ECE 562: Power Electronics I

Syllabus
Spring Semester, 2024

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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

Eddy Hall, room 102, CSU Fort Collins campus, Tuesday and Thursday, 4:00–5:15 PM (MST).

Prerequisites[†]

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

Optional Reference Textbooks

(Supplemental, not required) 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.

Primary Learning Materials

The primary learning material for this course will provided via the instructor's lecture slides and notes, displayed and/or written during lecture.

Communication Policy

Questions on the course material can usually be answered most quickly via email or Canvas messaging; email this is the preferred method when possible. The TA or instructor will respond to your inquiry within 36 hours (typically sooner). For more in-depth questions, please schedule an in-person or Zoom meeting with the TA or instructor. 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.

Homework Problems

Homework will be posted within Canvas and will consist of analytical problems and/or simulations. Homework will generally be released on a Tuesday and due Thursday of the following week. No late homework solutions will be accepted.

Mid-term Exam

There will be a mid-term exam in this course, which will be released on Canvas on **March 7, 2024**. 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 5, 2024. 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 28, 2022
Project 2	April 18, 2022

Software

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

Course Grading Weights

Homework:	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 TA. 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.

Tentative Lecture Topics by Week:[†]

Week	Topic	
1	1/16, 1/28	Course introduction, notation, linear and non-linear systems
2	1/23, 1/25	Solution of state-space equations, harmonic analysis
3	1/30, 2/1	Harmonic analysis (continued), Simulink tutorial
4	2/6, 2/8	Line-frequency diode rectifiers (single-phase)
5	2/13, 2/15	Full-bridge line-commutated rectifiers (three-phase)
6	2/20, 2/22	Full-bridge thyristor-controlled rectifiers (three-phase)
7	2/27, 2/29	Magnetics, basic magnetic component design
8	3/5, **3/7**	Exam review, Mid-term exam (take-home, no class session)
9	3/12, 3/14	Spring Break (no class)
10	3/19, 3/21	Non-isolated converters (Buck, Boost, Buck-Boost)
11	3/26, 3/28	Converter small-signal modeling and feedback control
12	4/2, 4/4	Fly-back converters, energy storage applications
13	4/9, 4/11	Three-phase full-bridge inverters, $abc/qd0$ transformations
14	4/16, 4/18	Three-phase inverter control, solar PV models
15	4/23, 4/25	Three-phase grid-tied power flows, Push-pull converters
16	4/30, 5/2	Special topics: resonant converters, zero voltage/current switching
17	5/6, 5/8	Final exam week (no class)

[†]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 homeworks. 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 (homeworks, 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 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 or some*thing* 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 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

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

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