



Maximizing Learning Experience in a Multidisciplinary Team-Taught Course

Anurag Srivastava, The School of Electrical Engineering and Computer Science, Washington State University

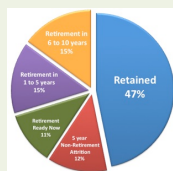


Educational objectives --

- Design a course with multi-disciplinary content including data communication, computing, control, cyber-security and power grid.
- Design a course to target audience of senior undergraduate and graduate engineering/ computer science students.
- Additionally, offer to online distance engineering students or engineers from industry.
- Design course materials to be easily adopted by instructors at other schools.
- Evaluate course outcomes and improve the content.

Workforce need for this education --

- With ongoing smart grid activities, there is a strong need for a workforce with interdisciplinary expertise to have sustained development and progress, specifically cyber-physical security.
- Curriculum at most universities have not yet been revised with ongoing smart grid initiative.
- The expectation is that the students completing this course are prepared to handle problems in smart grid cyber security based on their interdisciplinary expertise.



The developmental history --

Designed by 4 faculty and offered in Spring 2012 for first time and taken by 53 students.

In Class- 7 UG & 1 G (CS), 4 UG & 11 G (EE); Distance – 30 students.

Course Execution --

Course Contents in Spring 2012 (set of slides, multiple book chapters and reading material)

Smart Electric Grid Overview (2-3 weeks)

- Week 1: Overview and introduction to smart grid
- Week 2: Sense, communicate, compute and control in secure way
- Week 3: Performance objective, SCADA, NERC/FERC, operational standards

Communication (3 weeks)

- Week 1: Layered communication model, physical & link layers, network layer
- Week 2: Transport layer: datagram and stream protocols; glue protocols: ARP, DNS, routing
- Week 3: MPLS; power system application-layer protocols: SCADA, ICCP, IEC 61850, C37.118; multi-cast and its uses

Power System Data Management and Computation (3 weeks)

- Week 1: Utility IT infrastructures; control center structure & software; CIMs, IEC 61850 and 61970
- Week 2: Fault-tolerant computing basics; distributed computing basics
- Week 3: Distributed computing architectures; middleware; WAMS data delivery requirements and mechanisms

Cyber Security (3 weeks)

- Week 1: Basic concepts and applications of cryptography, software vulnerabilities
- Week 2: Malware, network attacks, web security, Stuxnet
- Week 3: Network protection, security testing, security practices, governmental efforts

Linking All Topics Together (1-2 weeks)

- Overall system architecture, WAMS application, NERC CIP standards, case studies



Delivery Methods

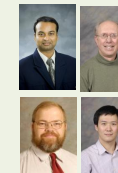
- In class
- Online using Angel and Tegrity tools available at WSU



Teaching Faculty Members

Team taught by 4 faculty members:

- Anurag Srivastava (Power Grid),
- Carl Hauser (Communication)
- Dave Bakken (Data Management/ Computation)
- Min Sik Kim (Cyber Security)



Course Evaluation

- Students feedback and evaluation of course
- Student performance based on 8 assignments, 2 quiz, 1 mid term take home exam, 1 final take home exam, and 1 final project

Overall rating of course by students

Excellent	Good	Neutral	Poor
33%	40%	13%	13%

Learning experience for students

Very Often	Sometime	Few Times	Never
80%	7%	13%	0%

What worked and what not

- Student liked interdisciplinary assignments and the course being very relevant to recent development of the smart grid
- Some of the students felt bored while others worried at any given time due to interdisciplinary nature of course and their background
- Very challenging to teach multidisciplinary course to diverse set of students

Execution plan for next offering --

- Case study based teaching with enhanced collaborative efforts
- Facebook page for the class to encourage interdisciplinary collaboration among students and provide feedback about learning experience
- Online hands-on experimental module integrated with lectures
- Interdisciplinary assignments with clear instructions for collaborative efforts
- Customized reading material before class

