ECE 566: Grid Integration of Wind Energy Systems

Syllabus
Spring Semester, 2023

Professor:	Dr. James Cale	Email:	jcale@colostate.edu
Office Hours:	By appointment	Phone:	(Given in class)

Meeting Location and Time

Eddy Building, classroom 102, CSU Fort Collins campus, Tuesday/Thursday evenings, 4:00–5:15 PM (MST), also streamed via Echo/Zoom for online students.

Course Description: The modern electricity grid is evolving to include increasing numbers of variable and renewable generation sources. This course covers several aspects of wind energy conversion systems (WECS) and their interconnection to the power grid. The course provides students with the background to understand, model and simulate a complete wind turbine system, including the wind resource, mechanical torque production, electrical motor and drive system responses. Various wind turbine topologies and control concepts are covered. The integration and impact of wind generators on the power grid are also discussed.

Prerequisites[1]

- ECE 461/462 Power Systems-I/Laboratory OR ECE 565 Electric Power Engineering AND
- Working knowledge of MATLAB/Simulink (or similar software) is *required*.
- ENGR 570 Coupled Electromechanical Systems is recommended, but not required

Supplementary Textbooks (not required)

S. Heier. *Grid integration of wind energy conversion systems*. 3rd Ed. John Wiley & Sons: W. Sussex, England, 2014. ISBN: 978-1-119-96294-6.

P.C. Krause, O. Wasynczuk, S. Sudhoff, *Analysis of Electric Machinery and Drive Systems*, 2nd Ed. Wiley/IEEE Press, 2002. ISBN: 978-0471143260.

Other Learning Materials

Additional technical content for this course will provided via the instructor's lecture notes, displayed and/or written during lecture.

Communication Policy

Questions on the course material can usually be answered most quickly via Canvas messaging or email; this is the preferred method when possible. The instructor will respond to your inquiry within 36 hours (typically sooner). For more in-depth questions, you may set up a personal Zoom meeting. Important: this is *graduate-level course*; questions/office hours will not be used to "walk you through" any assignments. Meetings are for clarifying course content or logistical questions, if needed.

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[1]Contact the instructor (jcale@colostate.edu) with questions and/or requests for waivers for the prerequisites.

Course Grading Weights

Homework:	20%
Mid-term exam:	30%
Simulation Project 1:	25%
Simulation Project 2:	25%

Homework

Homework sets will consist of shorter analytical or numerical simulation (component/subsystem) problems, and paper reviews. All homework will be graded and will generally be due two weeks after distribution (dates/times will be listed on the assignment). No late homework will be accepted.

Mid-term Exam

There will be a mid-term exam in this course, which will be released on Canvas on **March 9, 2023**. The exam will be "open-book, open notes" and you will have 48 hours to submit your solution. The mid-term exam problems will be based on the material discussed in lecture, the textbook, and quizzes. A review for the mid-term will be given during class on March 7, 2023. No make-up exams will be given, except possibly under severe extenuating circumstances. If unable to make a deadline or comply with the time constraint for any reason, contact the instructor at least five days beforehand.

Simulation Projects

This course includes two simulation projects, covering subsystem and/or system-level aspects of wind turbine systems discussed in class. You will be allowed to work in teams of 2-3 (max) students. These simulations will include electromagnetic transients and switching-level behavior, generally on μs timesteps. MATLAB/Simulink is highly recommended for performing these simulations, and this software is available to all CSU students. An alternative is EMTDC/PSCAD. Examples and solutions given in this class will use MATLAB/Simulink.

Final Grade Assignments

Grade	Score
A+	96.67–100.00
A	93.33–96.66
A−	90.00–93.32
B+	86.67–89.99
B	83.33–86.66
B−	80.00–83.32
C+	76.67–79.99
C	70.00–76.66
D	60.00–69.99
F	0.00–59.99

Working Together

Studying together in this class is encouraged. However, any individual assignment (homework, mid-term exam) *must be solely your own work.* Projects are the only team-based assignments. Solutions will be checked to ensure academic honestly. Academic misconduct has serious consequences (see below).

Academic Integrity

The faculty expects every member of the CSU community to practice honorable and ethical behavior both inside and outside the classroom. Any actions that might unfairly improve a student's score on homework or examinations will be considered academic misconduct and will not be tolerated. Examples of academic misconduct include (but are not limited to):

- Sharing results or other information during quizzes, projects or examination.
- Working on an assignment before or after the official time allowed.
- Requesting a regrade of answers or work that has been altered.
- Submitting work that is not your own.
- Representing as your own work anything that is the result of the work of someone else. This includes solutions obtained via solution manuals, the Internet and/or other services.

At the professor's discretion, academic misconduct on an assignment or examination/report will result in a reduced score, a zero score, or a failing grade for the course. All occurrences of academic misconduct will be reported to the Vice President for Student Affairs and copied to the Electrical and Computer Engineering Department Head. If there is any question as to whether a given action might be construed as academic misconduct, please see the professor before you engage in any such action. For more information, please see CSU's page on Practicing Academic Integrity.[2] For information on the Honor Pledge, see the Honor Pledge.[3]

Sexual Harassment-Free Environment

Colorado State University strives to create and maintain a work and study environment that is fair, humane, and responsible so that each member of the University community is treated with dignity and rewarded for such relevant considerations as ability and performance. Abusive treatment of individuals on a personal or stereotyped basis is contrary to the concepts of academic freedom and equal opportunity. Sexual harassment is one form of such abuse and cannot be tolerated.

For more information, please see the CSU Office of Equal Opportunity's Sexual Harassment Policy[4] and Principles of Community[5].

COVID-19 University Policy

We will follow all guidance by the University regarding implementation of COVID-19 policies and safeguards, which may change from time to time. As of May 2022, all

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[2]http://learning.colostate.edu/integrity/
[3]http://tilt.colostate.edu/integrity/honorpledge/
[4]http://oeo.colostate.edu/sexual-harassment-policy
[5]http://oeo.colostate.edu/colorado-state-university-principles-of-community/

CSU faculty, staff and students are *required* to use the COVID Reporter[6] to tell the CSU Public Health office without delay if they:

- test positive (even via a home test)

- believe they have been exposed

For the latest information about the University's COVID resources and information, visit the CSU COVID-19 site: https://covid.colostate.edu/.

Additional Resources and Policies

For additional information on university resources and policies, see the "Resources and Policies" document posted under Canvas > Modules > Organizational.

Note: This course was originally conceived and designed by Prof. S. Suryanarayanan, formally with Colorado State University. The current version of this course includes substantial modifications done by Prof. Cale with Prof. Suryanarayanan's consent.

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[6]https://covid.colostate.edu/reporter/