ECE425: Solid State Power Conversion
ECE821: Advanced Power Electronics and Applications

Fall 2019

Instructor:	Bingsen Wang	Course website:	D2L.msu.edu
Classroom:	EB 1225	Lecture hours:	M,W 5:00–6:20p
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Course Type:

Lecture

Textbook:

P. T. Krein, *Elements of Power Electronics*, 2nd Edition, Oxford University Press, 2015.

Reference Books:

- N. Mohan, T. M. Undeland and W. P. Robbins, *Power Electronics: Converters, Applications and Design*, 3^{rd} Ed., John Wiley & Sons, 2003.
- J. G. Kassakian, M. F. Schlecht and G. C. Verghese, *Principles of Power Electronics*, Addison-Wesley, 1991.

Supplemental Materials:

Additional notes will be provided and posted on D2L.

Objectives:

At the completion of ECE 425 students should be able to:

1. develop and quantify common performance objectives for power electronic circuits, such as efficiency, power factor, etc.
2. develop simple power electronic converter topologies to meet certain functional specifications

3. analyze power electronic converter operation to develop design guidelines for choice of switching devices and reactive elements
4. identify and use switching device and reactive component performance characteristics to apply them appropriately in power electronic circuits
5. obtain averaged state space description and block diagram representation of power electronic converters
6. simulate operation of power electronic converter using general purpose system simulation tools
7. develop and describe dynamic behavior of power electronic converters using small signal transfer functions
8. design simple closed loop regulators for power electronic converters to meet functional objectives
9. extend simple power electronic converters to realize inverters and rectifiers
10. describe operation of diode and SCR based power electronic circuits
11. outline operating principles of application of power electronic circuits as motor drives, UPS systems, active filters, etc.
12. use systematic problem solving techniques to partition complex problems
13. use simplifying assumptions to approach solutions to ill-posed design problems
14. present solutions to technical problems effectively using reports
15. use mathematical analysis software tools to solve engineering design problems

Additional objectives for ECE821 students include:

1. deeply understand the power electronic system in the context of applications
2. demonstrate the skills of system modeling, design, and control in a chosen research project
3. verify the system operation through a detailed simulation

Course Topics:

1. Power converter topologies and realization (2 weeks)
2. Passive Components (1 week)
3. Modulation and waveform analysis (1 week)
4. Single phase and 3-phase inverters (1 week)

5. Single phase and 3-phase rectifiers (1 week)
6. SCR circuit and cycloconverter (1 Week)
7. Matrix converter and multilevel converter (1 week)
8. Waveform analysis and harmonic filtering (1 week)
9. Steady state model and transfer functions (1.5 weeks)
10. Control and regulator design (1.5 weeks)
11. Gate drive and snubber circuits (1 week)
12. Applications of power electronics (1 week)

Attendance:

Attendance is mandatory, but there will be no attendance taken during lectures. Regardless of attendance, it is the students' responsibility to know exactly what is discussed in class and assigned, such as homework, notes, assignments, or changes in schedule. *Absence is not an excuse for anything.*

Attendance of the exams is, of course, mandatory and monitored. Absences due to serious reasons (health, family, religion, job interviews, even participation in sports) may be accepted, if a request and arrangements for a make-up test are made as soon as the student knows. In no case these reasons can become an excuse for lower expectations, nor can the same reason for makeup exams appear repetitively. The Ombudsman's site http://www.msu.edu/unit/ombud/excuses.html has a comprehensive discussion of this.

Quality of Work:

Tests and Homework should be clean, legible, self contained and self explanatory. All assumptions must be stated and thoughts outlined. sequence of equations and results is not adequate. There will be no partial credit given for problems not solved to the end. Work that is not legible or well explained will not be graded.

Prerequisites:

ECE 320, ECE 313, and ECE 420 as a pre- or co-requisite.
Ability to use Kirchhoff's Laws, phasors, Faraday and Ampere Laws, average and RMS power, magnetic media, circuit analysis, and Matlab. Basic understanding of control principles.

Homework and Tests:

There will be a homework assigned almost every week. Solutions will be posted on D2L a week later. Past experience makes it strongly recommended that students do the homework by themselves, or at least attempt it seriously, so that they can come up with questions and solution methods. Keep in mind that the University expects three hours of work at home for every lecture hour, and this expectation remains in this class.

There will be one mid-term exam. You may have one handwritten 8.5 x 11 in sheet of notes, with your name on the top. No photocopies will be allowed. It is a good idea to prepare these sheets well ahead of time, when solving homework problems. For the final exam and you may have two such sheets.

Cheating will not be tolerated at any level. Besides the obvious legal and ethical aspects, cheating lowers the quality of the University degree, angers fellow students, and diminishes the enjoyment of teaching for the instructor. Any instance, even the most minute, will have the heaviest possible repercussions.

Students with Disabilities will have all the accommodations determined by the Resource Center for Persons with Disabilities. The instructor should be notified during the first week of classes of such requirements.

The exam dates are below:

Midterm 1 (Week 8)	Content covered in weeks 1-7	100 pts
Final (Dec 13, 10am-12 noon)	Comprehensive	150 pts
Homework		150 pts
	Total	400 pts

For ECE821 students, there will be an additional research project to be distributed. The research project is worth 100 points. Hence, the total number of points for ECE821 students will be 500.

Late Homework Policy:

For homework that is turned in late, each extra day will cost an additional 10% discount of the originally graded score. For example, if you turn in your homework two days after the due date and the original score is graded homework is 90 out of 100, then your final score for that home work will be 72, which is 80% of the original 90.

Grading:

The raw score points out of either 400 points or 500 points normalized to a score on the basis of 100 points. Then the scaled score is converted to grades.

4.0: $\geq$90	3.5: $\geq$85, $<$90	3.0: $\geq$80, $<$85
2.5: $\geq$75, $<$80	2.0: $\geq$70, $<$75	1.5: $\geq$65, $<$70
1.0: $\geq$60, $<$65	0.0: $<$60	