# SYLLABUS PART ONE

## INFORMATION ABOUT THE COURSE

### COURSE TITLE AND COURSE NUMBER:

ECE 8930: Modeling and Control of AC Three-phase PWM Converters – 89051/89052

### TERM: Fall 2021

State date and end date: August 18, 2021 – December 3, 2021

Last day to register or add a class or declare Audit: August 24, 2021

Last day to drop a class or withdraw from the University without a W grade: August 31, 2021

Fall break: October 11 – October 12, 2021

### CLASS MEETING TIME AND PLACE:

Tuesday and Thursday, 3:30 pm to 4:45 pm

102 ZGEC, CURI & 223 Riggs, Main campus

### TIME TO WAIT:

Students are expected to wait 15 minutes if an instructor is late

### INFORMATION ON MODALITY:

In-person

### INSTRUCTOR NAME:

Zheyu Zhang

### INSTRUCTOR EMAIL:

E-mail: zheyuz@clemson.edu
Email questions will be answered within 24 hours (Excluding weekends and university holidays)
Please use [ECE8930] in the subject line

### UNIVERSITY OFFICE PHONE:

843-730-5067

OFFICE ADDRESS/OFFICE NUMBER:

309 Zucker Family Graduate Education Center

1240 Supply St., N. Charleston, SC 29405, USA

OFFICE HOURS:

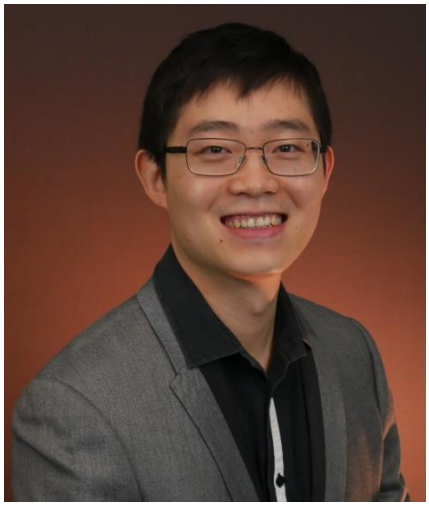
Tuesday/Thursday 11:00 am – 12:00 pm primarily through Zoom Personal Meeting Room and in the office by appointment
https://zoom.us/j/2947747574?pwd=UTBkeklUL09tbVhEczRHdmp1UG9lZz09

Meeting ID: 294 774 7574;  Passcode: dh1G9W

During cancelled lectures

Individually scheduled

INSTRUCTOR PHOTO:



COURSE DESCRIPTION

Multi-phase (esp. three-phase) AC PWM converters are one of the most popular and important types of power electronics converters. Many emerging applications require the use of three- and multiphase PWM converters: electrified transportation, electronic power distribution systems, and renewable energy systems. They are used in industrial automation, vehicles, wind power generator, appliances in the form of electric motor drives; and used in power systems as electronic transformer, power flow controller, and compensator. There is a real need to have a course focusing on the modeling and control of AC three-phase PWM converters. In details, the course aims at developing the understanding of power conversion

principles in three-phase PWM converters and learning to design the control for the converters used in most applications through: use of switching state vectors and different modulation schemes, development of averaged models of rectifiers and inverters in stationary and rotating coordinates, small-signal modeling in rotating coordinates, and closed-loop control design. The course targets for graduate students with fundamental power electronics knowledge.

## Learning Outcomes

After completing this course, students will be able to:

- Understand the modeling and control of three-phase PWM converters
- Model a three-phase converter, including
    - Averaged models in stationary coordinates
    - Averaged models in rotating coordinates
    - Small-signal models
    - Modulator models
- Design the closed-loop control
- Use MATLAB/SIMULINK simulation tool for modeling and control design
- Give a technical presentation

## Prerequisites

ECE4930/6930 - Introduction of Power Electronics Technology and Applications

ECE 4190/6190 - Electric Machines and Drives

## Required Materials

Simulation software — MATLAB/SIMULINK (license will be provided in the class)

Textbook (optional) — 1) R. Krishnan, Electric Motor Drives: Modeling, Analysis, and Control, Upper Saddle River, NJ: Prentice Hall, 2001; 2) D. G. Holmes and T. A. Lipo, Pulse Width Modulation for Power Converters: Principles and Practice, New York, NY: IEEE Press and John Wiley & Sons, 2003.

## Required Technical Skills

MATLAB/SIMULINK

Basic feedback control and regulator design

Basic knowledge of power electronics circuits

Basic knowledge of switching circuit modeling techniques

Major Assessment/Grading Activities

| Grading Type | Weighting |
|---|---|
| **Homework (four)** | 30 % |
| **Participation and discussion** | 5 % |
| **Project (two)** | 25 % |
| **Student presentation (two)** | 15 % |
| **Final project (one)** | 25 % |
| **Total** | 100 % |

Procedures for turning in homework – online submission through canvas.

GRADING SYSTEM

| Letter | Points |
|---|---|
| **A** | 90 - 100 |
| **B** | 80 – 89.99 |
| **C** | 70 – 79.99 |
| **D** | 60 – 69.99 |
| **F** | < 60 |

GRADING POLICIES

Late work:

- Except in cases of documented emergencies, late work will lead to 10 points penalties (note that each assignment/project has the full score of 100 points)
- Late work after one week of the deadline will not be counted except in cases of documented emergencies

Absences:

- Should you miss a class (including online), it is YOUR RESPONSIBILITY to contact with your instructor within one week to deliver the written excuse by email. Missing class WILL AFFECT your final grade. See grading policy below.
- A student will be marked absent if not in class/online within 5 minutes of starting time. This can be changed into a tardy. The student is responsible for contacting the instructor after class.
- The student is responsible for asking the professor to change an absence into a tardy if the student arrived more than 5 minutes late immediately after the class in which the tardy occurs. (No changes will be made on a later day.) The third tardy will result in a loss of 2 participation points, the fourth 2 more points, etc.

- Exception — for part-time graduate students, absence is exempt if it is due to the full-time job (e.g. scheduled meeting, biz travel, etc.). Please send an email to your instructor before the class, in the meantime, make sure you will spend equivalent time to review the lecture slides and learn by yourselves.

**Topical Outline**

1. Introduction to power conversion principles in three-phase PWM converters
2. Introduction to three-phase variables and coordinate transformations
3. Basic topologies of three-phase converters
4. Averaged models in stationary coordinates
5. Averaged models in rotating coordinates
6. Small-signal models
7. Modulation techniques
8. Closed-loop control design
9. Parallel converters
10. Multi-level converters

---

## FOR STANDARD ACADEMIC POLICY LANGUAGE AND STUDENT RESOURCES, SEE THE UNIVERSITY POLICY AND STUDENT SUPPORT SYLLABUS PART 2

In part two, you will find these required items:

- An accessibility statement is required in the syllabus.
- The Title IX statement is required in the syllabus.
- The Academic Integrity statement is required in the syllabus.
- The emergency preparedness statement is required in the syllabus.

MODIFICATION STATEMENT:

The instructor reserves the right to modify any aspect of the syllabus at any time during the semester for reasons including but not limited to COVID-related situations. The date of this version of the syllabus is August 17, 2021.