
ECE 4200 & 6200 All Sections
Renewable Energy Grid Penetration

Class Location/Time: Riggs 226 & ZGEC-104 with Hybrid / Blended Online with Zoom
Tuesday, Thursday 11 AM - 12:15 PM, or as scheduled
Course Modality: HYBRID / SYNCHRONOUS ONLINE, or as designated in CANVAS / IROAR
Instructor: Prof Johan H Enslin Email: jenslin@clermson.edu Office: Z-GEC 109
e-Office Hours: Per appointment on Zoom

Teaching Assistant: Elaina Stuckey edstuck@g.clemson.edu
e-Office Hours: Tu/Th 9 – 10 AM with Zoom
Grader: Taylor Parks tparks2@g.clemson.edu
e-Office Hours: Mon/Fri 2-3 pm with Zoom

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 and Student Learning Outcomes:

At the completion of the course, students should be able to:

- 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 through practical and hands-on case modeling of renewable energy sources.

Required Materials

1. Required: Renewable and Efficient Electric Power Systems, 2nd edition, by Gilbert M. Masters, ISBN: 978-1118140628.
2. Course Notes and Lectures

3. Each student is required to have a laptop computer, internet connectivity capable of transmitting and receiving video, a video camera, a microphone, do modeling with remote campus access and a cell phone.
4. Useful References:
 - a. Photovoltaic power system: modelling, design and control, by Weidong Xiao, Wiley 2017.
 - b. Microgrid dynamics and control, by Hassan Bevrani, et al, Wiley 2017.
 - c. Electric Energy: An Introduction, Third edition, by El-Sharkawi, CRC Press, 2013.
 - d. Design of Smart Power Grid Renewable Energy Systems, by A. Keyhani, John Wiley & Sons, Inc., 2011.

Topical Outline

Classroom Policies: Class attendance (virtual or hybrid is compulsory for this class through attendance register and Quiz Tests, see [Undergraduate Catalog](#) for guidance. Class attendance (virtual or hybrid in person) is critical to the educational process. In the event of a true emergency, the student should make direct contact with the course instructor, preferably before a class or an exam takes place. Students should also develop a plan for any make-up work. It is the student's responsibility to secure documentation of emergencies, if required. A student with an excessive number of absences may be withdrawn at the discretion of the course instructor. 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, assignments, exams and requirements for ECE-6200 (graduate students) are different from ECE-4200 (undergraduate students).

Class Schedule for Spring 2021 is shown below. Some classes will be in workshop format. Students are expected to present their findings and assignment results in the class.

Course Outline:

Week 1- Chapter 1	The U.S. Electric Power Industry
- Chapter 2	Basic Electric and Magnetic Circuits (Self study)
Week 2 - Chapter 3	Fundamentals of Electric Power (Review)
Week 3, 4 - Chapter 4	Solar Resources
Week 5 - Chapter 5	PV Materials and Electrical Characteristics
Week 6 - Chapter 6	Photovoltaic Systems
Week 7, 8 - Chapter 7	Wind Power Systems
Week 9 - Chapter 9 & M1	Energy Storage
Week 10 - External M2	Standards and Voltage Profiles
Week 11,12 - External M3	PV, Wind and Storage Converters and Characteristics

Week 13 - External M4	Renewables and Electric Vehicles on the Distribution System
Week 14 - External M5	Power Quality and System Reliability
Week 15 - External M6	Impacts on T&D System Protection

Important Dates:

First Class:	Thursday January 7, 2021
January 12, T	Last day to register or add a class, or declare Audit
Jan 18, M	Martin Luther King Jr. holiday
January 20, W	Last day to drop a class or withdraw from the University without a W grade
January 27, W	Last day to apply for May commencement
February 26, F	Last day for instructors to issue mid-term evaluations
March 12, F	Last day to drop a class or withdraw from the University without final grades
Mar 15-19, M-F	Spring break
April 26-30, M-F	Examinations
May 6-7, Th-F	Commencement

Grading

There are frequent project assignments and a comprehensive system design for this course. A final term paper on the project in IEEE format, the design and simulation information and models, will be the Design Project deliverable.

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

	ECE-4200:	ECE-6200:	Dates:
Homework Assignments	15	10	Throughout Semester
Design and Simulation Projects	20	40	Throughout Semester
Mid-term tests and Exams (3)*	60	45	3/11, 4/13 and 4/28
<u>Class Attendance</u>	<u>5</u>	<u>5</u>	<u>Ongoing</u>
Total	100	100	

Grading Scale:

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

Undergraduate Students (4200):	Graduate Students (6200):
A = 90 – 100	A = 90 – 100
B = 80 – 89.9	B = 80 – 89.9
C = 70 – 79.9	C = 70 – 79.9
D = 60 – 69.9	F = Below 70
F = Below 60	

Exams: All students must attend all tests and exams. Makeup tests will not be given under any circumstances. A student who misses a MidTerm Exam or project design 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.

MidTerm Exams and tests will all be on CANVAS or in a Take Home test format. 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 during the class as follows:

Test 1: Tuesday, March 9, 2021 (CANVAS or Take Home Test)

Test 2: Tuesday, April 13, 2021 (CANVAS or Take Home Test)

Final Exam*: Wednesday, 3-5:30 PM, April 28, 2021 (CANVAS or Take Home Test)

Final Project Term Paper: On CANVAS before Wed. 4/20/2021 5:30 PM

*Final Exam is optional for all students. If a student receives 90% or above in each midterm test, with a class average of A or above, they may be exempted from the Final Exam.

Design and Simulation Project (Team Project): There is a comprehensive system design for this course. Details for the project will be provided in a separate file later. A final term paper on the project in IEEE format, the design and simulation information and models, will be counted as the Design Project deliverable. For undergraduates a maximum of four (4) students may participate in a team and for Graduate students a maximum of two (2) will form a team.

Homework: All homework will be collected at the beginning of the class period in which it is due (typical at 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.

Class Attendance Grade: The attendance grade will be calculated from attendance register, and quizzes.

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

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.

Policies Associated with Hybrid Classes

1. The university will assign students a day of the week they are to come this class; on other days, they must attend online.
2. Attendance is mandatory physically present in classes or with video connection via Zoom.
3. For online only students, attendance is mandatory via video connection (Zoom).
4. If a class or test need to be cancelled or reschedules, a notification announcement via CANVAS will be sent.
5. Notification of Absence need to be sent to the TA, with a copy to the instructor via email to inform the instructor of emergency absences.
6. Students need to be available about classroom entry and dismissal. To maintain physical distancing, individuals arriving first to the classroom should sit farthest from the door. Similarly, at the conclusion of class, students closest to the door should leave first.
7. While on campus, face coverings are required in all buildings and classrooms. Face coverings are also required in outdoor spaces where physical distance cannot be guaranteed. Please be familiar with the additional information on the Healthy Clemson website, such as the use of wipes for in-person classes. If an instructor does not have a face covering or refuses to wear an approved face covering without valid accommodation, students should notify the department chair. If a student does not have a face covering or refuses to wear an approved face covering without valid accommodation, the instructor will ask the student to leave the academic space and may report the student's actions to the Office of Community & Ethical Standards as a violation of the Student Code of Conduct. If the student's actions disrupt the class to the extent that an immediate response is needed, the instructor may call the Clemson University Police Department at 656-2222.
8. Specific COVID-19 related information for student absences:
For a student who reports testing positive or is being asked to quarantine because of exposure to the virus, it will be up to the student to inform the instructor that they will be moving to online only instruction for at least the next two weeks. Students are directed to use the Notification of Absence form in Canvas to initiate this notification, which can be found under the "Help" button on the left navigation.
9. Please note that the University may convert to a purely online mode at any time.

Additional Policies

ACCESSIBILITY STATEMENT: 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 a class should let the instructor 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 or by emailing studentaccess@lists.clemson.edu.

Students who receive Academic Access Letters are strongly encouraged to request, obtain, and present these to their instructors 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: <http://www.clemson.edu/campus-life/campus-services/sds/>.

TITLE IX STATEMENT: 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.

SAFE CAMPUS: Clemson University is committed to providing a safe campus environment for students, faculty, staff, and visitors. As members of the community, we encourage you to take the following actions to be better prepared in case of an emergency:

- a. Ensure you are signed up for emergency alerts (<https://www.getrave.com/login/clemson>)
- b. Download the Rave Guardian app to your phone
(<https://www.clemson.edu/cusafety/cupd/rave-guardian/>)
- c. Learn what you can do to prepare yourself in the event of an active threat
(<http://www.clemson.edu/cusafety/EmergencyManagement/>)

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 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.

COPYRIGHT STATEMENT: Materials in this course are copyrighted. They are intended for use only by students registered and enrolled in this course and only for instructional activities associated with and for the duration of the course. They may not be retained in another medium or disseminated further. They are provided in compliance with the provisions of the Teach Act. Students should be reminded to refer to the Use of Copyrighted Materials and "Fair Use Guidelines" policy in on the Clemson University website for additional information: <https://clemson.libguides.com/copyright>.

MODIFICATION STATEMENT: The instructor reserves the right to modify any aspect of the syllabus at any time during the semester for reasons including but not limited to COVID-related situations.