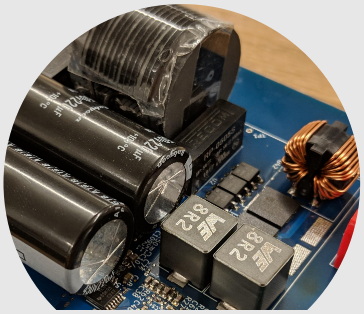

Power Electronics: Modern Topics and Practice

EE 394V

Instructor Info

Alex Hanson

Office Hrs: TBD

EER 7.866

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Course Info

Rec Prereq: EE394J Adv Pwr El

Mon & Wed

1:30p-3:00p

GAR 0.132

Lab Info

recommend M/W

recommend morning

EER 1.808

TA Info

Ao Sun

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Course Philosophy / Overview

Students will spend 150-200 hours or more on a given course, or the equivalent of 4-5 weeks of full-time work. These hours are typically spent on various exercises with no useful output other than as a chance to practice. It's rather like riding a stationary bicycle – you output energy, but you don't actually use it. You just want the exercise.

In this course, I would like to do something useful with your learning. As such, the main focus of the class will be on project(s) where the product is authentically needed, by a real person, right now. In addition to putting your course hours to efficient use, I believe this is the most effective (and enjoyable) environment for learning. I've never met a student who said "I learned more during my last semester of college than I did during my first three months on the job." By embarking on these authentic project(s), I hope to cultivate a sense that we are working together toward shared goals.

The course is designed to introduce you to "doing" power electronics in an authentic research/design scenario in which you have a great deal of ownership over the final product. The project(s) will have an real client (for Fall 2019, the client is me) and the final products, if successful, will be used in real life. The project(s) are chosen to emphasize the "full stack" of project skills – analysis, design, prototyping with PCBs, debugging, and communicating your work.

Along the way, we will cover in class a variety of important topics in modern power electronics. Topics have been chosen based on importance to practicing power electronics engineers, viability of current and future research in that topic, and conceptual/academic value. My goal is not to overload you with assignments on these topics, though I will assign some homework ($\sim$ every other week). Problems are chosen to be interesting, rather than hard. In most cases, the problems are of intrinsic value, and I strongly recommend keeping your homeworks the same way you would keep course notes or a textbook.

Prerequisite Knowledge

This course is a graduate-level course intended for students with some background in power electronics. I assume you are familiar with pulse-width-modulated converters (buck, boost, buck-boost) in continous-conduction and discontinous-conduction modes, the basics of inductor/transformer operation and design, and a strong grasp of fundamental circuits. I don't want to "skip over" anything I assume you already know, but the prerequisite knowledge will be covered quickly and with an attempt to give you an advanced perspective.

Students *must* have had at least one course in power electronics that covered the prerequisites. I *recommend* that students have EE 394J: Advanced Power Electronics under their belt, but I won't require it. If you have concerns, or believe you should be exempt from the pre-requisites, let's talk about it.

Third-party materials

Required Texts – None. I will point you to (and provide) any readings I see as necessary outside of in-class material. Some of the topics we will cover are hot off the research presses and appear in no textbooks I know of. I will provide class notes for some sessions, but not all. As such, I *highly* recommend that you come to class every class period.

For additional perspectives: I recommend these texts as references for the class and I think they are a worthy addition to your personal library. You are not required to have them.

Erickson/Maksimovic, *Fundamentals of Power Electronics* – ISBN: 9788181283634. This textbook is the gold standard reference in the field. It can be tough sledding as a learning aid at times.

Kassakian, *Principles of Power Electronics* – ISBN: 9780201096897. This is an excellent book for learning power electronics. As a reference, the concepts are still good today but some design decisions are quite dated.

Severns/Bloom, *Modern DC-to-DC Switchmode Power Converter Circuits* – ISBN: 9780442213961. This is less a textbook than a reference book covering a *huge* variety of circuit topologies with uniquely-good sections on integrating multiple magnetic components on a single core. An oldy but a goody.

Sevick, *Transmission Line Transformers* – ISBN: 9781884932182. This is one of the only texts on transmission line transformers, a topic that straddles power electronics and rf engineering. There is a new(ish) edition that has been heavily edited by Raymond Mack since Sevick's passing.

Valvano, *Real-Time Interfacing to ARM Cortex-M Microcontrollers* – ISBN: 9781463590154. You may find Professor Valvano's texts useful for your microcontroller code development.

Zinsser, *On Writing Well* – ISBN: 9780060891541. I can't overestimate how important communication is to the career success of a professional engineer in *any* context (academia, industry, government, consulting, ...). Zinsser's book is not about grammar and spelling (nobody cares), it's about writing clearly and concisely. Highly recommended.

Doumont, *Trees, Maps, and Theorems* – ISBN: 9789081367707. Another excellent communication book specifically for those in the sciences and engineering.

Tufte, *The Visual Display of Quantitative Information* – ISBN: 9780961392147. Tufte goes a little overboard at times, but I think everyone should spend some quality time questioning the power of their figures. Plus there's all the pretty pictures.

Make-up Policy

If you foresee that you will have problems meeting the nominal obligations of the class and you talk to me *before* those problems become relevant, I guarantee that we can find a mutually acceptable solution. Otherwise, I make no guarantee. That said, this class is more about your overall output, so little blips along the way shouldn't matter much.

Students are expected to attend classes regularly. A student who incurs an excessive number of absences may incur penalties consistent with university and department policy. That said, this is a graduate course and accommodations will be made for students attending conferences, etc. For your rights and obligations, including for religious holy days, please see: https://catalog.utexas.edu/general-information/academic-policies-and-procedures/attendance/

Please see the registrar for the most up-to-date academic calendar: https://registrar.utexas.edu/calendars/19-20

Inclusivity

This class is a place where you will be treated with respect. I have tried to create a course structure that encourages cooperation and collegiality. I expect *everyone* to respect *everyone* of all ages, professional or personal backgrounds, beliefs/religious affiliations, ethnicities/national origins, genders/gender identities/sexual orientations, abilities - and other visible and non-visible differences. If you experience any behavior that makes you feel unwelcome, please come talk to me immediately.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Services for Students with Disabilities (SSD) office (https://diversity.utexas.edu/disability/) as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please e-mail me as soon as possible in order to set up a time to discuss your learning needs. Official University deadlines may apply.

Academic Integrity

Students are expected to understand academic integrity and adhere to it. *Violations of academic integrity may be out of my hands.* This course anticipates and encourages a great deal of collaboration, and I cannot enumerate everything you must do to be academically honest. Some key points for this class:

- Teach and learn from your classmates on assignments. Still, when you turn them in, you are certifying that the assignment represents *your* understanding and that it is *your* solution.
- Work with your partner(s) on project(s). Still, when you turn it in, you are certifying that you all understand every piece of the project and that you could do it again and alone given the time. You also certify that your contributions were all substantial and that any differences in input were mutually acceptable. Projects must be such that a reasonable person would view you as co-first authors.

For your reference:

- See http://deanofstudents.utexas.edu/conduct/academicintegrity.php
- See https://catalog.utexas.edu/general-information/appendices/appendix-c/student-discipline-and-conduct/ section 11-505 (faculty dispositions) and 11-702(a) (authorized academic sanctions).

Students are expected to uphold the University Honor Code:

"The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, fairness, and respect toward peers and community."

Official Correspondence

The University of Texas at Austin considers e-mail as an official mode of university correspondence: https://cio.utexas.edu/policies/u
electronic-mail-student-notification-policy. You are responsible for following course-related information on the Canvas site for the course.

Course Schedule (subject to change)

Week	Topics	Project items due	Homeworks due
1: Wed Aug 28	PWM Converters Review	-	-
3: Wed Sep 4	PWM review + DCM	P0: KiCad, LTspice, and TI	HW0
4: Mon Sep 9	Switching loss, reverse recovery	-	-
5: Wed Sep 11	Soft switching and gating loss	-	-
6: Mon Sep 16	Passives/μC modules	-	HW1
7: Wed Sep 18	Magnetics	-	-
8: Mon Sep 23	Magnetics	-	-
9: Wed Sep 25	Magnetics	-	-
10: Mon Sep 30	Layout, thermals	P2: Final Schematics due	HW2
11: Wed Oct 2	resonant converters	-	-
12: Mon Oct 7	resonant converters	P3: Layouts	-
13: Wed Oct 9	resonant converters	-	-
14: Mon Oct 14	HF magnetics	P4: Order PCBs	HW3
15: Wed Oct 16	HF Magnetics	-	-
16: Mon Oct 21	HF Magnetics	-	-
17: Wed Oct 23	HF Magnetics	-	-
18: Mon Oct 28	the DAB converter	-	HW4
19: Mon Nov 4	Switched-capacitor converters	-	-
20: Wed Nov 6	Switched-capacitor converters	P5: Final reports	-
21: Mon Nov 11	AC Systems, Commutation	Project 2 proposals	HW5
22: Wed Nov 13	AC Systems, Commutation	-	-
23: Mon Nov 18	Power Factor Correction	-	-
24: Wed Nov 20	Power Factor Correction	-	-
25: Mon Nov 25	Duality	-	HW6
26: Mon Dec 2	Non-electrical modeling	-	-
27: Wed Dec 4	Stacking	-	-
28: Mon Dec 9	Partial/Diferential Power Processing	Project 2 due	-

Grading Scheme

I have saved grades for last because I do not want to focus on them and, more importantly, because **I do not want *you* to focus on them**. Research shows that extrinsic motivators (rewards and punishments, like grades) tend to replace intrinsic motivations (desire to learn, thirst for mastery, curiosity) – economists would say the grades "crowd out" other motivations rather than adding to them. Research also shows that external motivations are short-lived, fickle, and stress-inducing. Nobody needs that.

Furthermore, grades are inauthentic and rarely encountered in the real world. The closest thing you'll likely find is a "performance review" with your boss, which is different in a variety of ways. In a job:

- Rarely are there many of you working on the exact same thing(s)
- Unless you are on the edge of getting fired, the assessment is formative (meant to help you grow and improve) rather than summative (meant to evaluate your fitness)
- How your boss is evaluated is disconnected from what evaluation your boss gives you
- You are evaluated on how well you perform authentic tasks (work with real consequences) rather than synthetic exercises (exams, homework)

Because I am required to give you a grade, I am stuck between an administrative rock and a pedagogical hard place. Below is my best attempt to maximize your learning while satisfying the need for grades:

1. **Choice of assessments:** The class will rely mainly on authentic projects rather than synthetic assessments. I can't cover everything this way, so I will give some homework assignments. There will be no exams.
2. **Feedback approach:** I will hand back each assignment with comments only (when comments and grades are both written, students are less likely to read the comments). For the sake of transparency, if you wish to know your grade on an assignment, we can talk about it in office hours or by appointment.
3. **Opportunity for revision:** I may give you the chance to revise an assignment or do something extra to show me that you've met the learning objectives.
4. **Final grade determination:** At the end of the course, I will ask you what grade you believe you should receive (self-evaluation is also common in performance reviews). Students are surprisingly good at giving themselves fair grades. If we disagree, we will discuss why. The ultimate decision is, of course, mine.

Grades will be "holistic with a minimum." What I mean is that your "calculated" total grade from all of your projects and assignments is the minimum grade I will suggest, but I reserve the right to increase that grade based on a holistic evaluation. Your calculated total grade will be based on the following:

50%	**Project:** This will be an end-to-end design project, i.e. including design, component selection and PCB layout, prototyping, evaluating, and reporting. This will take approximately 2/3 of the semester
25%	**Assignments:** Approximately every other week
25%	**Second Project:** (time permitting, else 70% project, 30% assignments) You will have ownership of this project's subject (i.e. what you'll develop) and its form (e.g. experimental vs written). I will approve your project idea before you begin. Details will be released later in the semester.

Grades will reflect how I would recommend you to my colleagues for a job based only on your performance in the course. Your grade will be on an absolute scale, not relative to your classmates. Nevertheless, if I've inadvertently made any part of the class too hard, I can take that into account (as any letter-of-recommendation writer would take context into account). I translate my recommendation into letter grades roughly as follows:

A	=	"Recommend without reservation" – typically 90+% correct technical reasoning for homework-type problems; 90+% success on achieving project goals with proper design exposition; well-reasoned and clear for written problems/reports (percentages don't apply well here).
B	=	"Recommend with minor reservations about knowledge or work product" – typically 80+% technical, 80+% project success, minor but noticeable difficulties in writing quality.
C	=	"Not recommended, but has content exposure" – typically 70+% technical; 70+% project success; distracting, misleading, or disorganized writing.
D/F	=	"Not recommended."