EE 270 Modeling and Control of Power Electronic Converters

Fall, 2021

Instructor: Haoyu Wang

Office: Rm. 3-530, SIST BLDG; wanghy.shanghaitech@gmail.com; (021)2068-5082

Class Hours: Mondays and Wednesdays 1:00pm-2:45pm; Rm. 1B-108, SIST BLDG

Office Hours: Mondays and Wenesdays 2:45pm-3:45am; the other times are fine, but by appointment only

Course Website: http://pearl.shanghaitech.edu.cn/teaching/2021fall/EE270/

TA: Jiawei Liang; liangjw@shanghaitech.edu.cn; (021)2068-5097

TA Office Hours: Wednesdays 3:00pm-5:00pm, 3-503 SIST BLDG;

Course Description: An introduction course to switched-mode power converters. The first part of the course treats basic circuit operation, including steady-state converter modeling and analysis, switch realization, discontinuous conduction mode, and transformer-isolated converters. Next, converter dynamics and control are covered, including ac modeling of converters using averaged methods, small-signal transfer functions, and classical feedback loop design. Finally, advanced modeling, analysis and control techniques are covered, including Feedback Theorem; circuit averaging, averaged switch modeling, and simulation; DCM modeling, extra element theorems; and current-programmed control.

Prerequisite(s): Circuits Theory

Credit Hours: 4

Required Text:

R. W. Erickson, and D. Maksimovic, *Fundamentals of Power Electronics*, 3rd Edition, Springer Science & Business Media, 2020. ISBN: 978-3-030-43879-1

Recommended Texts:

The following recommended texts will provide background for the course.

N. Mohan, and T. M. Undeland, *Power Electronics: Converters, Applications, and Design*, 3rd Edition, John Wiley & Sons, 2007. ISBN: 978-0-47-122693-2

M. H. Rashid, *Power Electronics: Circuits, Devices and Applications*, 4th Edition, Prentice Hall, 2013. ISBN: 978-0-13-312590-0

Course Contents:

1. Introduction
2. Principle of Steady-State Converter Analysis
3. Steady-state equivalent circuit modeling, losses, and efficiency
4. Discontinuous conduction mode
5. Converter circuits
6. AC equivalent circuit modeling
7. Converter transfer functions
8. Controller design
9. Feedback Theorem

10. Circulating averaging, averaged switch modeling and simulation
11. Modeling of DCM
12. Extra element theorems
13. Current programmed control
14. Advanced topics

Course Material: Most of the course material will be delivered within the lecture. Supplementary material, such as course notes, homework, and project announcement, will be updated on the class website at http://pearl.shanghaitech.edu.cn/teaching/2021fall/EE270/.

Homework: Homework will be given roughly every other week for approximately 2/3 of the semester. They will be distributed from the webpage. Homework will typically be due in class one week after it is posted and will be collected right before the lecture. The remainder of the semester will focus on an individual design project.

Late Policy: Late homework is allowed five days maximum after its due date, but its weight will be deducted by 20% per day.

Exams: Your exam score in the class will be based on two exams. The exact dates of the exams will be determined later and announced in class at least one and a half weeks in advance. Exam questions will be based on the lecture notes and homework.

Project: Students are also responsible for projects. There are two options for the course project. Option 1 : research oriented. You will work individually to design, analyze, and simulate a novel power electronic converter/control method/modeling method that improves the performance of the existing converter/control method from the literature.

Option 2: engineering oriented. You will work in a group of a maximum of 2 students to implement an onboard 65W type-C charger. Students will be required to submit a written report, as well as to give an oral presentation, describing the project in detail. Details of the project will be provided later.

Grading: Grading will be based on: homework (10%), mid-term exam (30%), final project (30%), final exam (30%). Scores will be translated into final grades at the end of the semester with a grading scale that will likely be: $0 - 40\% = F, 40\% - 65\% = C, 65\% - 85\% = B, 85\% - 100\% = A$.

Academic Dishonesty: Although I sincerely wish that I will not have to cope with this issue, I would like to make it very clear that academic dishonesty will not be tolerated. The following acts of academic dishonesty are prohibited: cheating, fabrication, facilitating academic dishonesty, and plagiarism. Academic dishonesty in this course includes copying homework or deliberately taking unfair advantage of the other students in the course. Once been found, it can lead one to a fail grade in this class and will be referred to the academic committee in the School of Information Science and Technology.