

ECE 4160/6160 - SMART GRID – SPRING 2020

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CLASS TIME: Tuesdays and Thursdays: 9.30 am to 10.45 am

CLASSROOM: Riggs Hall 226

OFFICE HOURS: Tuesdays: 8.15 am to 9.15 am or by appointment (However, the best way to reach me is via email)

TEACHER ASSISTANT: Parani Arun (parunag@g.clemson.edu)
Office hours: T/TH: 11:00 to 13.00, SB3 Riggs Hall

EMAIL COMMUNICATIONS: When you send me an e-mail message, use a descriptive subject line that starts with the course identifier ("ECE4160/6160"). This can significantly reduce the response time of the reply. If you do not receive a response within 48 hours, resend the message. It may have been caught in a spam filter.

REQUIRED TEXT: J. Momoh, *Smart Grid: Fundamentals of Design and Analysis*, Hoboken, NJ: Wiley, 2012. ISBN: 978-0-470-88939-8.

REFERENCES:

1. S.F. Bush, *Smart Grid: Communication-Enabled Intelligence for the Electric Power Grid*, West Sussex, United Kingdom: Wiley, 2014. ISBN: 978-1-119-97580-9.
2. J. Ekanayake, K. Liyanage, J. Wu, A. Yokoyama, and N. Jenkins, "*Smart Grid: Technology and Applications*", West Sussex, United Kingdom: Wiley, 2012. ISBN: 978-0-470-97409-4
3. Papers from IEEEExplore and Sciencedirect databases.
4. Guest Lectures
5. Additional material may be provided by the instructor.

COURSE OBJECTIVES:

The objectives of the ECE 4160 course are to enable undergraduate students to:

- Apply the interdisciplinary concepts and smart grid technologies learned from this course to design a modern power system, the next generation intelligent grid which is a system of systems.
- Differentiate a traditional power system from an intelligent power grid.
- Be able to contribute to the transformation of a traditional power system into an intelligent power grid.
- Demonstrate the concepts of smart grid technologies via a semester-long team (4 students) project.

The objectives of the ECE 61600 course are to enable graduate students to:

- Apply the interdisciplinary concepts and smart grid technologies learned from this course to design a modern power system, the next generation intelligent grid which is a system of systems.
- Differentiate a traditional power system from an intelligent power grid.

- Be able to think through the A to Z process needed to transform a traditional power system into an intelligent power grid.
- Implement an intelligent power grid.
- Demonstrate the breadth and some depth of smart grid technologies via a working laboratory prototype semester-long team (2 students) project.

COURSE DESCRIPTION: This introductory course on smart grid covers the concepts and technologies that transform the traditional power system into an intelligent power system (which is referred to as the smart grid today). The technologies needed for this transformation are of interdisciplinary nature and are introduced in this course.

The course specifically will cover the following topics:

Week #1:	Introduction and the traditional power system
Week #2:	Smart grid architectures
Week #3 & 4:	Intelligent measurements
Week #4:	Intelligent communication systems
Week #5:	Renewable energy sources
Week #6:	Electric vehicles
Week #7:	Intelligent power electronics
Week #8 & 9:	Computational technologies
Week #10:	Cyber security
Week #11:	Demand response management
Week #12 & 13:	Data and visual analytics
Week #13:	Performance and economic analysis
Week #14:	Smart grid and ethnics

Guest lectures will be offered as available during course of the semester and will be announced via Canvas.

PRE-REQUISITES: The basic requirement is a senior undergraduate standing with MATLAB and other programming language capabilities, Microsoft Office skills (word, presentation and spreadsheet) and creation of PDF documents.

GRADING: The grading requirements are different for the undergraduate (UG) and graduate students (G).

Assignments: a minimum of 6 assignments and no more than 8	
• UG	20%
• G	10%
Discussions (in-class and offline):	5%
Project (Team based):	
• UG : no more than 4 students	25%
• G : no more than 2 students	35%
Tests (include quizzes):	30%
• UG (two tests)	
• G (three tests)	
<i>An additional test for graduate students will be conducted.</i>	
Final Exam (comprehensive coverage of course content):	20%

Grades:

- **UG:** A – 90% - 100%; B – 80 to < 90%; C – 70 to <80%; D – 60 to < 70%; & F – < 60%
- **G:** A – 90% - 100%; B – 80 to < 90%; C – 70 to <80%; & F – < 70%

All disputes about an evaluation of any graded work during the semester must be submitted in writing (typed, not handwritten) within one week after an assignment, test or project has been distributed to students in the class. Any grade challenges must provide specific justifications for why the grade would be changed.

ATTENDANCE:

Regular class attendance and participation in discussions is expected with attendance taken as iROAR requires entry of student's last date of class attendance. Students are responsible for all material covered and assigned readings during the semester. If you anticipate not being able to attend a class for a particular reason, please e-mail me with the information (before the class to be missed). The optimal classroom learning experience depends on both a professional teaching environment and student participation.

In the event of an **emergency**, students should contact the course instructor, preferably before class or the exam. Students should speak with instructors regarding any scheduled absence as soon as possible and develop a plan for any make-up work, if allowed by the instructor. It is the student's responsibility to secure documentation of emergencies, if required by the instructor. A student with an excessive number of absences may be withdrawn at the discretion of the course instructor.

If the instructor is late, students are expected to wait 15 minutes for the instructor to arrive.

TESTS AND FINAL EXAM:

Absence from the tests/final exam will be excused only for medical reasons or serious immediate family problems. A student who anticipates missing a test/exam for legitimate university or professional activities shall discuss with the instructor at least one week prior and set up an alternative arrangement to have test taken before the intended date.

ASSIGNMENT/POST/HOMEWORK:

It is anticipated that there will be at least five assignments and no more than ten.

All course submissions shall be submitted using Canvas no later than **11.55 pm of the posted due date**. No late submissions beyond a day will be accepted. Late submissions require approval of the instructor and may be subjected to a 50% loss of points.

Any homework assigned will not be required for submission but they are mandatory readings. Quizzes and class discussions may be based on homework (missed quizzes will have no make-ups).

MEETING DEADLINES: Plan ahead for the unexpected! You are accountable for staying on schedule should technological or other problems arise. You should immediately contact the instructor if an emergency may affect your ability to meet course deadlines. Do not fall behind. Playing catch-up causes stress, and stress hinders learning.

- PROJECT WORK:** This is team based project. The projects will require written reports in IEEE PES paper format consisting of the following items:
- Title
 - Abstract
 - Introduction and motivation to the project topic with references (use the IEEE bibliography format)
 - Concept/Methodology
 - Description of concept in implementation (flowcharts, algorithms and/or programs)
 - Discussions on the findings and/or results
 - Summary (including future work).

Page length: Eight pages.

TEST/FINAL EXAM DATES (*tentative days):

*First Test:	Tuesday, February 11, 2020
*Second Test:	Tuesday, March 12, 2020
*Third Test (graduate students only, optional for undergraduates):	Tuesday, April 14, 2020
Final Examination:	Wednesday, April 29, 2020, 8.00 am to 10.30 am

Online students are to arrange a proctor and inform the instructor at least a week prior to any scheduled Test/Exam date. All communications are via email.

ACADEMIC INTEGRITY:

The following is Clemson's official statement on academic integrity:

"As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form. In instances where academic standards may have been compromised, Clemson University has a responsibility to respond appropriately and expeditiously to charges of violations of academic integrity."

Further information on Academic Integrity can be found in the [Undergraduate Announcements](#) and in the [Graduate School Policy Handbook](#).

Each student should read this policy annually to be apprised of this critical information.

ACCESS ACCOMMODATIONS

Clemson University values the diversity of our student body as a strength and a critical component of our dynamic community. Students with disabilities or temporary injuries/conditions may require accommodations due to barriers in the structure of facilities, course design, technology used for curricular purposes, or other campus resources. Students who experience a barrier to full access to this class should let the professor know, and make an appointment to meet with a staff member in Student Accessibility Services as soon as possible. You can make an appointment by calling 864-656-6848, by emailing studentaccess@lists.clemson.edu, or by visiting Suite 239 in the Academic Success Center building. Appointments are strongly encouraged – drop-ins will be seen if possible, but there could be a significant wait due to scheduled appointments. Students who receive Academic Access Letters are strongly encouraged to request, obtain and present these to their professors as early in the semester as possible so that accommodations can be made in a timely manner. It is the student's responsibility to

follow this process each semester. You can access further information here:
<https://www.clemson.edu/academics/studentaccess/index.html>.

ANTI-HARASSMENT AND NON-DISCRIMINATION

Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. This policy is located at <http://www.clemson.edu/campus-life/campus-services/access/title-ix/>. Ms. Alesia Smith is the Clemson University Title IX Coordinator, and the Executive Director of Equity Compliance. Her office is located at 110 Holtzendorff Hall, 864.656.3181 (voice) or 864.656.0899 (TDD).

COPYRIGHT STATEMENT:

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FINAL CONSIDERATIONS:

Learning:

At the end of the day it is how much you have learned from this course that matters. You are advised to be active course participant so that you will receive feedback to assist you with your learning and maximize your throughput.

Changes:

Any portion of this syllabus may be changed during the semester by the instructor as needed. You will be notified as soon as possible.

Agreement:

If you disagree with any of the policies or procedures stated above or cannot accommodate the time and work requirements of the course, you need to drop the course as soon as possible. By continuing, you agree to comply with all the policies and procedures described in the course syllabus.

EMERGENCY PROCEDURES:

Emergency procedures have been posted in all buildings and on all elevators. Students should review these procedures for their own safety. Students are required to monitor their university email (see <https://www.clemson.edu/studentaffairs/student-handbook/universitypolicies/email-communications.html>) thus establishing this as a convenient method for official communication to students. Students are also encouraged to enroll in CU-Safe alerts. See <https://www.clemson.edu/cusafety> for more information.

Last updated: January 9, 2020