14:332:494, section 2 Topics in ECE, index 18375,

Subtitle: Smart Grid: Fundamental Elements of Design,

Tuesday and Friday 1st period (8:40AM to 10:00AM) COR-538

The course will provide students with a working knowledge of fundamentals, design, analysis, and development of Smart Grid. The course offers an introduction to the basic concepts of power systems along with the inherent elements of computational intelligence, communication technology and decision support system. The automation and computational techniques needed to ensure that the Smart Grid guarantees adaptability and capability of handling new systems and components are discussed. The interoperability of different renewable energy sources are included to ensure that there will be minimum changes in the existing legacy system. Standards and requirements needed for designing new devices, systems and products for the Smart Grid are discussed. Power flow analysis and optimization schemes needed for the generation, transmission, distribution, demand response, and reconfiguration is explained in detail and simulation tools such as Matlab and Paladin are used.

Pre-Requisite Courses: None.

Pre-Requisite by Topic: None.

Textbook & Materials:

- James Momoh, "Smart Grid Fundamentals of Design and Analysis," Wiley, 2012 ISBN 978-0-470-88939-8
- Power point slides handout and lecture notes

References:

- A. Keyhani, "Smart Power Grid Renewable Energy Systems," Wiley 2011

Overall Educational Objective:

To provide students with a working knowledge of fundamentals, design, analysis, and development of Smart Grid, from the basic concepts of power systems to the inherent elements of computational intelligence, communication technology and decision support system.

Course Learning Outcomes:

A student who successfully completes this course will

1. Understand the fundamental element of the smart grid
2. Understand the fundamental structure of the power grid
3. Be able to use simulation tools such as Matlab and Paladin, for power flow analysis, optimization and state estimation
4. Be introduced to communication, networking, and sensing technologies involved with the smart grid
5. Be introduced to computational techniques involved with the smart grid (decision support tools and optimization)
6. Understand, standards, interoperability and cyber security

7. Be able to apply this knowledge in analysis and problem solving of smart grid architectures needs and challenges

How Course Outcomes are Assessed:
- HW Problems (20 %)
- One Mid-Term Exams (35 %)
- Final Exam or Project and oral presentation (45 %)

N = none S = Supportive H = highly related

Outcome	Level	Proficiency assessed by
(a) an ability to apply knowledge of Mathematics, science, and engineering	S	HW Problems, Exams, Lecture Discussions
(c) an ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	H	HW Problems, Exams, Lecture Discussions, Project
(d) an ability to function as part of a multi-disciplinary team	H	HW, Lecture Discussions, Project
(e) an ability to identify, formulate, and solve ECE problems	S	HW Problems, Exams, Lecture Discussions
(f) an understanding of professional and ethical responsibility	H	HW Problems, Exams, Lecture Discussions
(g) an ability to communicate in written and oral form	S	HW Problems, Lecture Discussions
(h) the broad education necessary to understand the impact of electrical and computer engineering solutions in a global, economic, environmental, and societal context	H	HW Problems, Exams, Lecture Discussions
(i) a recognition of the need for, and an ability to engage in life-long learning	H	HW, Lecture Discussions
(j) a knowledge of contemporary issues	H	HW Problems, Exams, Lecture Discussions
(k) an ability to use the techniques, skills, and modern engineering tools necessary for electrical and computer engineering practice	S	HW Problems, Exams,
Basic disciplines in Electrical Engineering	S	HW Problems, Exams
Depth in Electrical Engineering	N	
Basic disciplines in Computer Engineering	N	
Depth in Computer Engineering	N	
Laboratory equipment and software tools	S	Use of Matlab and other simulation software
Variety of instruction formats	H	Lecture & office hour discussions, projects, use of internet resources

Topics Covered week by week:

Week 1: Introduction to smart grid and power grid operation

Week 2-3: Elements of the power grid and measurement technologies: generation, transmission, distribution, and end-user; Basic concepts of power, load models, load flow analysis; Wide area monitoring system (WAMS), advanced metering infrastructure (AMI), and phasor measurement units (PMU); Introduction to simulation tools - Paladin.

Week 4-5: Elements of communication and networking: architectures, standards and adaptation of power line communication (PLC), zigbee, GSM, and more; machine-to-machine communication models for the smart grid; Home area networks (HAN) and neighborhood area networks (NAN); reliability, redundancy and security aspects.

Week 6-7: Elements of power networks and data analysis: introduction to state estimation; detection and identification of bad data; real-time network modeling; dynamic state estimation for the smart grid environment.

Week 8-9: Elements of computation and decision support tools: classical optimization methods, evolutionary computational techniques (genetic algorithms, particle swarm and ant colony optimization).

Week 10: Mid-term

Week 10-11: Elements of distributed energy resources (DER) and grid integration: renewable energy, energy storage; solar energy, wind energy, biomass, hydropower, geothermal and fuel cell; effect of electric vehicles (EVs).

Week 12-13: Elements of management: aspects of energy management in the smart grid; SCADA; microgrids; demonstration projects; case studies.

Week 14: Policy and economic drives of the smart grid; environmental implications; sustainability issues; state of smart grid implementation.

Week 15: Review and Final Examination

Computer Usage:

Students use simulation tools such as Matlab and Paladin.

Design Experiences:

Homework assignment and project have design and verification elements

Independent Learning Experiences:

Homework assignment, projects and simulation assignment for smart grid architecture and analysis.