# ECE 562: Power Electronics

*Syllabus*
Spring Semester, 2022


| | | | |
|---|---|---|---|
| Professor: | Dr. James Cale | Email: | James.Cale@colostate.edu |
| Phone: | (970) 412-0494 | Office: | Spruce Hall, Room 16 |
| Office Hours: | T/Th, 11:00–12:00, Spruce Hall, Room 16 (or Zoom, by request) | | |


**Course Description:** This course covers analysis and numerical simulation of basic power-electronic converters. Converters covered include uncontrolled and controlled line-frequency rectifiers; buck, boost and Ćuk converters; single- and three-phase inverters; fly-back and push-pull converters; resonant converters and zero voltage/current switching. We also analyze harmonics in power-electronic circuits and consider magnetic storage/component design. The course includes transient numerical simulation of power-electronic converters in MATLAB/Simulink. 3 credit hours.

### Meeting Location and Time

Military Sciences (MILSC) building, classroom 115, CSU Fort Collins campus, Tuesday and Thursday, 12:30–1:45 PM (MST).

### Prerequisites[†]

- ECE 332 (Electronics Principles II) with a grade of C or higher.
- Working knowledge of MATLAB is required for this class.

### Textbooks

R. Erickson and D. Maksimović, *Fundamentals of Power Electronics*. 3rd. ed., Springer: 2021. ISBN-13: 978-3030438791.

(Supplemental, not required) N. Mohan, T. Undeland, and W. Robbins, *Power electronics: Converters, applications, and design*. 3rd. ed., John Wiley & Sons, Inc: 2003. ISBN-13: 978-0471226932.

### 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 choose to bring them to the office hours on T/Th, 11:00–12:00 (MST). Important: this is *graduate-level course*; questions/office hours will <u>not</u> be used to "walk you through" any assignments. Office hours are for clarifying course content or logistical questions, if needed.

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

### Quizzes

Quizzes will be posted within Canvas and will consist of shorter analytical problems with multiple-choice answers, and/or short simulations. Quizzes will generally be released on a Tuesday and due on Thursday of the following week (see schedule of tentative release dates below). No late quiz solutions will be accepted.

### Tentative Quiz Release Dates

| Number | Released |
|---|---|
| 1 | 2/1 |
| 2 | 2/15 |

### Mid-term Exam

There will be a mid-term exam in this course, which will be released on Canvas on **March 10, 2022**. 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 8, 2022. 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.

### Computer Simulation Projects

This course will include two projects consisting of computer simulations and a summary report describing your results. The simulations will be performed using MATLAB/Simulink (Simscape Electrical library). The purpose of these simulations is to give you more experience applying the analysis techniques introduced in class. The project release dates are shown below. Project solutions (code + report) will generally be due three weeks after the release date.

### Project Release Dates

| | |
|---|---|
| Project 1 | March 22, 2022 |
| Project 2 | April 12, 2022 |

### Software

MATLAB installation `https://www.engr.colostate.edu/ets/matlab/`

### Course Grading Weights

| | |
|---|---|
| Quizzes: | 25% |
| Mid-term | 25% |
| Project 1 | 25% |
| Project 2 | 25% |

**Your grade will be calculated according to the weights above and your earned points on the assignments, *not* what may or may not be shown within Canvas.

**Regrades**

Regrading can only be accommodated under two circumstances: (1) incorrect calculation of scores or (2) incorrect assignment of scores. **All requests for regrading must be turned in within 5 days of the return of the graded project/exam**. When requesting a regrade, contact the course instructor. Note that your solution to the entire problem as well as the regrade request form will be scrutinized and the allocation of partial credit is at the discretion of the grader. In some cases, regrade requests may result in a reduced score.

**Lecture Topics by Session**:[†]

| Session | Topic |
|---|---|
| 1 | Course introduction, quasi-static sources and fields, magnetic material properties, review: energy, power, and phasor analysis |
| 2 | Inductance and inductive coupling, equivalent magnetic circuit representations, analysis of stationary magnetic system (transformers) |
| 3 | Numerical solution of linear and non-linear state-space systems, overview of analytical mechanics (with examples) |
| 4 | Field energy, electromagnetic energy conversion, derivation of linear and rotary force expressions, application to simple devices |
| 5 | Analysis of linear motors and variable reluctance stepper motors |
| 6 | Brushed and brushless (permanent magnetic) DC machines: theory and power electronic drives |
| | Midterm Exam |
| 7 | Winding functions and rotating magneto-motive forces |
| 8 | Reference-frame theory |
| 9 | Analysis of symmetrical induction machines (IM) |
| 10 | Analysis of IMs (continued), analysis of synchronous machine (SM) |
| 11 | Analysis of SMs (continued), analysis of permanent magnet synchronous machine (PMSM) |
| | Fall Recess |
| 12 | Analysis of PMSM (continued), overview of ac machine drives |
| 13 | Special topics: hybrid electric vehicles, magnetically levitated trains, vibratory modes and their mitigation |
| 14 | Finals Week (Final Report Due, Class Presentations) |

[*]Exam date.

[†]Session topics and dates may change based on added/deleted material and observed progress of students. In the event that the instructor is on business-related travel or personal (sick or emergency) leave the respective class may be canceled or taught by a teaching assistant.

**Lecture Material and Text**

Knowledge in this course is cumulative, so it's important to attend the lectures and complete all quizzes and project assignments. If you do not attend a lecture, or need to review prerequisite technical concepts or enhance your knowledge of MATLAB/Simulink, you are responsible for reviewing the material on your own time.

**Working Together**

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

**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 |

**Academic Integrity**

The faculty expects every member of the CSU community to practice honorable and ethical behavior. 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 homeworks, 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 ECE 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.* For information on the

*http://learning.colostate.edu/integrity/

Honor Pledge, see the Honor Pledge.[†]

### 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[‡] and Principles of Community[§].

### COVID-19 University Policy

**Important information for students: All students are expected and required to report any COVID-19 symptoms to the university immediately, as well as exposures or positive tests from a non-CSU testing location.**

If you suspect you have symptoms, or if you know you have been exposed to a positive person or have tested positive for COVID, you are required to fill out the COVID Reporter (https://covid.colostate.edu/reporter/). If you know or believe you have been exposed, including living with someone known to be COVID positive, or are symptomatic, it is important for the health of yourself and others that you complete the online COVID Reporter. Do not ask your instructor to report for you. If you do not have internet access to fill out the online COVID-19 Reporter, please call (970) 491-4600. You may also report concerns in your academic or living spaces regarding COVID exposures through the COVID Reporter. You will not be penalized in any way for reporting. When you complete the COVID Reporter for any reason, the CSU Public Health office is notified. Once notified, that office will contact you and, depending upon each situation, will conduct contact tracing, initiate any necessary public health requirements and notify you if you need to take any steps.

For the latest information about the University's COVID resources and information, please 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.



[†] http://tilt.colostate.edu/integrity/honorpledge/
[‡] http://oeo.colostate.edu/sexual-harassment-policy
[§] http://oeo.colostate.edu/colorado-state-university-principles-of-community/