College of Engineering and Architecture
Electrical Engineering and Computer Science
COURSE SYLLABUS

EECE418 Power Electronics

Instructor's full name: Charles Kim
Title: Power Electronics
Office location: LKD 3014
Office/department phone: 202-806-4821
Office hours: TR 1 - 3
Email address: ckim@howard.edu

CRN:
Credit hours: 3 credits
Class meeting days and hours: MW 11:10 - 12:30 pm
Classroom location: LKD3105
Semester and year: Fall 2025
Course website: www.mwftr.com/418F25.html

Course Description

Power electronics circuits convert electric power from one form to another using electronic devices. This course focuses on controlling power semiconductor devices to achieve power conversion functions. However, the emphasis of the course is on the circuit topology and functions rather than on semiconductor devices. The semiconductor devices work as switches for controlling output voltages and currents. The following 3 converters are specifically emphasized: ac to dc rectifiers, dc to dc converters, and dc to ac inverters. Applications of power electronics range from high-power conversion equipment, such as dc transmission, to everyday appliances, such as cordless screwdrivers or power supplies for phones and computers. Analysis tools and methods are discussed through the course to analyze the converters. In addition to the converter circuit analysis and simulation, a data-driven approach is also incorporated to understand the relationship between circuit parameters and the output voltage and current. This hybridization of circuit models and data-centric approaches align with the AUC Data Science & Analytics (DSA) Framework and the departmental goals of incorporating data science and machine leaning in teaching and research.

Prerequisites or Co-requisites

EECE203 Circuit Theory.
Content knowledge in EECE309 Electronics is not required but is helpful.

Course Objectives

1. Students understand the uncontrolled and controlled rectification of ac source.
2. Students understand the controlled dc-to-dc conversion
3. Students understand the controlled dc-to-ac inverter circuits

Student Learning Objectives: Upon completion of the course, students should be able to

1. solve power semiconductor converter's performance behavior by applying circuit model based approaches
2. simulate using circuit simulation software power semiconductor converters
3. measure and collect data from simulated converters, and critically analyze them and understand the relationship between the device parameters and the outputs of the devices.

Instructional Methods

1. In-person lecture
2. In-class activities

Textbooks, Tools, and Material

Textbook Information 1: Daniel W. Hart, Power Electronics, McGraw-Hill, ISBN: 978-0-07-338067-4
Textbook Information 2: Andrzej Trzynadlowski, Introduction to Modern Power Electronics, Wiley, ISBN: 978-1-119-00321-2.
Textbook Information 3: Shashi B. Dewan & Alan Straughen, Power Semiconductor, Wiley, ISBN: 978-0471211808.
Software Information and Access Instructions: LTSpice.
Other Materials: Supplied when needed.

Course Data Science Tools Access Instruction and Overview

For data-drive solution approach in Power Electronics, some data science tools are essential for data visualization and statistical analysis to machine learning and data cleaning. The minimum necessary tools are listed for access and overview.

TensorFlow

TensorFlowLinks to an external site. is an open-source machine learning framework developed by Google. It allows data scientists and developers to build and deploy machine learning models, particularly deep learning models. TensorFlow is highly versatile and supports a wide range of tasks, from image and speech recognition to natural language processing and predictive analytics. To make the onboarding smoother, start with TensorFlow's high-level Keras API, which simplifies model-building and is beginner-friendly. Due to its extensive library and robust community support, TensorFlo
w has become one of the most widely used tools in the machine learning ecosystem. You can also use TensorFlow within a Jupyter Notebook (discussed below) or with Google ColabLinks to an external site. without the need for a local setup.

Jupyter Notebook

An open-source interactive web-based platform, Jupyter NotebookLinks to an external site. allows users to write and run code in various programming languages, including Python, R, and Julia. It enables users to create and share documents that contain live code, equations, visualizations, and narrative text. Jupyter is essential for data cleaning, statistical modeling, and machine learning model development.

Google CoLab

Google Colaboratory, or ColabLinks to an external site., is a hosted Jupyter Notebook service that requires no setup to use and provides free of charge access to computing resources. Colab is suited to machine learning, data science, and education. Being a hosted Jupyter NotebookLinks to an external site. service, it allows users to write code in a web browser without needing to install any software locally. Colab integrates with Google Drive, allowing users to share their work. Also Colab notebooks can be loaded from GitHubLinks to an external site..

Kaggle

KaggleLinks to an external site. is an online platform for data scientists and machine learning researchers. It is well known for its resources of datasets, competitions, and notebooks. The

Kaggle platform provides a collaborative environment for sharing projects, code, and ideas, making it an ideal tool for anyone who aims to experience hands-on data science activities.

Matplotlib

A Python library called MatplotlibLinks to an external site. is for creating static, animated, and interactive visualizations. It offers a flexible and powerful interface for creating a wide variety of graphs and plots, including bar charts, pie charts, scatter plots, and histograms. It is suitable for generating professional-quality visualizations and reports. It is often used alongside other Python libraries like NumPy, pandas, and Seaborn for data exploration and analysis.

Seaborn

Seaborn is a Python data visualization library based on matplotlib. It provides a high-level interface for drawing attractive and informative statistical graphics. To see the code or report a bug, please visit the GitHub repository. General support questions are most at home on stackoverflow, which has a dedicated channel for seaborn.

scikit-learn

scikit-learnLinks to an external site. is one of the most widely used Python libraries for machine learning. It provides tools for data mining and analysis. It supports a range of machine learning algorithms including classification, regression, clustering, and dimensionality reduction. It is built on top of NumPy, SciPy, and Matplotlib, integration into existing data science workflows easy and convenient.

Course Schedule (Bi-Weekly Module)

Module	Subject	Topics
1	Background and Review of Circuit Analysis	• Industrial Power Converters • Switches • Power Computations I
2	AC to DC Rectifier I	• Power Computations II • Uncontrolled Half-wave rectifier
3	AC to DC Rectifier II	• Controlled Half-wave rectifier • Uncontrolled Full-wave rectification • LTSpice simulation of Half-wave and full-wave rectifiers
4	AC to DC Rectifier III	• Controlled Full-wave rectification • Simulation of full-wave rectifier and data collection under different circuit parameters • Data Science Lab session for data wrangling & visualization • Relational analysis of the simulated rectifiers
5	DC-to-DC Converter I	• Linear Voltage Regulators • Basic Switching Converter • Buck Converter
6	DC-to-DC Converter II	• Boost converters

		• Buck-Boost Converter • LTSpice simulation of DC converters • Measurement and data collection of simulated DC-DC converters • Data Science Lab session for data wrangling & visualization • Relational analysis of the simulated DC-DC converters
7	DC-to-AC Inverter I	• Half-bridge and full-bridge inverter circuit • Square Wave Inverters • LTSpice simulation of inverters
8	DC-to-AC Inverter II	• Pulse-Width-Modulation • Pulse-Width-Modulated inverters • Simulation and data measurement of single-phase bridge inverter • Data Science Lab session for data wrangling & visualization • Relational data analysis of the simulated bridge inverter for finding relationship between the device parameters and the output

Course Requirements *(What must students do to fulfill the objectives?)*

1. Class Attendance
2. Active Participation
3. On-time assignment submission
4. Academic Integrity: The "Academic Code of Conduct" in the H-Book prohibits cheating, plagiarism, and copyright infringement. Penalties for violations range from a "0" for the assignment or exam to an "F" in the course or suspension. See CETLA's Plagiarism webpage for more information about plagiarism as well as ways to avoid it. Please note that in this course I reserve the right to check your work using a plagiarism detector such as Turnitin.

Course Policies

1. Computation of Final Course Grade

Category 1: Assignments (30%)
Category 2: Quizzes (20%)
Category 3: 3 Mid-Term and Final Exams (40%)
Category 4: 1 project (10%)
Category 5: Attendance (on time arrival) (extra 5%)

Total: (100 + 5) %
Letter grade scale: A>=90; 90>B>=80; 80>C>=70; 70>D>=60; F<59

2. Incomplete Grades and Withdrawals

A grade of Incomplete (I) is given only if you have fulfilled most of the course requirements prior to the Registrar's withdrawal deadline and an emergency prevents you from completing the course. Such an emergency must be documented by your dean or advisor. However, if you have not completed most of the coursework, make sure you withdraw before the deadline; otherwise, I will have to enter the grade you have earned thus far. Please note that if you receive an Incomplete, you can complete only the coursework you missed, and you must complete that work by the end of the following semester, in accordance with University policy.

3. Lateness

If you cannot submit homework on time because of an emergency, you should document the emergency. (For instance, submit a doctor's note.) If you experience computer-related problems, you should request a note from a technical assistant or, immediately e-mail helpdesk@howard.edu and "cc" me to document your problem.

4. Missed Exams or Classwork

If you miss a quiz or other classwork because of an emergency, you should submit a documented excuse as explained above. Then I will determine whether to excuse you from the assignment or permit you to make up the missed work.

5. Attendance, Tardiness, and Class Participation

You are expected to attend classes regularly and promptly. If you are absent or tardy, you will miss not only valuable instruction but possibly credit as well. In either case, you are responsible for finding out from your classmates what was discussed, assigned, or distributed in class.

6. Electronic Devices

You are expected to conduct yourself during class time in a professional and respectful manner. Therefore, unless I instruct otherwise, please turn your cellphone off or put it on "vibrate" during class. Also, please refrain from surfing the Web, emailing, texting, tweeting, and engaging in other distracting activities during class time. If you engage in such activities, you will be required to turn off the device or leave the classroom, forfeiting class participation points.

7. Communication

The best way to reach me is to email or Slack me. However, if you need to discuss a confidential matter, you may call my office, visit during my office hours, or make an appointment. However, please note that I check the collaboration platform, voicemail, and email only during business hours (M-F 9am – 5pm). If I receive a message, I will try to respond within 24 hours or the next business day.

8. Academic honesty and integrity AND student code of conduct

You are expected to adhere to the student code of conduct in academic honesty and integrity. Giving or receiving help in assignments, exams, and any other required course submissions is cheating and violation of the code. If you are caught in the cheating, your score of the submission is automatically zero. Further disciplinary action may follow.

Support Services

1. American Disabilities Act (ADA)

Howard University is committed to providing an educational environment that is accessible to all

students. In accordance with this policy, students who need accommodations because of a disability should contact Special Student Services (202-238-2420) as soon as possible after admission to the University or at the beginning of each semester. If you need a special accommodation required by the American Disabilities Act, please document and discuss your disability with me during the first week of classes**.**

2. Statement on Interpersonal Violence

Howard University takes sexual assault, dating violence, domestic violence, stalking and sexual harassment seriously. If a student reveals that he or she needs assistance with any of these issues, all Responsible Employees, which includes faculty, are required to share this information with the University Title IX Office (202-806-2550). Students can be referred for confidential services to the Interpersonal Violence Prevention Program (IVPP) (202 806-7647) or University Counseling Services (202 806-6870). For more information about these services, please go to www.CampusSafetyFirst.Howard.Edu.

2. Center for Academic Excellence
The Center for Academic Excellence provides tutors to assist undergraduates with a variety of General Education subjects. To request a tutor, go to http://undergraduatestudies.howard.edu/cae/tutor-clearinghouse. The center also provides academic counselors and student success workshops to help you stay in school and excel.

3. Program for Academic Support Services (PASS)
The Graduate School's PASS program offers courses for international graduate students and other graduate students who need to improve their English writing skills. To seek assistance, go to http://www.gs.howard.edu/pass/default.html.

4. Writing Center [FOR ENGLISH, WAC, OR WRITING MATTERS COURSES]
For assistance with your writing, you may visit the English Department's Writing Center online or in Locke Hall (Room 100)—with or without a referral. At the Center you will find tutors and software to help you with a variety of problems—from lack of organization to lack of subject-verb agreement. However, the tutors will not proofread or edit for you. Instead, the tutors will do the following: identify your writing problems, teach you how to solve those problems, and evaluate your progress. To schedule an appointment on campus, go to http://www.coas.howard.edu/writingcenter. To enroll in the online site, go to http://www.cetla.howard.edu/wac/students.aspx. Remember, however, that you can also find assistance on the Writing across the Curriculum (WAC) website, http://www.cetla.howard.edu/wac/students.aspx.

5. Canvas
You are expected to use Canvas throughout this course. If you are unfamiliar with Canvas, please complete the **hands-on orientation** described on the FAQs page and submit the confirmation page to me during the first week of classes.

6. Technical Support
If you encounter technical problems with your email, Canvas, Bison Web, or some other University-wide technology, go to http://itsupport.howard.edu to open a ticket or email helpdesk@howard.edu. For information about computer labs, software distribution, IT security, printing, and other IT topics, see the **service catalogue** (http://www.howard.edu/technology/services/service_catalogue.html) on the website of Enterprise Technology Services (ETS).

7. University Libraries

Go to http://library.howard.edu/StudentLibraryInfo to find out how to access resources and services at the Howard University Libraries. Be sure to check the "Research Help" portal at http://library.howard.edu/searchportals, and find out how to use the Summon search engine, the RefWorks bibliography manager, and Ask a Librarian to "chat" with a reference librarian.