UNIQUE 17415 - EE 394J-11 – ADVANCED TOPICS IN POWER ELECTRONICS

Meetings: Monday and Wednesdays from 3:00 to 4:30 PM in ENS 145

Professor: Alexis Kwasinski (ENS438, akwasins@utexas.edu, Phone: 512-232-3442)

Course Home Page: http://users.ece.utexas.edu/~kwasinski/EE394J11Fa13.html

Office Hours: Mondays and Wednesdays (1:30 – 3:00 pm); or by appointment.

T.A./Grader: Youngsung Kwon

Prerequisites: Fundamentals of power electronics, circuits, control systems, and semiconductors or consent from the instructor. Familiarity with at least one computer simulation software and modeling. Knowledge on how to browse through professional publications.

Reference Textbook(s): There is no required textbook. Reference textbooks are:
> Krein, *Elements of Power Electronics*; Banerjee and Verghese, *Nonlinear Phenomena in Power Electronics*; Mohan, Undeland, Robbins, *Power Electronics: Converters, Applications, and Design*; selected papers;

Course Description: This course discusses selected topics in power electronics systems and circuits at a basic to medium graduate level. The focus is oriented towards stationary applications for an efficient and reliable use of energy. Some primary applications include micro-grids, renewable and alternative energy, sustainable systems, reliable power conversion circuits, smart grids, and others. The course is divided in three main parts: circuit analysis, modeling, circuit topology design, and controls and applications. Selected topics discussed within these three parts include, but are not limited to:
- Circuit analysis and modeling:
  - Modeling and analysis of dc-dc converters. Analysis of switched systems.
  - Real components (switches, loads, sources, and passive components).
- Circuit topology design and control.
  - Single-phase and 3-phase rectifiers.
  - Single-input and multiple-input dc-dc converters.
  - Inverters.
  - Thermal aspects
  - Introduction to reliability
- Controls and applications
  - Linear and nonlinear control methods in power electronics.
  - Power electronics converters for renewable and alternative energy. Maximum power point tracking.
  - Grid interaction. Islanding. EMI and power factor control
  - Power electronics for energy storage systems.

This course has two main goals and all activities of this course are planned to support meeting these two main goals. The first goal is to discuss topics related with advanced power electronics. The second goal is to prepare the students to conduct research or help them to improve their research skills. This latter goal implies that students are expected to have a proactive approach to their course work, which in many cases will require finding on their own proper ways to find unknown solutions to a given problem. Still the instructor will provide guidance on skill necessary to succeed in this course goal. Guidance topics include, but are not limited to, writing technical journal tips or presentation skills.

Schedule:

Week 0, Wed. 28	Introduction. Course description. Power electronics perspectives. Review of fundamental concepts.
Week 1 (Sept. 2).	Continuation of the review of fundamental concepts. Switched model. (Monday is a holiday).
Week 2 (Sept. 9).	Average and linear models.

Week 3 (Sept. 16). Semiconductor switches model (diodes, MOSFETs and IGBTs).
Week 4 (Sept. 23). Real loads, sources, and passive components. Rectifiers (Wed. *Dr. K. at ECCE*)
Week 5 (Sept. 30). Rectifiers. Single-input dc-dc converters.
Week 6 (Oct. 7).   Single-input dc-dc converters. Multiple-input converters.
Week 7 (Oct. 14).   Inverters   (*Dr. K at INTELEC 2013*)
Week 8 (Oct. 21).   Thermal design. Reliability
Week 9 (Oct. 28).   Linear and nonlinear control methods in power electronics.
Week 10 (Nov. 4).   Linear and nonlinear control methods in power electronics Power electronics converters for renewable and alternative energy.
Week 11 (Nov. 11)   Power electronics converters for renewable and alternative energy. Maximum power point tracking
Week 12 (Nov. 18)   Grid interaction. Islanding. EMI and power factor control.
Week 13 (Nov. 25)   Power electronics for energy storage (batteries, ultracapacitors and flywheels).
Week 14 (Dec. 2)   Presentations

Grading:
Homework: 25%
Project preliminary evaluation: 15%
Project report: 30%
Presentation: 20%
Class participation: 10%

Letter grades assignment: 100% – 96% = "*A+*", 95% – 91% = A, 90% – 86% = A-, 85% – 81% = B+, and so on.

Homework:
Homework is designed to support both main course objectives. Hence, it may require some more time than conventional homework assignments that you are used to receive in other courses. Solving homework assignment problems will also require students to find solutions with minimal guidance from the instructor. The goal of this approach for homework assignment planning is for students to learn how to find paths for solutions to problems. Many homework problems may have each different paths to various solutions and all of them are valid. The focus when grading homework is, then, more on the process taken to address the problem and not so much on a numerical answer. Hence, it is very important that homework problem solutions explain clearly but concisely the path taken to find the solution to a given problem and that students include some brief discussion explaining their answer to each homework question. Due to the complexity of this unconventional approach to homework, it will be assigned approximately every 2 weeks. Making mistakes is part of the learning process. For this reason the lowest score for an assignment will not be considered to calculate the homework total score. However, all assignments need to be submitted in order to obtain a grade for the homework.

Project:
The class includes a project that will require successful students to survey current literature. The project consists of carrying out a short research project throughout the course. The students need to identify some topic related with the theory or application of power electronics circuits. The project is divided in two phases:
1) Preliminary phase. Due date: September 30. Submission of references, application description, and problem formulation (1 to 2 pages long).
2) Final phase. Due date: Nov. 25 Submission of a short paper (the report), at most 10 pages long, single column.

Participation:
Participation points are assigned at instructor's discretion based on the perceived attitude of individual students towards learning and participation in classes during the semester.

Presentations
Every student is expected to do a presentation discussing his/her project to the rest of the class as if it were a conference presentation of a paper. The format of the presentations will be announced during the semester and its

date will also be confirmed during the semester because these two variables depend on the number of students registered for the course.

Disclaimers:
Although unlikely, this syllabus and course topics may change according to my judgment as to what is best for the class. Any changes will be declared in class. For example, due to the particular nature of my research I may need to travel to disaster areas on short notice. Although I will communicate these trips in advance along with any potential changes that these trips may cause, it is not possible to know at this time when those trips may occur. General course schedule and administrative deadlines follow The UT Austin calendar, long session 2013-2014, which can be found at http://registrar.utexas.edu/calendars/13-14.

Students with disabilities may request appropriate academic accommodations from the Division of Diversity and Community Engagement, Services for Students with Disabilities, 471-6259. The link to this office is: http://www.utexas.edu/diversity/ddce/ssd/. An official letter should be provided outlining authorized accommodations.

University of Texas Honor Code: "The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the university is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community." Each student in this course is expected to abide by this University of Texas Honor Code. Any work submitted by a student in this course for academic credit will be the student's own work. Link to University Honor Code: http://registrar.utexas.edu/catalogs/gi09-10/ch01/index.html. A good explanation of what constitutes plagiarism can be found in the following IEEE's web page: http://www.ieee.org/publications_standards/publications/rights/ID_Plagiarism.html. Notice that paraphrasing could be considered a case of plagiarism.

By UT Austin policy, you must notify me of your pending absence at least fourteen days prior to the date of observance of a religious holy day. If you must miss a class, an examination, a work assignment, or a project in order to observe a religious holy day and if you notify me of such absence at least fourteen days in advance you will be given an opportunity to complete the missed work within a reasonable time after the absence.