EECS 419  Power Electronics
Fall 2011

1. **Prerequisites:** EECS 215 and EECS 216, and preceded or accompanied by EECS 320, or graduate standing.

2. **Lecture, Lab Times:**
   - Lecture: MW 3-4:30
   - Lab: Thursday or Friday 3-6

3. **Purpose:** Meeting the future’s energy and environmental challenges will require the efficient conversion of electrical energy from one form to another. This course will discuss the circuits used to efficiently convert AC power to DC power, DC power from one voltage level to another, and DC power to AC power. The components used in these circuits (e.g., diodes, transistors, capacitors, inductors) will also be covered in detail. A key aspect of power electronic circuits is the control algorithms used to achieve the desired behavior (e.g., output voltage regulation), and so control theory as it applies to these circuits will be discussed. A lab will be held with the class where the students will obtain hands-on experience with power electronic circuits.

4. **Objectives:** Upon successful completion of this course, the student should:
   1. Understand how fundamental power electronic circuit topologies operate.
   2. Quantitatively determine the power quality impact of AC-connected power electronic circuits.
   3. Be able to design control algorithms for DC-DC converter circuits.
   4. Be familiar with the properties of power semiconductor devices (i.e., diodes, transistors, ...) as they are used in power electronic circuits.
   5. Understand how to calculate the efficiency of power electronic circuits.
   6. Be able to analyze and design magnetic inductors and transformers for power electronic circuits.
   7. Possess a basic understanding of the cooling of power electronic circuits.
   8. Have hands-on experience with many power electronic circuit topologies in the laboratory.
   9. Have designed a power electronic circuit as part of a course project.

5. **Topics**
   - AC-DC Conversion
   - DC-DC Conversion
     - Fundamental converter topologies
     - Isolated converter topologies
   - Control of DC-DC Converters
   - Power Semiconductor Devices
     - Diodes
     - Thyristors
     - BJTs
     - MOSFETs
     - IGBTs
   - Power Electronic Components
     - Capacitors
Inductors, Transformers
Auxiliary Circuitry
Gate and Base Drive Circuits
"Snubber" Circuits
Thermal Analysis

6. Texts:

Required:

Suggested:

7. Instructors:

Prof. Heath Hofmann
4116 EECS
(734) 647-1107
hofmann@eecs.umich.edu

Office hours:
Tuesdays and Wednesdays 10:30-12
Other times by appointment

Prof. G.R. Lahiji
3115 EECS
(734)763-1156
roientan@umich.edu

Office hours:
Monday and Thursday 1:30-3:00
Other times by appointment

8. Exams: The class will have one in-class midterm (whose time has yet to be determined) and a final. If you have a valid reason for missing the midterm, you must notify the instructor at least two weeks in advance so that a conflict exam can be prepared. Students from all sections will take identical exams. Exams are closed-book, but each student is allowed a single 8.5” by 11” note sheet. Exams are returned during lecture sessions. Any student caught cheating on an exam will receive a grade of 0 for the exam. Additional sanctions may also be pursued, following university guidelines.

9. Homeworks: Homeworks will be assigned on Mondays, and, unless otherwise noted, will be collected during lecture on the Wednesday of the following week. Students are encouraged to discuss homework problems in groups. **However, each student must submit their own work.** Students submitting identical work will receive a grade of zero for the homework set. Problem set solutions will be posted on the CTOOLs web site. Graded homework sets will be returned in class. **Late homework will not be accepted.** However, the lowest homework score will be dropped in calculating your overall homework grade. In order to perform well on the exams, it is important that you work each problem assigned. Although your final homework grade may be unaffected if you do not turn in one of the problem sets, your exam grades, which play a much larger role in determining your final grade, will be adversely affected.
10. **Labs:** In addition to the lectures, a lab will be held every week where the students will obtain hands-on experience with electric machines and drives. Students will work with a partner in the labs, and submit a joint lab report. In addition to including the data obtained during the lab, lab reports must be well-written and clearly explain the concepts presented during the lab. It is **not** acceptable to use data collected by other lab teams in your lab report; you must use your own. If there are problems with your lab data, contact the lab assistant. Measured results will be compared to expected values, with any discrepancies clearly discussed. Further information on the preparation of lab reports will be handed out during the first lab section.

Lab times will be established during the first week of classes, after student’s schedules have been submitted, to determine times that will work best.

11. **Project:** At the end of the semester, students will complete a project involving the design, construction, testing, and demonstration of a power electronic circuit. Students will work on the project during lab times with their lab partner.

12. **Grading:** The following weighting factors determine your total course score:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project</td>
<td>10%</td>
</tr>
<tr>
<td>Homework</td>
<td>20%</td>
</tr>
<tr>
<td>Lab Reports</td>
<td>20%</td>
</tr>
<tr>
<td>Midterm</td>
<td>25%</td>
</tr>
<tr>
<td>Final</td>
<td>25%</td>
</tr>
</tbody>
</table>

The class average does not determine the cutoff points for letter grades. Instead, the cutoff points reflect the technical competencies required of an electrical engineer. The following scale determines your final course grade:

- A+ 95%-100%
- A  90%-95%
- A- 85%-90%
- B+ 80%-85%
- B  75%-80%
- B- 70%-75%
- C+ 65%-70%
- C  60%-65%
- C- 55%-60%
- D+ 50%-55%
- D  45%-50%
- D- 40%-45%
- E  <40%

At the discretion of the instructor, the minimum score needed to earn a certain letter grade may be lowered, but it will not be raised.

13. **Web Page:** Problems sets and other important files and announcements will be posted on the EECS 498 CTOOLS site.

14. **Attendance:** Although attendance will not be taken, you are expected to attend lecture. It is a student’s responsibility to acquire handouts and information disseminated in class.
15. **Honor Code**: Students in the College of Engineering at the University of Michigan are expected to be intimately familiar with its Honor Code. Details of the Honor Code are available online at:

http://www.engin.umich.edu/students/honorcode/