Summer 2018, Session I - Course Syllabus : Fundamentals of Wind Power

Course: ECE & ME 4570 / 6570 - Fundamentals of Wind Power, 3(3,0)

Class Time: Monday – Friday (on line course)

Instructor: Dr. John Wagner, Professor of Mechanical Engineering, jwagner@clemson.edu
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Teaching Assistant (TA): Chengshi (Charles) Wang, chengsw@g.clemson.edu,

Office Hours: *****Telephone_Skype - Questions can be directed to Dr. Wagner and the TA during their (a) scheduled availability as identified in periodic course e-mails, or (b) specific appointments per student's request as communicated and confirmed through e-mail.

*E-mails - Generally limited to administrative questions and the arrangement of Telephone_Skype appointments for Dr. Wagner and the TA

Appointments: You can arrange for a Telephone_Skype meeting by sending a mail message to Dr. Wagner and/or the TA.

Textbooks: J. F. Maxwell, J. G. McGowan, and A. L. Rogers, Wind Energy Explained – Theory, Design, and Applications, John Wiley & Sons, 2010, ISBN: 978-0-470-01500-1. (*recommend hardcopy to accommodate Respondus LockDown Browser*)

Dr. John Wagner, Fundamentals of Wind Power, Lecture Notes and Homework Problems, May 2018. (*available on Canvas; suggest printing a copy to accommodate the Respondus Browser software package*)

References: M. Hansen, Aerodynamics of Wind Turbines, Routledge, 2015.

S. Heier, Grid Integration of Wind Energy Conversion Systems, Wiley, 2014.

F. M. Vanek and L. D. Albright, Energy Systems Engineering – Evaluation & Implementation, McGraw Hill Professional, 2016.

Catalog Description:

Introduces wind turbine systems, including wind energy potention and application to power generation. Topics include wind energy principles, wind site assessment, wind turbine components, power generation machinery, control systems, connection to the electric grid, and maintenance. May also be offered as ECE & ME 6570.

Course Objectives:

1. To develop historical and societal perspectives regarding the demand for mechanical and electrical power generation from the renewable wind using land and offshore turbines.

2. To identify and mathematically model the wind turbine components, calculate the available wind power, predict mechanical loads based on design, and discuss the generation of electrical power.
3. To numerically simulate the wind turbine dynamic system behavior with integration of components, sensors, and control for given application.
4. To evaluate the environmental, political, and economic issues associated with wind energy.

Attendance Policy:

This is an on-line course, so physical attendance is not applicable. However, it is expected that you will view each of the on-line section slides and videos posted on Canvas. You will be responsible for all material covered in class, both from the slides and the required textbook.

Class E-mail:

We will use the Canvas e-mail utility to communicate with the class members. You should check your e-mail regularly, since we will send out important information and reminders this way. You can also contact the instructor and teaching assistant using the e-mail address(es) listed above as well as through the Telephone_Skype.

On Line Procedures:

ECE & ME 4570 / 6570 is an on-line course during the Summer One session. All materials, except for the textbook, will be provided on Canvas. The suggested study pace for the course will also be posted. Procedures for taking the two on-line exams will be provided to the class via on-line postings and/or e-mail messages.

We will only answer e-mails related to administrative issues. It is too difficult and time consuming to answer technical questions with an e-mail. If you really believe you need to ask a quick technical question using e-mail, then please send it to the teaching assistant (TA). Technical questions to us can be asked by making an appointment to call the TA or instructor. If you are residing on the Clemson University campus or in the greater Clemson community this summer, you can also make an appointment for an office visit.

Course Grading:

Final grades will be determined by statistically weighting the homework, midterm exam, and the final exam based on the scale listed below which is composed of three components.

ECE & ME 4570	Homework (assignments throughout summer session)	= 20 %
	Midterm Examination (2.5 hours)	= 40 %
	Final Examination (2.5 hours)	= 40 %
	Total	= 100%

ECE & ME 6570	Homework (assignments throughout summer session)	= 15 %
	Midterm Examination (2.5 hours)	= 35 %
	Final Examination (2.5 hours)	= 35 %
	Design Project	= 15 %
	Total	= 100%

Grading Policy:

All questions and problems regarding examination grades must be presented in writing within two (2) school days after the particular test score has been posted. Course grades will be assigned based on all the work you have completed during the session following traditional practices. In ECE & ME 4570, A=90-100, B=80-89, C=70-79, D=60-69, and F<60 while for ECE & ME 6570, A=90-100, B=80-89, C=70-79, and F<70.

Midterm & Final Exam (Test Attendance Policy)

There will be an open book, open notes, open homework Midterm Exam and Final Exam. You will be allowed to have one 8.5"*11" sheet of paper for each exam on which you may write anything you wish; you may bring along the original sheet to the Final. Exams will be on-line multiple choice, fill-in-the-blank, true/false, and/or essay questions. The midterm and final exam will be held on days 14-of-27 and 27-of-27 (refer to the Suggested Study Pace for Course) and will be 2½ hours in duration. You will be required to use Respondus LockDown Browser on your computer when completing the Canvas-based tests.

An absence from a test will only be excused for a medical reason or a serious immediate family problem. A student who anticipates missing a test should speak with the instructor at least one week prior to the exam date. No make up tests will be given. However, the respective course grading weights listed above might be adjusted (at the discretion of the instructor) to accommodate a missed examination if a compelling basis can be established by the student.

Exam Administration:

Exams must be taken with a pre-approved proctor. Proctors should be a supervisor of the student at a place of employment, a member of the clergy, a librarian, a teacher, and/or some similar profession. Please note that *no immediate family members should serve as a proctor*. The exam proctor must fill out all of the information on the form and then return it to the student so that they can scan and submit this document via Canvas by day 10-of-27. *To ensure the timely completion of this form, a 1% penalty in the final course score will be assessed for each day the proctor form is late*. For convenience, the proctor form is located on-line.

Homework:

Homework assignments along with the solutions will be posted on-line. Students are required to work out the problems in their own handwriting / self-generated computer responses, scan them into a PDF file, and submit their assignments. The homework solutions are due on days 13-of 27 (Sets 1-6) and 25-of-27 (Sets 7-11) as single PDF files to Canvas (note: requested file size <12MB). Working these problems is essential to the learning of the course materials. In fact, most of your learning will come from doing the homework. It is expected that your solutions will represent your own work, although working in groups is allowed, and even encouraged. To reduce the submitted homework for grading, you can select to work 6-of-9 problems for the section assignments. Please complete "Grading Sheet for Homework Problem Sets of Sections 01-11" and attach with the two submissions. *No late homework accepted*.

Design Project (ECE & ME 6570):

A multiple week design project will be assigned on day 1-of-27 for ECE & ME 6570 students to fulfill the graduate requirements of this technical elective. The multi-disciplinary project,

due on day 25-of-27, requires the student to prepare a comprehensive, yet concise, engineering report that fully covers the important issues associated with a small-scale wind turbine installation. The assignment features wind turbine operation and system design, tower selection, electric power connect and control, economic analysis, and acoustic/environmental analysis. Complete information regarding the project, including the scoring rubric, are available in separate documents.

Integrity Disclaimer on Design Project Title Page: All submitted reports must include a signed integrity disclaimer at the top of the front page to be accepted. The disclaimer must be signed by the student. The disclaimer must state, "I certify that all the writing is my own and not acquired from external sources. I have cited sources appropriately and paraphrased correctly. I have not shared my writing with other students, nor have I acquired any written portion of this document from past or present students."

All design reports must be submitted to Canvas at which time the Turnitin utility will scan the document. Turnitin detects and deters plagiarism in written assignments. In the event of plagiarism, a zero will be immediately assigned to the report. Further, the plagiarism will be documented and submitted to the appropriate Clemson University academic office.

Academic Honesty (Clemson University Undergraduate and Graduate Announcements):

"*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.*"

For ECE & ME 4570 students, "When, in the opinion of a faculty member, there is evidence that a student has committed an act of academic dishonesty, the faculty member shall make a formal written charge of academic dishonesty, including a description of the misconduct, to the Associate Dean for Undergraduate Studies. The reporting person may, at his/her discretion, inform each involved student privately of the nature of the alleged charge. In cases of plagiarism (I.B.2.) instructors may use, as an option, the Plagiarism Resolution Form available from the Office of Undergraduate Studies."

Those students enrolled in ECE & ME 6570 should refer to the Clemson University Graduate School "Academic Integrity, Graduate Policy and Procedures (Implementation Date: Fall 2010)" for the graduate level academic honesty materials.

Academic Integrity:

Anyone caught in an act of academic dishonesty (cheating) will be penalized to the extent allowed by Clemson University Academic Regulations. It is the responsibility of the student to become familiar with the official definitions of plagiarism and penalties for violating the academic integrity policies. For details, see the most recent Undergraduate and Graduate Announcements on Academic Integrity.

Canvas:

The Canvas utility (www.clemson.edu/canvas) will be used for this course. For students not familiar with this utility, please visit the Clemson Computer and Information Technology at *www.clemson.edu/ccit/learning_tech/computer_training/student_orientation/index.html* and select the Learning Technology entry. Inside Canvas itself, the Course Syllabus, Schedule, and Examination Proctor Form will be readily located in the "Modules" area if not displayed upon log in. Similarly, the Homework Assignments, Home Solutions, Learning Material Sections (Slides), Learning Material Lectures (MP4 Files), Homework Submission, and Laplace Transform Tables will also be placed in the "Modules" area.

Finally, the submission of the exam proctor form, homework assignment file, and design project (for ECE & ME 6570 students in the latter case) will be located in "Modules – Student Submitted Materials" area of Canvas for the course.

Calculator and Computer Usage:

You will need a scientific calculator for this class for both the homework and the two examinations. The software package MATLAB (The Mathworks) or equivalent (e.g., OCTAVE) may be used for the homework assignments (optional and not required) but not the two examinations. Students completing the design project should plan on submitting a professional appearing comprehensive report featuring text, equations, numerical calculations, graphical results, etc. These individuals may wish to draw upon a variety of computer tools.

Learning Disabilities:

It is Clemson University policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have disabilities. Students are encouraged to contact Clemson University Student Disability Services to discuss their individual needs for accommodation, obtain a letter if appropriate, and then to discuss those needs with us.

Any student with an official Clemson University recognized learning disability should kindly inform the instructor within the 1st week of the course (by day 06-of-27) so that appropriate arrangements can be made to meet the individual's needs.

Clemson UniversityTitle IX (Sexual Harassment) 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 (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) 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/. Mr. Jerry Knighton is the Clemson University Title IX Coordinator. He also is the Director of Access and Equity. His office is located at 111 Holtzendorff Hall, 864.656.3181 (voice) or 864.565.0899 (TDD).

Course Topical Outline:

1. Introduction
2. Historical Perspectives on Wind Turbines
    a. Windmills and Wind Turbines
    b. Global Installations
    c. Case Study – Aermotor Windmill
3. Wind Energy System Components
    a. Blades, hub, nacelle
    b. Gearbox, generator, brakes
    c. Tower, foundation, control system
4. Turbine Design
    a. Review of Fluid Flow Concepts
    b. Aerodynamics and Wind Machines
    c. Blade Design
5. Mechanics and Dynamics
    a. Drivetrain Components
    b. General Principles Primer (stress, strain, vibrations)
    c. Rotor Dynamics
6. Electrical Aspects of Wind Turbines
    a. Electrical Fundamentals
    b. Electrical Machines
    c. Power Converters and Ancillary Equipment
7. Fatigue and Wind Turbine Design
    a. Primer on Fatigue
    b. Fatigue in Wind Systems
    c. Wind Turbine Design Process
8. Wind Turbine Control
    a. Control Primer
    b. Wind Turbine Model
    c. System Monitoring
9. Wind Energy System Economics
    a. Engineering Economics Basics
    b. Wind Turbine Cost Analysis
10. Wind Farm Feasibility Studies
    a. Wind Turbine Siting
    b. Environmental and Wildlife Impact
    c. Noise Issues
11. Conclusion