EE 431-Control System Theory- 3 Hours
Elective course

1. *2007-2008 Catalog description*
Linear, non-linear, and discrete automatic control systems: classical and modern control theory; computer-aided design and simulation. Prerequisites: Senior standing in EE.

2. *Prerequisites by topics:*
a. Differential and integral calculus.
b. Laplace transforms.
c. Theory of signals and systems.
d. Analysis of transistor and operational amplifier circuits.

3. *Textbook(s) and/or other required material*
Required: EE 431 Lecture Workbook (700 pages), G. Dempsey
Recommended: Feedback Control Systems, 4th edition, Prentice-Hall, Phillips & Harbor.

4. *Class Schedule:* Three sessions per week, each 50 minutes, for 14 weeks

5. *Topics Covered (Outcomes influenced)*
Modeling:
- Block diagram reductions of single-loop, multi-loop, feed-forward, disturbance rejection configurations (7 a,b)
- Development of control model for electrical and mechanical systems (7 b)

Analysis:
- Transfer functions of closed-loop systems (7 c)
- Time and frequency response of open-loop and closed-loop systems (7 c,d,e,g)
- Use of Control System Toolbox for control system analysis (7 d,l)
- Steady-state error analysis, stability analysis (Routh-Hurwitz), root locus analysis (7 e,f)
- System identification using time and frequency domain data (7 g)
- Quick sketching of system's root locus from transfer functions or pole-zero maps (7 h)
- Quick sketching of system's frequency response curves from transfer functions or pole-zero maps (7 h)
- Minimum and non-minimum phase systems (7 h,k)

Design:
- Time and frequency domain specifications (7 e)
- Root locus design: lag, lead, lag-lead, P, PI, PD, and PID controllers (7 i)
- Frequency domain design (proportional control only) (7 j)
- Controller design for minimum and non-minimum-phase plants (7 k)
- Use of Control System Toolbox for control system design (7 l)

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

7. *Course Outcomes (Program Outcome contributions): In learning the course topics, the student will attain the following outcomes. (note – graded deliverables measure performance relative to the outcomes)*
a. The student will determine input-output transfer functions of single-loop and multi-loop control systems. (9A,B,C,D)
b. The student will develop control block diagram models for electrical and electromechanical systems. (9A,B,C,D)
c. The student will determine impulse, step, and ramp responses of closed-loop systems. (9A,B,C,D)
d. The student will use the Control System Toolbox to simulate control systems. (9A,B,C,D)
e. The student will analyze systems to determine performance characteristics (control specifications) in the time and frequency domains. (9A,B,C,D)

f. The students will use root locus to predict performance characteristics in the time and frequency domain. (9A,B,C,D)
g. The student will determine system models from time and frequency domain data. (9A,B,C,D)
h. The student will sketch Bode curves and root locus from transfer functions or pole-zero maps for minimum and non-minimum phase systems. (9A,B,C,D)
i. The student will design lag, lead, lag-lead, P, PI, PD, and PID controllers using root locus method for given control specifications. (A,B,C,D)
j. The student will design a proportional controller using a frequency domain method for given control specifications. (A,B,C,D)
k. The student will design controllers for non-minimum phase systems. (A,B,C,D)
l. The student will use the Control System Toolbox to verify root locus and frequency domain designs. (A,B,C,D)

8. *Grading policy:* The degree to which students attain the course outcomes is determined by the following grading policy.
Homework 0% (25 assignments and 1 design project, used to determine borderline grades)
Test 1: 15%
Test 2: 20%
Test 3: 20%
Test 4: 20%
Final Exam: 25%
All tests are closed- notes, one page equation sheet provided. The students will also complete a required reading assignment on a contemporary issue in the area of control theory. A one page summary of the findings is required. If the assignment is not completed by the time of the final exam, an IN (incomplete) will be given for the final course grade. A grade of C corresponds to meeting the minimum competency required to understand course topics and attain course outcomes.

9. *Relationship of course to program outcomes*

label	Program Objective (A graduate from the program will)	Contribution
A	demonstrate knowledge of the mathematical and scientific foundation of electrical engineering.	Strong
B	demonstrate 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.	Moderate
D	understand that acquisition of new knowledge is needed for success in the electrical engineering profession.	Moderate
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.	Foundational
G	understand the importance of professional and ethical behavior.	Moderate

10. *Prepared by:* Gary Dempsey 2/24/08