EGR 433 : Power Electronics

Gordon and Jill Bourns College of Engineering
California Baptist University
Syllabus Part 1
Fall Semester 2025

Course Title:

EGR 433: Power Electronics (3 credits)
This course is required for all Electrical & Computer students.

Course Description (from CBU Undergraduate Catalog):

Introduction to the power electronic systems, power controls, switching circuits; power converter topologies and magnetic components including AC/DC, DC/DC, DC/AC converters and their applications.

Prerequisites or Co-requisites:

EGR 431: Control Systems
EGR 333: Electronics I

Textbook:

Ned Mohan, *Power Electronics, A First Course: Simulations and Laboratory Implementations 2nd Edition* John Wiley & Sons, 2023.

Reference :

Daniel W. Hart, *Power Electronics,* McGraw Hill, 2011.

Course Objectives and Expected Learning Outcomes:

Upon successful completion of this course, students should possess the following skills.

1. Describe the role of Power Electronics as an enabling technology in various applications such as energy conservation, renewable energy, transportation, flexible production systems, etc. (Ch 1)
2. Identify a switching power-pole as the basic building block and to use Pulse Width Modulation to synthesize the desired output. (Ch 1)
3. Design the switching power-pole using available power semiconductor devices, their drive circuitry and driver ICs and heat sinks. You will be able to model these in PSpice. (Ch2)
4. Learn the basic concepts of operation of dc-dc converters in steady state in continuous and discontinuous modes and be able to analyze basic converter topologies. (Ch 3)
5. Using the average model of the building block, quickly simulate the dynamic performance of dc-dc converters and compare them with their switching counterparts. (Ch 3)
6. Design, using simulations, the interface between the power electronics equipment and single-phase and three-phase utility using diode rectifiers and analyze the total harmonic distortion. (Ch 5)

7. Design the single-phase power factor correction (PFC) circuits to draw sinusoidal currents at unity power factor. (Ch 6)
8. Learn basic magnetic concepts, analyze transformer-isolated switch-mode power supplies. (Ch 7, Ch 8)
9. Learn the basic concepts of operation of inverters.
10. Learn the theoretical background of photovoltaics and the role of power electronics in a solar system.
11. Learn the role of Power Electronics in utility-related applications which are becoming extremely important.

Class/Laboratory Schedule:

The class meets three times every week for 1 hour per session. The laboratory component has roughly one session every week. Each lab session is 2 hours. The laboratory will parallel class work. Lab assignments will be assigned regularly.

Contribution of Course to Meeting the Requirements of the ABET Criterion 5:

Estimated content: Engineering Science – 2 credits, Engineering Design – 1 credits..

Relationship of Course to Program Outcomes:

This course addresses the following CBU ECE student learning outcomes: SLO #1, 2, 4, 5, 7, 11.

Prepared by: Seunghyun Chun **Date:** 24, April, 2025

EGR 433 : Power Electronics

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Syllabus Part 2
Fall Semester 2025

Class/Laboratory Meeting Times and Locations:

Lecture: T,R 12:15-1:45 pm, TEGR201
Laboratory: Section A : M 2:30-4:30 pm, TEGR 314

Instructors:

Dr. Seunghyun Chun (Lecture Section A, Lab Section A)
Office: TEGR 319 Phone: (951) 552-8641
E-mail: schun@calbaptist.edu
Webex(For Virtual Office Hours) : https://calbaptist.webex.com/meet/SChun
Office hours: M,T,W,R 10:30a – 12:00p, M,W 1:00p – 2:00p

Curriculum Partners : CUSP (University of Minnesota), Mr. Yonghan Kang(AMD), Mr. Philip Schaefer(Masters Electric/Pacific Energy)

Course Purpose:

This course is an introduction to the devices, circuits, and systems utilized in power electronics. An overview of power semiconductors: switching diodes, thyristors, gate turn-off thyristors, insulated gate transistors, MOS-controlled thyristors, and other controllable switches. General power electronic circuits such as uncontrolled and phase controlled dc converters, dc-to-dc switch mode converters, dc-to-ac switch mode inverters, and their application in motor drive, speed control, and power supplies are included.

Software Tool:

You will be using a simulation software PSpice 9.1 Student Version. For information on a student version of, please check out this link:
http://www.ece.umn.edu/groups/power/labs/pspice_pe/pspice_installer_with_pe_libraries.zip

Course Information on Blackboard:

Some of the course materials will be posted online at the CBU Blackboard. Please check it regularly. Also check your CBU email for messages and homework solutions.

Course Instructional Method:

This course consists of lectures, two mid-terms, a final, homework and laboratory assignments.

Homework:

Homework is due on ***Friday 10:00am*** of each week**.** Solutions will be provided during the following class. You should write your name clearly on the first page of your homework. **The work submitted most be your own work and must be neat and legible.**

Laboratory:

The laboratory will parallel class work. Lab assignments will be assigned regularly. Each student should find a partner for the semester and work in groups of two in the lab. Some labs may have pre-labs, which must be done **before you go to the lab**. If there is a pre-lab, show your pre-lab work to the instructor before you start the lab. A lab report is due at the start of the next lab. Lab reports must be typed, unless otherwise indicated. You are responsible for documenting the work you have **done in a clear and concise manner**. You will be graded on the logical steps of your work, organization, and quality of technical presentation. Each student must submit his/her own pre-lab and lab report, unless otherwise indicated.

Attendance:

Attendance at all lectures and labs is required. Attendance will be taken at the beginning of classes. You must give the instructor a written notice (or email) in advance, or within 24 hours after class in case of an emergency. A note from your doctor, coach of campus sports team, court, etc. may be required if applicable. **You will lose 1% of your final grade (up to 5%) for each unexcused absence**. While an attendance grade of 0% (exactly 5 unexcused absences) is possible, any subsequent unexcused absence will result in a grade of "F" for the course. The student is responsible for studying materials covered during missed class and completing associated course work. **Students with 3 unexcused absents or 3 missing assignments or 5 failing grades will be reported to** Retention Alert **(Retention Management).** You can also check your attendance record on insideCBU to make sure it is correct.

Makeup policy:

Make-up exams or labs will be allowed only for excused absences.

Grading Policy:

Attendance	5%
Homework	15%
Laboratory	20%
Midterms	30% (15% + 15%)
Midterm #1	15% (covers (Ch. 1)-(Ch. 3))
Midterm #2	15% (covers (Ch. 1)-(Ch. 6))
Final	30% (comprehensive (Ch. 1) – (Ch. 14))

Grades will be assigned on the following basis:
A 93-100% A- 90-92% B+ 87-89% B 83-86% B- 80-82%
C+ 77-79% C 73-76% C- 70-72% D+ 67-69% D 63-66% D- 60-62%
F below 60%

Notes:

- **No late homework will be accepted.**

TENTATIVE SCHEDULE EGR 433

CLASS	Chapter	SECT	Lecture Topics	Lab
9/2	Chapter 1	Intro, 1.1 - 1.4	• Introduction to Power Electronics	No Lab
9/4	Chapter 1,2	1.5-2.2	• Basic Building Block	
9/9	Chapter 2	2.3-2.4.3	• Design of Switching Power-Pole	Lab Intro/Safety
9/11	Chapter 2,3	2.4.4-3.4	• Practical Considerations in Implementing Switching Power-Poles DC-DC Converters	
9/16	Chapter 2,3	2.4.4-3.4	• Practical Considerations in Implementing Switching Power-Poles DC-DC Converters	Safety Quiz PSPICE Intro MOSFET Lab
9/18	Chapter 3	3.5-3.6	• Buck Converter • Boost Converters	
9/23	Chapter 3	3.7 – 3.11	• Buck Boost Converter • Other Topologies	PSPICE Practice with Buck Converter Prelab
9/25	Chapter 3	3.12-3.15	• Average Representation • DCM in DC-DC Converters	
9/30	Exam 1 Review			Buck Converter Lab
10/2	**Exam 1, CH 1-3**			
10/7	Chapter 4	4.1 – 4.3.1	• Review of Linear Control Theory	Boost Converter Lab
10/9	Chapter 4	4.3.2- 4.4	• Linearization of various transfer function blocks. Voltage Mode Control Design	
10/14	Chapter 5	5.1-5.2	• Waveforms • Rectification	Buck Boost Converter
10/16	Chapter 5,6	5.3-6.3	• Diode Rectifier Bridge	
10/21	Chapter 6	6.1-6.3	• PFC	Voltage Mode Control Lab Simulation Lab
10/23		6.4-6.9	• PFC Controller	
10/28	Exam 2 Review			No Lab
10/30	**Exam 2, CH 4-6**			
11/4	Chapter 8	EM Basics 8.1-8.4	• EM Basics • Flyback Converter	No Lab
11/6	Chapter 8	8.5- 8.8	• Forward Converter • Full Bridge Converter • Half Bridge Converter	
11/11	Inverters	Lecture Slides	• Full Bridge Inverters • Squarer-Wave Inverters • Anti Parallel Diodes	Flyback Converter Simulation Lab
11/13	Inverters	Lecture Slides	• Total Harmonic Distortion of Inverters • Amplitude and Harmonic Control	
11/18	Inverters	Lecture Slides	• Multilevel Inverters	No Lab
11/20	Inverters	Lecture Slides	• Pulse Width Modulation switching	
	Thanksgiving Holiday			
12/2	Comprehensive Review			
	Final Exam : Tuesday, December 9, 2025, 9:30am – 11:30am, TEGR201			

Academic Integrity:

Students are encouraged to help each another, but ***academic dishonesty will not be tolerated***. Detailed information on academic dishonesty and guidelines for academic integrity can be found on the home site for the College of Engineering on Blackboard (it is listed as CBU Engineering). You can find the academic integrity policy in "Academics" in the section "Engineering Policies".

Note that you must work on the solution to a problem or program by yourself (although it is permissible to discuss the concepts and requirements with your classmates). Be prepared to explain your solution to the instructor. Blatant copying of another student's completed work will result in a grade of zero for all parties involved. Provable cases of academic dishonesty will be reported to the Dean of Students.

Recording Class Sessions:

Recording of class sessions without the prior express written permission of the instructor is prohibited. Any permission granted shall include the requirements that a recording may only be used for content study purposes only and sharing a recording with anyone outside of the course and/or posting on social media are strictly prohibited. This course policy is in alignment with Student Handbook and the Standard of Student Conduct. Refer to Student Handbook policies 15.6, 15.7, and 15.8 for more information.

Generative Artificial Intelligence (AI)

Generative AI (ChatGPT, Github Copilot, etc.) provides the foundation for a valuable set of tools within our industry and, as such, is something that students should become comfortable using in an ethical way. The use of generative AI should be treated the same as collaboration with another student and, as such, whenever generative AI is consulted there should be acknowledgement of that input listed in a prominent location at the top of the first page of your assignment or in the comments at the top of your code.

As we, as a society, grapple with the ethical use of Generative AI, it is best to ask if its use is appropriate until more formalized standards are in place. Also, it is important for students to understand several things about generative AI:

1. It is often incorrect, and this may or may not improve over time. The code/answers recommended by a generative AI tool should ALWAYS be checked against authoritative sources (just like anything that comes from an external source).

2. Any code submitted to a generative AI site becomes PUBLIC DOMAIN. Students should NEVER willingly paste anything (code, documents, etc.) that is proprietary and subject to copyright.

In general, students are responsible for the work they submit. All final submissions should be a student's own work with proper credit given to all collaborators (whether the source is humans or a generative AI).

Finally, while the instructor may permit and/or encourage Generative AI tools for some assignments, the instructor also holds the right to ban Generative AI tools for other assignments (and will do so, especially for exams, for example). Thus, it is imperative that, while Generative AI tools can be amazing for productivity and learning, the student is still expected to be able to demonstrate proficiency in all course material WITHOUT the use of Generative AI.

Use of Artificial Intelligence (AI) Tools

Students are permitted to use artificial intelligence (AI) tools (such as ChatGPT, Copilot, etc.) to support their learning on homework and lab assignments in this course. These tools can be helpful for exploring problem-solving approaches, checking reasoning, and reviewing circuit concepts.

However, students are expected to:

- **Engage critically** with AI output, verifying correctness and understanding the steps. AI is fallible and may provide incomplete or incorrect solutions.
- **Document usage** when significant help is received from AI (e.g., noting "Used ChatGPT to help verify KCL setup for Problem 3").
- **Do their own work** on quizzes and exams, where AI use is strictly prohibited.

The goal of this policy is to encourage students to use AI as a *learning aid* rather than a substitute for problem-solving. Proper use of AI should enhance your understanding of circuit theory, not replace it.

CBU's College of Engineering Mission Statement:

"Preparing engineering students of competence and character, with a Christian worldview who are called to serve, equipped to lead and sent to engage the world with their lives and the appropriate use of technology."

CBU's College of Engineering Program Objectives:

We believe that achievement and ongoing development of all of the engineering program objectives are dependent upon a thorough understanding of the Christian worldview and its implications and relevance for the individual and their interaction with and service to humanity. Hence our first goal is foundational to all of the rest. Expanded explanation can be found in the online document below:
http://www.calbaptist.edu/engineering/default2.aspx?id=3680

Our alumni will show evidence of integrating a Christian worldview into their life and vocation by following the example of Christ in being an articulate, ethical and empowered servant leader. This implies being aware of and meeting the needs of humanity by doing most if not all of the following: serving community and faith based organizations, serving professional societies, and serving employers by being a steward of time, competencies and resources.

Our alumni will show evidence of being competent in core disciplines of engineering by active participation in professional engineering activities. These activities will involve some of the following: creating, researching, innovating, designing, building, testing, inspecting, evaluating, estimating, planning, allocating, forecasting, selling, educating, communicating and collaborating.

Our alumni will show evidence of recognizing the importance of lifelong learning through involvement in post graduate learning activities. These activities would include participating in training or continued education, receiving a post graduate degree, attending and or delivering presentations, papers or posters at professional conferences, taking and passing the EIT and PE exam, and/or attending or delivering presentations at professional society meetings or in academic and educational settings.
Our alumni will show evidence of success in at least one of a variety of post graduate experiences. These experiences include but are not limited to employment in industry, public service, education, missions/NGO's, and/or participation in graduate school.