**Smart Grid: Security, Privacy and Economics**

Spring 2015, Tuesdays, 2:00-4:45, Sims 337  
PAI 730; LAW 868; ECS 700  
http://presage.syr.edu/

**Steve Chapin**, Electrical Engineering and Computer Science  
**Shiu-Kai Chin**, Electrical Engineering and Computer Science  
**Prasanta Ghosh**, Electrical Engineering and Computer Science  
**Keli A. Perrin**, Institute for National Security and Counterterrorism  
**Peter Wilcoxen**, Public Administration and International Affairs

### Office Locations and Contact Information:

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Email</th>
<th>Office location</th>
<th>Office hours</th>
</tr>
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<tbody>
<tr>
<td>Steve Chapin</td>
<td>chapin</td>
<td>4-295 CST</td>
<td>MW 11-12</td>
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<tr>
<td>Shiu-Kai Chin</td>
<td>skchin</td>
<td>4-293 CST</td>
<td>MW 1-2:30 PM</td>
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<tr>
<td>Prasanta Ghosh</td>
<td>pkghosh</td>
<td>4-131 CST</td>
<td>By appointment</td>
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<td>Keli Perrin</td>
<td>kaperrin</td>
<td>300 Dineen</td>
<td>By appointment</td>
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<tr>
<td>Peter Wilcoxen</td>
<td>wilcoxen</td>
<td>426 Eggers</td>
<td>TT 10:30-12:00</td>
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</tbody>
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### Course Web Site:

Available through Blackboard.

### Course Description and Objectives:

Rapid deployment of advanced communication and networked computer control is revolutionizing the electric power system. The “Smart Grid” as it is often referred to, is allowing greater decentralization, potentially greater energy efficiency, and lower environmental impacts. However, it requires a high degree of connectivity between devices controlled by different parties. The data being exchanged will be highly personal and granular, potentially compromising individual privacy and safety. If not done correctly, decentralized control will dramatically increase the range and severity of cyber security vulnerabilities. This interdisciplinary, team-taught course covers the fundamental engineering, economic, and legal principles underlying the grid. It focuses on building the skills needed to design and test the protocols, policies, and specifications for enabling technologies that will guarantee the security and integrity of the grid while preserving personal privacy and providing maximum market flexibility with minimal need for new regulation. Students who complete the course will be able to integrate four perspectives—technology, security, economics, and law—allowing them to lead the development of the next generation electric grid.

### Textbooks and Course Materials:

There are two required textbooks for the course (one of which is a free PDF file) and additional readings will be made available on Blackboard. Please check Blackboard regularly for updates throughout the semester. The two books are:


Evaluation:

There are three major components to evaluation in this course and they are described briefly below. More details about the group assignments will be provided separately later in the semester.

*Weekly Assignments* (25%). There will be a weekly assignment which will usually be done in class. These are intended to help you apply the concepts covered that day and will be graded mostly on effort. An honest effort that’s on the right track but not exactly right will receive a check; a particularly good effort that’s mostly or entirely right will receive a check plus; and an effort that’s pretty far off track will receive a check minus. Any sort of check is significantly better than failing to turn in an assignment.

*Group Projects* (three at 15% each). There will be three longer exercises that you will do in groups outside of class. The first will focus on communications, control and privacy issues for end users, the second will focus on reliability issues in the distribution grid, and the third will focus on generation dispatching at the transmission level. More information will be provided later in the semester when each project is handed out. The dates the projects will be due are listed below.

*Individual Term Paper* (30%). The remainder of your grade will be based on an individual term paper on a grid-related topic of your choice, subject to approval by the instructors. The assignment will have three components:

- **Prospectus.** The prospectus should be no longer than one page and should include the following information: (1) a concise statement of your topic, (2) a short argument explaining why the topic is important, (3) a list of data or information sources you expect to use, and (4) a very rough outline of what you expect to have in the body of the paper.

- **Paper.** The paper should be 10-20 pages long (double-spaced in 10 or 12 point font) unless a different length has been approved in advance by the instructors. It will be graded on three criteria: factual content, strength and clarity of argument, and quality of exposition. Please pay attention to the paper's organization, spelling, grammar, punctuation, and the layout of graphs and tables: it should look professional.

- **Presentation.** At the end of the semester you will present the key findings from your paper to the class. You will have 10 minutes to present and then several minutes for questions. Your presentation should be suitable for an interdisciplinary audience.

*Participation.* Apart from the weekly assignments, there’s no separate grading component for class participation. However, participation is a vital part of this course and especially important given the interdisciplinary nature of the topic. Please attend all classes and try to participate in discussions and other class activities. Also, please feel especially free to ask faculty and students from disciplines other than your own to explain any points you don’t understand: a key goal of the course is to build everyone’s ability to work in an interdisciplinary setting.

Academic Integrity:

All members of the Syracuse University community—faculty, staff, and students—are expected to abide by the University's academic-integrity policy, which is available at [http://academicintegrity.syr.edu](http://academicintegrity.syr.edu).
For your term paper, please be very careful to use quotes correctly and to include appropriate citations and footnotes to avoid any appearance of plagiarism. Among other things plagiarism includes ANY text cut and pasted from the web or another document without quotation marks (“....”) and a citation or footnote next to it; or simply moving words around or substituting words in a web paragraph. Please be aware that papers may be run through TurnItIn, a web service that is very good at detecting these and other forms of plagiarism.

Accommodations:

Our community values diversity and seeks to promote meaningful access to educational opportunities for all students. Syracuse University and the instructors are committed to your success and to supporting Section 504 of the Rehabilitation Act of 1973 as amended and the Americans with Disabilities Act (1990). This means that in general no individual who is otherwise qualified shall be excluded from participation in, be denied benefits of, or be subjected to discrimination under any program or activity, solely by reason of having a disability.

If you believe that you need accommodations for a disability, please contact the Office of Disability Services (ODS) at 804 University Avenue, Room 309 or call 315-443-4498 for an appointment to discuss your needs and the process for requesting accommodations. ODS is responsible for coordinating disability-related accommodations and will issue students with documented disabilities “Accommodation Authorization Letters”, as appropriate. Because accommodations may require early planning and generally are not provided retroactively, please contact ODS as soon as possible. For more information see http://disabilityservices.syr.edu.

Religious Observances:

SU’s religious observances policy recognizes the diversity of faiths represented among the campus community and protects the rights of students, faculty, and staff to observe religious holy days according to their tradition. Under the policy, students are provided an opportunity to make up any examination, study, or work requirements that may be missed due to a religious observance provided they notify their instructors before the end of the second week of classes. For fall and spring semesters, an online notification process is available through MySlice/Student Services/Enrollment/My Religious Observances from the first day of class until the end of the second week of class. For more information see http://supolicies.syr.edu/emp_ben/religious_observance.htm.
Tentative Topics and Schedule:

Introduction

Jan 13
Introduction
An overview of the grid
Fundamentals of privacy
Fundamentals of security
Exercise

Part 1: End Users

Jan 20
Applications of cryptography
Fundamentals of electricity
Energy services and electricity demand
Exercise

Jan 27
Weaknesses of traditional residential billing
Access to residential usage data
Commercial and industrial usage and billing
Introduction to smart devices and meters
Exercise

Due: prospectus for individual paper

Feb 3
An example smart networked device
Command, control and communication
Securing the example device
Exercise

Out: group project on end users

Feb 10
Distributed generation and demand response
Information sharing: electric vehicle use case
Locational privacy
Exercise

Feb 17
Networks of smart behind-the-meter devices
Smart meters: functions
Smart meters: data and privacy
Exercise
Part 2: The Distribution Grid

Feb 24
- Introduction to distribution grids
- Power system reliability
- Exercise
- Assignment: Submit questions prior to next class
  **Due: group project on end users**

Mar 3
- Communication technologies
- Guest Speaker
- Assignment: Submit questions prior to next class
  **Out: group project on distribution**

Mar 10
- No class: Spring Break

Mar 17
- Data breaches
- Alternative rate models
- Guest Speaker
- Exercise
- Assignment: Submit questions prior to next class

Mar 24
- EVs: Distribution grid challenges
- EVs: Aggregation and demand response
- EVs: Opportunities from vehicle-to-grid flows
- Guest Speaker
  **Due: group project on distribution**

Part 3: The Transmission Grid

Mar 31
- Introduction to the transmission grid
- Tools for analyzing transmission flows
- Monitoring and synchrophasors
- Exercise

Apr 7
- ISOs, dispatching and location-based pricing
- Externalities and social costs
- Exercise
  **Due: individual paper**
  **Out: group project on dispatching**

Apr 14
- Transmission grid mission assurance
- Transmission-level communications
- Regulation
- Exercise
Apr 21

Presentations
Due: individual presentation
Due: group project on dispatching

Apr 28

Concluding discussion

Summary of Key Due Dates:

Jan 27  Prospectus for individual paper
Feb 24  Group project on end users
Mar 24  Group project on distribution
Apr 7   Individual paper
April 21 Group project on dispatching
April 21 Individual presentation