%). The final project will be an extension of elements previously covered in the above "challenges and mini projects." The most important outcome of your project should be a clear and concise 8-minute presentation that describes the problem that you researched (one slide), the data and/or model/methods that you used to attack your problem (2-3 slides), and the results of your research, which should include a few beautifully informative data graphics.

  - You are welcome to work with one or two other class member (teams no larger than 3 students) to develop a "collaborative" project with a joint presentation (with a 12, rather than an 8-minute presentation). Your project will be graded based only on this presentation; a written report is not required. Therefore the presentations should be very high quality. Your presentation should include appendix slides that describe any details that may be helpful in grading.
  - If you are taking this course for undergraduate credit (not including AMP credit), the final project is optional (it can be used to improve your grade, but not doing a report will not hurt your grade). For undergraduate credit, all other graded items will be re-scaled appropriately to produce 100%.

6 Group work

Students are highly encouraged to work together on homework, but not (obviously) on exams. For the final project, see above.

7 Academic integrity

It is expected that everything that you submit with your name on it is your own work. Anything that is not 100% your own work should be clearly labeled as such (credit your sources, group members, etc.). Note that copying and pasting an image, a chunk of text or an equation from the web and sticking it in an exam or on a homework submission, without citing the source is plagiarism. Students who submit others' work as their own may not pass the course and will be referred to the Center for Student Ethics and Standards for further discipline. The UVM policy on academic integrity is a useful guide: http://www.uvm.edu/~uvmppg/ppg/student/acadintegrity.pdf.

8 Statement on Alcohol and Cannabis in the Academic Environment

As a faculty member, I want you to get the most you can out of this course. You play a crucial role in your education and in your readiness to learn and fully engage with the course material. It is important to note that alcohol and cannabis have no place in an academic environment. They can seriously impair your ability to learn and retain information not only in the moment you may be using, but up to 48 hours or more afterwards. In addition, alcohol and cannabis can:

- Cause issues with attention, memory and concentration
- Negatively impact the quality of how information is processed and ultimately stored
- Affect sleep patterns, which interferes with long-term memory formation

It is my expectation that you will do everything you can to optimize your learning and to fully participate in this course.

9 Statement on Students with Disabilities

In keeping with University policy, any student with a documented disability interested in utilizing accommodations should contact SAS, the office of Disability Services on campus. SAS works with students and faculty in an interactive process to explore reasonable and appropriate accommodations, which are communicated to faculty in an accommodation letter. All students are strongly encouraged to meet with their faculty to discuss the accommodations they plan to use in each course. A student's accommodation letter lists those accommodations that will not be implemented until the student meets with their faculty to create a plan. Contact SAS: A170 Living/Learning Center; 802-656-7753; access@uvm.edu; or https://www.uvm.edu/academicsuccess/student_accessibility_services.

10 Statement on Religious Holidays

Students have the right to practice the religion of their choice. Students should submit in writing to the instructor by the end of the second full week of classes their documented religious holiday schedule for the semester. An arrangement could then be made to make up the missed work.