EE 487 – Electric Machinery and Drives

Designation: EE elective course for electrical engineering majors.

University Bulletin Description: EE 487: Analysis of variable-speed drives comprised of AC electric machines, power converters, and control systems.
Prerequisite: EE 387

Prerequisites by Topics:
1. Understanding of and ability to use differential equations and Laplace Transforms in the analysis of linear-time-invariant, continuous-time systems.
2. Understanding of ability to determine force and torque production of magnetic-field-based devices.
3. Understanding of and ability to analyze three-phase power systems and devices.
4. Understanding of and ability to analyze electric machines under steady-state conditions.

Textbook/Required Materials:
Course notes provided by instructor.

Learning Outcomes:
This course will cover power electronic drives for rotating electric machinery. Through lecture, out-of-class assignments, and laboratory exercises, students are provided learning experiences that enable them to:
1. Understand how three-phase voltages of variable frequency and magnitude can be generated using power electronic circuitry.
2. Understand and analyze the dynamic behavior of AC machines, including surface-mount permanent magnet machines, synchronous reluctance machines, interior permanent magnet machines, and induction machines.
3. Understand the different control algorithms used to regulate torque, speed, and/or position in variable-speed drives.
4. Compare and contrast the performance of different AC machines in various variable-speed drive applications.

Topics:
1. Overview of three-phase power systems, harmonic analysis, control theory
2. Power electronics circuitry (diode rectifiers, DC-AC inverters)
3. Generation of average-value AC waveforms using pulse-width modulation (PWM)
4. Electromechanical theory (magnetic systems, torque and force generation, multi-phase analysis)
5. AC Machines (surface-mount permanent magnet machines, synchronous reluctance machines, interior permanent magnet (IPM) machines, induction machines)
6. Control (introduction to feedback control, V/Hz control of induction machines, field-oriented control schemes)

Class/Laboratory Schedule:
3 50-minute lectures per week. 1 2-hour lab approximately every other week, for a total of 5 labs throughout the semester.

Computer Usage:
1. MATLAB to simulate dynamic behavior of AC machines in homework exercises.
2. MATLAB to generate control algorithms used in lab exercises.

Laboratory Projects/Assignments: 5 lab reports
1. Laboratory activities consist of five, 2-hour hands-on experiments and one Final Project.

The experiments are the implementation of theories covered in lectures. They are carefully designed to help students understand difficult concepts. The first lab involves the use of a three-phase diode rectifier and three-phase DC-AC converter to convert 3-phase 60HZ AC into three-phase AC of arbitrary frequency and magnitude. The second lab involves the understanding of equivalent two-phase models of three-phase machines. The third and fourth labs provide experience with surface-mount PM and induction machine drives, respectively. The fifth lab involves the use of a V/Hz drive to regulate the speed of an induction machine. Written lab reports are required for each lab.

2. In the final project, the students design and simulate a field-oriented controller for an AC machine using the MATLAB Simulink environment.

Contribution to Meeting the Requirements of Criterion 5. Curriculum:
This course contributes to both the engineering topics and design components.

Relationship to Program Outcomes:
The course relates to the following program outcomes:

O.1.1. Graduates will possess mathematics skills necessary for electrical engineering.
O.1.3. Graduates will have attained computer proficiency.
O.2.1. Graduates will understand how to analyze and design simple electrical/electronic circuits.
O.2.2. Graduates will understand electronic devices.
O.2.3. Graduates will understand the basic concepts of linear systems and how they interact with continuous-time signals.
O.2.4. Graduates will understand fundamental concepts in electromagnetics and be able to use them in applications.
O.3.1. Graduates will have in-depth technical knowledge in one or more areas of specialization.
O.3.2. Graduates will have practical understanding of the major electrical engineering concepts and demonstrate application of their theoretical knowledge of the concepts.
O.4.1. Graduates will interact with industry both within and outside of a classroom setting.
O.5.1. Graduates will have good teamwork skills.
O.5.2. Graduates will possess good oral and written communication skills.
O.6. Graduates will appreciate their role as engineers in society.

Prepared by: Heath Hofmann **Date:** June 16, 2008