Syllabus

Course Number: ECE 5410

Title: Power Electronics and Controls

Credits: 4 (Lecture)

WSU Catalogue Description:

Control of electrical energy using solid state devices, diodes, thyristors, and triacs; mathematical analysis of circuits containing these devices; power converters and control; solid-state drives for motor control.

Pre-requisite: ECE4330

Instructor: Anil Tuladhar
Office Hours: Friday 4:30-5:30 pm (by appointment)
Phone: 313-434-1903
Email: aniltuladhar@yahoo.com

Course Meeting Time: Friday 5:30 pm – 9:20 pm

Course Meeting Location: 0111 Main

Course Focus:

This course introduces students to basic power electronic devices and their application in power conversion/conditioning technologies.

Learning Objectives:

At the end of this course, students will be able to:

1. Understand basic principles of Power Switching Devices.
2. Understand basic principles of Power Converter controls.
3. Understand the losses generated at active and passive components.
4. Power Electronics for Battery Technology.
5. Design a simple DC/DC converter.
6. Design a simple DC/AC inverter.
7. Understand various power conversion topologies used in harvesting renewable energy resources.
## TENTATIVE SCHEDULE

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Term Project</th>
<th>Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Overview of Power Electronic Systems and Semiconductor Switches</td>
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<tr>
<td>Week 2</td>
<td>Review of Basic Electrical and Magnetic Circuit Concepts and Computer Simulations</td>
<td>Form Project Groups</td>
<td>Assignment 1</td>
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<td>Week 3</td>
<td>Thyristor circuits continued</td>
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<tr>
<td>Week 4</td>
<td>IGBTs and MOSFETs</td>
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<td>Assignment 2</td>
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<tr>
<td>Week 5</td>
<td>Converter Topologies</td>
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<td>Week 6</td>
<td>Feedback Control Loop Design</td>
<td>Report Project Progress</td>
<td>Assignment 3</td>
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<tr>
<td>Week 7</td>
<td>Motor Drive Applications and DC motor Drives</td>
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<td>Mid-term exam (Take home)</td>
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<td>Week 8</td>
<td>Induction and Synchronous Motor Drives</td>
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<tr>
<td>Week 9</td>
<td>July 4th week (Reading week)</td>
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<td>Assignment 4</td>
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<tr>
<td>Week 10</td>
<td>Power Electronics and renewable energy resources</td>
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<tr>
<td>Week 11</td>
<td>Practical Design Issues</td>
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<td>Assignment 5</td>
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<tr>
<td>Week 12</td>
<td>Final Project Presentation</td>
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<tr>
<td>Week 13</td>
<td>Final Exam</td>
<td>Final Project Report Due</td>
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Project Description

Objective:

Choose any topic you like to work on but it has to be a realistic one and related to Power Electronics. It can be a new product idea, a real prototype or a detailed concept.

Each team will select a project topic that they will carry through the course to apply power electronics concepts. Each team is expected to conduct a literature search to determine if requirements for such a product or a concept already exist in the literature. If yes, try to add a few new features to enhance it if not develop your idea into a real product.

Suggested Topics:

- Energy Harvesting techniques (vibration, wave energy, ocean current etc).
- Fuel Cell Related Technologies.
- Electric Vehicle Technologies.
- Battery Related Technologies.
- Wind Power Related Technologies.
- Solar Power related Technologies.

Project Teams:

In the second week of the course, we will form project teams and on the third week we will select project topics. Teams will consist of about two or three students.

Text Book:


Other Resources:

MATLAB/SIMULINK Software
PSIM Software

Recommended References:


Grading:

<table>
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<tr>
<th>Component</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Term Project</td>
<td>30%</td>
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<tr>
<td>Assignments and Quizzes</td>
<td>20%</td>
</tr>
<tr>
<td>Mid-term and final Exam</td>
<td>50%</td>
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- Individual projects, exams, and assignments might be curved.
- All exams will be design related and open book.
- Project reports have to be typed.
- Assignments late by one class will be evaluated at 90%.

Class Preparation and Participation:

You are expected to come to class prepared and actively participate in class discussions.

Outcome Coverage:

(a) An ability to apply math, science and engineering knowledge. The learning in this course will require direct application of mathematical, scientific, and engineering knowledge. The learning requires performing computations involving Fast Fourier Transform, calculus, Laplace - transform, and z-transform, among other techniques.

(b) An ability to apply complex variables in the analysis of both continuous and discontinuous circuits and systems. This course is based on modeling and control design of power electronic circuits in frequency domain. The student will derive state space average model of switching circuits.

(c) An ability to design and conduct experiments, as well as to analyze and interpret data. The student will carry out computer simulation experiments as well as interpretation of the resulting data using PSIM, MATLAB/SIMULINK and its toolboxes (e.g., Power System Block-Set, Control System Toolbox).

(d) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. The student will learn to be aware of hardware implementation cost and system performance specification constraints.

(e) Identify, formulate and solve engineering problems. The student will learn how to identify, formulate, and solve power electronics problems.

(f) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. The student taking the course will realize the broad applicability of power electronics and its impact and
benefits to solving real world problems with positive economic and societal consequences. Recent growth in adapting renewable energy sources has created a big market area for power electronic products.

**Accommodations for Students with Disabilities:** If you have a documented disability that requires accommodations, you will need to register with Student Disability Services for coordination of your academic accommodations. The Student Disability Services (SDS) office is located at 1600 David Adamany Undergraduate Library in the Student Academic Success Services department. SDS telephone number is 313-577-1851 or 313-577-3365 (TDD only). Once you have your accommodations in place, I will be glad to meet with you privately during my office hours (or call me at 313-343-1903) to discuss your special needs. Student Disability Services’ mission is to assist the university in creating an accessible community where students with disabilities have an equal opportunity to fully participate in their educational experience at Wayne State University.

**Cheating Policy and Penalty for Cheating:** It is the responsibility of each student to adhere to the principles of academic integrity. Academic integrity means that a student is honest with him/herself, fellow students, instructors, and the University in matters concerning his or her educational endeavors. Thus, a student should not falsely claim the work of another as his/her own, or misrepresent him/herself so that the measures of his/her academic performance do not reflect his/her own work or personal knowledge. Cheating will not be tolerated. Cheating includes (but is not limited to) any communication (written or oral, active or passive) during examinations and sharing of work, such as using the same models or computer programs or copying work. All homework and projects must be an individual effort unless specifically noted. **STUDENTS WHO CHEAT ON ANY ASSIGNMENT OR DURING ANY EXAMINATION WILL BE ASSIGNED A FAILING GRADE (i.e., F) FOR THE COURSE.** Students who witness cheating should report the incident to the instructor as soon as possible (your identity will be strictly protected).

**Note:** The WSU policy is that an Incomplete grade can only be assigned if:

1. A student is passing the class based on the other material that has been submitted.

2. The work can be completed without attending the class in a future semester.

**Prepared By:** Anil Tuladhar

**Last Revised:** March 29, 2012