ECE 4200 & 6200 All Sections
Renewable Energy Grid Penetration

Class Location/Time: Rhodes Annex 111 & ZGEC-102 with Online,
Tuesday, Thursday 11AM -12:15 PM

Instructor: Prof Johan H Enslin Email: jenslin@clemson.edu Office: ZGEC 109
Office Hours: After class or by appointment

Teaching Assistant/Grader (if applicable): Ali Arzani (aarzani@clemson.edu) &
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Course Description

Integration of large-scale distributed renewable energy resources (DER) into the electric grid introduces real-time and near real-time system operational challenges around reliability and security of the power supply.

This course introduces the basic definition of electrical power, interfacing primary sources, generator/load characteristics, and renewable energy resources. Topics include solar energy grid integration, wind energy grid integration, energy storage management, harmonic distortion, voltage sags, and national standards.

Prerequisite: ECE 2070 or ECE 3200, each with a C or better.

Course Objectives

The main objectives of the course are:
• Provide in-depth knowledge on interconnecting renewable energy resources, industry emerging trends, standards, policy and regulations.
• Basic definition of electrical power, interfacing primary sources, generator/load characteristics, and renewable energy resources.
• Topics include solar energy grid integration, wind energy grid integration, energy storage management, harmonic distortion, voltage sags and national standards.
• Provide an opportunity to apply learnings though practical and hands-on case modeling of renewable energy sources.

Required Materials

1. Required: Renewable and Efficient Electric Power Systems, 2nd edition,

2. Course Notes
3. Useful References:

Topical Outline

Classroom Policies: Attendance is strongly encouraged. No make up for missed classes, exams, or assignments will be given. Students are required to be present for the final examination and tests. Students are responsible for all material covered, all extra material assigned for reading and all assignments given. Some lectures may cover material not found in the textbook. It is the responsibility of each student to make up any deficiencies that result from missed classes. Students are expected to wait 15 minutes before leaving if the instructor is late. Cell phones must be turned off or silenced before coming into class.

Note that the design project for ECE-6200 (graduate students) is different from ECE-4200 (undergraduate students).

Class Schedule for Spring 2017 is shown below. Some classes will be in workshop format. Students are expected to present findings and assignment results.

Course Outline:
Chapter 1 The U.S. Electric Power Industry
Chapter 2 Basic Electric and Magnetic Circuits
Chapter 3 Fundamentals of Electric Power
Chapter 4 Solar Resources
Chapter 5 PV Materials and Electrical Characteristics
Chapter 6 Photovoltaic Systems
Chapter 7 Wind Power Systems
External M1 Voltage Drop and Power Loss Calculations
External M2 Application of Capacitors to Distribution Systems
External M3 Distribution System Voltage Regulation
External M4 Power System Harmonics and Filter Design
External M5 Impact of Renewable Energy Resources on Power Grid

Important Dates:
First Class: Thursday January 11, 2018
Last Day to Add a Class: January 17, 2018
Last Day to Drop a Class with “W” Grade: January 24, 2018
Last Day to Drop a Class without a Final Grade: March 16, 2018
Spring Break: March 19-23, 2018
Final Exams: April 30 – May 4, 2018
Grading

The weight of each item and the final grade is as follows:

- Assignments: 10%
- Class Participation (Bonus): 5%
- Design Project: 30% (due 3/8 & 4/19)
- Tests: 30%
- Final*: 30%

Grading Scale:
Below is the letter grade scale that will be used in this class:

**Undergraduate Students:**
- A = 90 – 100%
- B = 80 – 89%
- C = 70 – 79%
- D = 60 – 69%
- F = Below 60%

**Graduate Students:**
- A: 90 – 100%
- B: 80 – 89%
- C: 70 – 79%
- F: 70 % and below

Exams: All students must attend all tests. Makeup tests will not be given under any circumstances. A student who misses a test or the final examination for any reason will receive a grade of zero for that test or examination. To accommodate students who must miss class when a test is given because of a true and documented personal emergency, significant illness or other circumstances beyond their control, the final examination score will be substituted for the missed test score.

All exams and tests are closed book and notes. One double page of notes and equations are allowed and need to be handed in for possible bonus points. No computers with network access are allowed and all smart phones need to be on airplane mode. All questions and problems regarding grades must be presented within one week after the test, homework, or project has been returned.

**Tentative dates for the tests are as follows:**

- **Test 1:** Tuesday, February 27, 2018
- **Test 2:** Tuesday, April 19, 2018
- **Final Examination:** Not confirmed

*Final exam is optional for all students. If a student receives 90% or above in each midterm test, they may be exempted from the final exam if they chose to do so. The final exam is comprehensive and it will replace the lowest mid-term test grade.*
Homework: All homework will be collected at the beginning of the class period in which it is due (Thursday classes). Students are expected to complete all assignments. Late homework will not be accepted. If you are going to miss a class where homework is due, you must turn it in beforehand or receive a zero on the assignment. All homework must be legible and use of engineering or computer paper is preferred. Submissions that cannot be read will be marked wrong.

Bonuses: Bonuses may be added to the total grade during the semester. Bonuses include pop quizzes, IEEE/PES seminars, field trips, and announced bonus homework.

Changes to Syllabus: The instructor reserves the right to make changes to this syllabus during the semester. Students will be given adequate notice in class of any changes.

Students with Disabilities: Students with disabilities who need accommodations should contact the instructor with a Faculty Accommodation Letter from Student Disability Services as soon as possible in order to ensure proper accommodations can be made for the student. The student must notify the instructor at least one week before any test for which accommodations are needed.

Collaboration with classmates on homework assignments is encouraged, however you may not copy solutions and all work submitted must be your own. No work from prior classes may be submitted. Any violations of these policies will be reported to the University.

**Additional Policies**

See Policy - ECE Common Course Syllabus - Fall 2017