# EE 217 - Smart Grid
# Course Syllabus/policy

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## 1 Overview and Prerequisites

This course is an in-depth study of the ways in which information and communication technologies (ICT) are being deployed to modernize the electric energy infrastructure, i.e. "Smart Grid." In this course we will define Smart Grid as the use of ICT (in combination with power electronics and policy) to make electricity cleaner, less costly, and more reliable.

The prerequisites for this course are either EE 113 and/or graduate student standing.

## 2 Text and readings

The required text for this course is: "Smart Grid (R)Evolution Electric Power Struggles" by Stephens, Wilson and Peterson. In addition, supplemental readings, to be provided through the course web site, will be used extensively throughout the course.

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 six primary objectives. See the schedule below for an outline

1. Demonstrate a high level of qualitative and quantitative understanding of how modern power systems operate from a physical and economic perspective.
2. Describe in detail how ICT is impacting patterns and methods of electric energy generation
3. Describe in detail how ICT is impacting patterns and methods of electric energy transmission
4. Describe in detail how ICT is impacting patterns and methods of electric energy distribution
5. Describe in detail how ICT is impacting patterns and methods of electric energy consumption

6. Demonstrate an understanding of how principles of complex systems, such as power-law probability distributions, self organized criticality, robustness/fragility/resilience, and synchronized oscillators, can aid us in understanding modern power systems.

# 4 Schedule

The schedule will evolve as we go along, however the following is a notional estimate:

| Weeks | Topics |
|---|---|
| 1-2 | Power systems history and basic physics. For those who have had a power systems course already, supplemental challenge problems will be assigned. The history portion will particularly focus on how it is that we ended up with the currently push toward smart grid (a topic that we will revisit throughout the course).<br>• Basics of AC power<br>• The beauty and simplicity of the Electro-mechanical grid<br>• Market and policy changes |
| 3-5 | Smart Grid & power supply<br>• Power System economics<br>• Renewable, intermittent power sources<br>• Storage<br>• The need for demand response—the emissions and economics costs of peak power<br>• Microgrids<br>Note that the Sep. 11 course will be moved to Sep. 13, location TBD. |
| 5-7 | Smart Grid & the retail customer<br>• Advanced Metering Infrastructure & the smart meter<br>• Home area networks<br>• Business cases for AMI<br>• Commercial & Industrial energy management<br>• Distributed renewables<br>• Demand response programs & technology<br>• Energy Efficiency programs & technology<br>We will likely have a mid-term exam during this period. |

| Weeks | Topics |
|---|---|
| 7-9 | Smart Grid & distribution<br>• Advances in storm response<br>• Distributed renewables & storage<br>• Microgrids (part 2)<br>• Distribution network reconfiguration and other intelligent distribution control methods.<br>• Plug-in electric vehicles and the distribution system |
| 9-11 | Smart Grid & transmission<br>• Synchronized Phasor Measurement Units<br>• Flexible AC Transmission Systems<br>• High Voltage DC<br>• VAR control; Synchronized Condensers<br>• Estimating and mitigating blackout, particularly cascading failure blackout, risk |
| 12 | Take-home final exam to be distributed to students by e-mail. |
| – | Our final exam period will be used for project presentations. |

## 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. Both exams will be of the take-home sort, but intended to require not more than 3 hours.
- Regular homework assignments/mini-projects (20%). We will have short homework assignments due roughly once per week. HW is due in class, in ***paper*** format. Late HW will not be accepted, but your lowest score homework assignment will be dropped, so if you miss one it's not a big deal. HW may include:
  - A short set of quantitative problems.
  - A reading assignment (typically journal articles), and a written response.

  - 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).

- Final project (20%). The final project will be on a topic of your choosing. 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 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 other class member 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.
  - 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).

- Seminar attendance & responses (5%). There will be several smart-grid related seminars during this semester. These will be announced as the course goes along. A few of these will be during class periods, and a few will be on Mondays at 1pm. Undergrads are required to attend the in-class seminars and submit a thoughtful 1-2 paragraph written response. Graduates are required to attend both in- and out-of-class seminars, and provide a thoughtful 1-2 paragraph written response to each. Responses will be due during the class period after the seminar (on blackboard). These will be graded on a 0-2 scale, and the lowest score will be dropped (so you can miss one seminar).

## 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.). Students who submit others' work as their own will 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.