Department of Electrical and Computer Engineering
University of Central Florida

EEL 4294 Introduction to Smart Grids
Spring Semester 2018

Designation: UG Elective

2017-18 Catalog Description: Fundamentals of electric power systems, distributed generation and smart grid components, voltage control and VAR compensation, demand response, leader-follower optimization, resiliency.

Pre-requisite(s): EEL3307 and EEL 3657; or EEL 4216; or C.I.
(3-phase circuits, electronics, linear control)

Class location and time: TBD

Office hours: TBD

Instructor: Dr. Zhihua Qu.
Office: HEC 439C
Phone: 407-823-5976.
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Course Objectives: The course is to provide students with a working knowledge of fundamentals, analysis and design of Smart Grid. The course offers an introduction to the basic concepts of power systems along with necessary elements of estimation, control and optimization. The automation and optimization techniques are introduced for ensuring that the Smart Grid has adaptability and resiliency as well efficiency and reliability. The goal is to expose students to emerging technologies in this broad field of smart grid and energy systems so the students become prepared for employment as well as graduate schools.

Learning Outcomes: By the end of this course, undergraduate students will be able to:

1. Students will understand fundamentals of power generation, transmission and distribution as well as the core issues that need to be addressed in smart grid
2. Students will have the ability of analyzing power systems: power flow analysis, and dynamic analysis
3. Students will be able to apply basic algorithms of operating and controlling power systems: economic dispatch, unit commitment problem, state estimation, electricity market, VAR control.
4. Students will learn the technologies that support smart grid deployment: PMU, AMI, wide area monitoring, and state estimation.
5. Students will learn the functionality of smart grids: demand response, and resilience.

Textbook Required: Selected topics and chapters from the references. All required support materials will be made available through Canvas and no copyrighted materials will be included in these resources.

References:

- DOE web sites: http://energy.gov/oe/services/technology-development/smart-grid
- J. J. Grainger and W. D. Stevenson Jr., *Power Systems Analysis*, McGraw Hill, 1994
- A. Keyhani, *Design of Smart Power Grid Renewable Energy Systems*, Wiley, 2011.
- J. Momoh, *Smart Grid: Fundamentals of Design and Analysis*, Wiley, 2012
- S. Borlase, *Smart Grids: Infrastructure, Technology, and Solutions*, CRC Press, 2012
- A. J. Wood and B. F. Wollenberg, *Power Generation, Operation, and Control*, 2nd edition, John Wiley & Sons, Inc, 1996.
- Z. Qu, *Cooperative Control of Dynamical Systems*, Springer Verlag, London 2009
- G. M. Masters, *Renewable and Efficient Electric Power Systems*, John Wiley & Sons, Inc. 2004.

Exams, Homework and Grading:

- In-class exam: One exam, 75 minutes, 100 points, open book and open notes. *30% of the total grade.*
- Homework: 7 homework assignments, 100 points each. *10% of the total grade.*
- Projects: 2 projects, 1-week time each, 100 points each, use standard software available. *20% of the total grade each.*
- Lab: 3-5 lab sessions, 2 hour each, and 100 points each. *10% of the total grade each.*
- Supplemental work: Attend 2-3 FEEDER-organized seminars offered by distinguished speakers or utility guest speakers. *10% of the total grade.*

A = $\geq$ 90%	C = 70-74%
B+ = 85-89%	D+ = 65-69%
B = 80-84%	D = 60-64%
C+ = 75-79%	F = < 60%

Instructional Delivery: This course will be 70% lecture, 20% projects and labs, and 10% seminars/discussions.

Class Schedule:

Week 1
Introduction to Smart Grid, Part I
Introduction to Smart Grid, Part II

Week 2
Holiday
SCADA
Week 3
Power flow analysis I
Power flow analysis II
Week 4
Power flow analysis (computer lab, EGN I 257)
Economic dispatch
Week 5
Economic dispatch
Economic dispatch (computer lab, EGN I 257)
Week 6
Unit commitment
Unit commitment (computer lab, EGN I 257)
Week 7
dynamic analysis I
dynamic analysis II
Week 8
State estimation
PMU and State Estimation
Week 9
Spring break week
Week 10
Exam 1 review
Exam 1
Week 11
Electric power market modeling and simulation
voltage and var optimization I
Week 12
voltage and var optimization II
voltage and var optimization (computer lab, EGN I 257)
Week 13
voltage and var optimization (computer lab, EGN I 257)
Power system resilience I
Week 14

Power system resilience II
Power system resilience (computer lab, EGN I 257)
Week 15
demand response and leader-follower optimization I
demand response and leader-follower optimization II
Week 16
demand response / optimization (computer lab, EGN I 257)
Study day
project presentation and submission

Academic Integrity
You are expected to practice the highest possible standards of academic integrity. Any deviation from this expectation, including but not limited to improper citation of sources, using another student's work, and any other form of academic misrepresentation, will result in a minimum academic penalty of your failing the assignment. You will be referred to the Office of Integrity and Ethical Development for possible additional disciplinary measures.

Attendance Policy
This is a undergraduate level course where participation is expected. Hence, absence in excess of 10% of class meetings will result in the lowering of the earned total by one letter grade for each absence in excess of 10%.

Disability Services
Any student with a documented disability should contact the Student Accessibility Services (SAS) at 407-823-2371 to make arrangements for appropriate accommodations.

Submission of Assignments
All submissions should be done through Canvas, UCF webcourse portal www.webcourses.ucf.edu

Distance Learning Related Components
All learning outcomes in this distance learning mode are equivalent to face-to-face version of this course.

This course is an asynchronous online course. Students will work at different times from different locations and will not be required to attend any face-to-face or synchronous meetings at the same time.

All discussion board posts and emails will be responded to within 24 hours. Feedback will be provided on all assignments within 48 hours.

Online lectures will be provided through Canvas. Therefore, students must has access to the Internet to view/hear lectures. No special software is required. Students will also submit all assignments and take all quizzes/tests through Canvas.

Minimal technical skills are needed in this online course. All work in this course must be completed and submitted online. Therefore, students MUST have consistent and reliable access to a computer and the Internet. Before starting this course, students must feel comfortable doing the following. The minimal technical skills students should have include the ability to:

- organize and save electronic files,
- use email and attached files,
- check email and Blackboard daily, and
- download and upload documents.

Contribution of course to meeting the Professional Component: Math & Science Topics (10%), Engineering Topics (80%), General Education (energy, 10%)

Prepared by: Dr. Zhihua Qu **Date:** February 28, 2017

Relationship of the course to Program Outcomes:

Description of the Program's Student Outcomes addressed by the course	
Outcome	**Description**
1	Graduates will have the ability to apply knowledge of mathematics, science and engineering
5	Graduates will have the ability to identify, formulate, and solve engineering problems
11	Graduates will have the ability to use the techniques, skills and modern engineering tools necessary for engineering practice
12	Graduates will have the ability to use differential equation for solving practical engineering problems
13	Graduates will have the ability to use complex numbers for solving practical engineering problems

Relationship of the Student Outcomes and ABET *a-k*													
ABET *a-k* ⇨ / **Student Outcomes** ⇩	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**12**	**13**
1	x												
5					x								
11											x		
12												x	
13													X

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