EE 430 - Electromechanical Systems - 3 Hours
Elective Course

1. *2007-2008 Catalog description*
   Introduction to dynamic systems analysis with emphasis on mathematical modeling of sensors and electeomechanical devices for control system applications. Fundamentals of power and industrial electronics. Prerequisites: EE301; EE303.

2. *Prerequisites by topics*
   a) Electrical circuit analysis
   b) Complex numbers and phasors
   c) AC steady-state analysis of electrical circuits
   d) Transfer functions in the Laplace transform domain

3. *Textbook and/or other required materials*
   Required: None

4. *Class Schedule*
   Four lecture class sessions per week, each 50 minutes, for 14 weeks (total of 56 lecture periods)

5. *Topics Covered (Course Objectives influenced)*
   - Magnetic field intensity, permeability, flux, and flux density (7a)
   - Magnetic behavior of ferromagnetic materials: (7b)
     1. hysteresis
     2. eddy currents
     3. losses due to hysteresis and eddy currents
   - Faraday's Law and induced voltages in electrical or electro-mechanical devices (7d,e,f)
   - Inductance associated with various magnetic circuit configurations (7a,d,e,f,g,h)
   - Techniques for switching heavy inductive loads reliably with various power electronic components: (7e,g)
     1. MOSFET and IGBT switches
     2. Freewheeling (or flyback) diodes
     3. Power diode switching characteristics (forward and reverse recovery times)
     4. Snubber circuits
   - Theory and application of three phase AC systems: (7c,d,f)
     1. Wye sources
     2. Balanced Wye and Delta loads
     3. Unbalanced Wye and Delta loads
   - Transformer operation and modeling (7d)
     1. Equivalent AC circuit
     2. Voltage regulation and efficiency
     3. Frequency response
   - Sensor types and applications (brief)
   - Characteristics and applications of three phase induction machines: (7f)
     1. Induction machines
        a) Induced torque
        b) Slip/torque, speed/torque, and speed/power characteristics
     2. Selecting AC machines for specific applications
   - Characteristics and applications of DC machines: (7e)
     1. Motors
        a) Commutation
        b) Back EMF
        c) Induced torque
        d) Speed/torque characteristics
        e) Electro-mechanical model
     2. Generators (brief)
     3. Selecting DC machines for specific applications

5. *Topics Covered (Course Objectives influenced) [cont'd]*
   - Modeling and Analysis of Dynamic Electrical Systems (7h)
     1. Simple RLC circuits
     2. Practical models for inductors and capacitors

   - Modeling and Analysis of Dynamic Mechanical Systems: (7h)
     1. Linear spring-mass-damper systems
     2. Torsional spring-mass-damper systems
     3. Electrical analog to spring-mass-damper systems
   - Introduction to Dynamic Electromechanical System Modeling (7g, h)
     1. Electromechanical model for magnetic actuators and relays (solenoids)
     2. DC machines
        a) No load operation
        b) Applied loads
           1. Inertial loads
           2. Inertial loads with friction

6. *Contribution of the course to meeting the professional component*
   Engineering science - 50%, Engineering design - 50%

7. *Course Outcomes (Program Outcome contributions)*
   a) Students will use the relationships between field intensity, permeability, flux density, and flux for analysis and design of practical magnetic circuits. (9A, B)
   b) Students will use the fundamental concepts of hysteresis and eddy currents in ferromagnetic materials to estimate the associated losses in practical electrical or electromechanical devices. (9A, B)
   c) Students will use the fundamental concepts of single and three phase AC systems for analysis and design. (9B, D)
   d) Students will use the fundamental concepts of transformer modeling for analysis and design. (9B, D)
   e) Students will use the fundamental concepts of DC machines for analysis and design. (9B, D)
   f) Students will use the fundamental concepts of three phase induction machines for analysis and design. (9B, D)
   g) Students will use the fundamental concepts of electro-mechanical actuator operation and modeling for analysis and design. (9B, D)
   h) Students will use the fundamental concepts of electrical, mechanical, and electro-mechanical system dynamic models for analysis and design. (9A,B,D)

8. *Grading Policy*
   The degree to which students achieve the course outcomes is determined by the following grading policy.

   Grades will be dictated by the results of four one-hour exams based on the following percentages.
   Exam 1: 100 points (25%)
   Exam 2: 100 points (25%)
   Exam 3: 100 points (25%)
   Exam 4: 100 points (25%)

   Letter grades will be assigned for each exam to provide students with a grade estimate throughout the semester, but the final course grade will be determined by a curve based on the combined numerical results of all four one-hour exams. Although the arithmetic mean of the combined numerical results will usually correspond to a "middle" B, the letter grade corresponding to the arithmetic mean may be shifted up or down based on the performance of the present class with respect to the degree to which students meet the course outcomes specified in item 7 above. A grade of 'C' corresponds to minimum acceptable level of competency relative to the course outcomes. Exams missed without prior approval

will result in a zero for that exam. In addition, cheating on examinations will be dealt with as described in the Bradley University Academic Handbook.

9. Relationship of course to program outcomes

label	Program Outcomes (A Graduate from the program will:)	Contribution
A	have knowledge of the mathematical and scientific foundation of electrical engineering	Strong
B	have knowledge of and the ability to apply techniques and technology of electrical engineering	Strong
C	complete a design project sequence, culminating in a capstone project at or near the professional level	Foundational
D	understand that acquisition of new knowledge is needed for success in the electrical engineering profession	Strong
E	meet Bradley's general education requirements which are based on the principles of liberal education	NA
F	have experience in communicating technical information and working on teams	NA
G	understand the importance of professional and ethical behavior	Moderate

10. Prepared by: Steven D. Gutschlag 5/28/08