Beginning-of-Course Assessment Memo
ECE 4855 – Control Laboratory (Fall 2012)

Course Description:
This is a laboratory course consisting of design, analysis, construction, and testing of electrical and electromechanical circuits and devices (1.5 credits).

Prerequisites by Topics:
- Fundamentals of electrical devices (motors and generators) and signal conversion.
- Basic properties of operational amplifiers, including their functions in analog scaling, summation, differentiation and integration circuits.
- Basic analysis, design and synthesis techniques of linear feedback control systems.
- Ability to use computer-based control systems analysis programs such as Matlab.

Co-requisite:
ECE 4850 – Linear Control Systems.

Objective:
This course is designed for seniors in Electrical Engineering to conduct experiments to gain experience in design, analysis, construction, and testing of electric, electromechanical, and digital circuits and devices. It covers various feedback control systems concepts such as control system modeling, control system response, stability, position feedback control, velocity feedback control, proportional, integral and derivative (PID) control, frequency response, and digital control.

Course Objective and Program Outcomes Map:
1. 1.c, 2.d (in depth); 1.d, 2.c, 2.f (familiarity); 3.d (exposure).

Supervisor:
Dr. Gang Tao, Thornton Hall, Room E311, 924-4586, gt9s@virginia.edu.

Textbook:

Lab Hours:
2:00 - 5:00, Tuesdays and Thursdays, Thornton Hall, room C125.

Assessment Scheme:
1.c: Design and conduct of 12 control system experiments
1.d: Standard of technical presentation in lab reports
2.c: Use of instruments and Matlab in control system design and analysis in experiments
2.d: Analysis and report of 12 control system experiments
2.f: Examination of control system knowledge through the design, conduct and report of experiments
3.d: Practice of the UVa honor code in completing lab reports.

Course Summary:
This is a design-oriented laboratory course consists of pre-lab, lecture, experiment implementation and test, analysis and report sessions for each of the 12 lab projects:
1. Servo system basics: learn to use the experimental equipment unit: Analogue Servo Fundamentals Trainer 33-002, and review some basic properties of op-amps and their applications.

2. Motor and tachogenerator: examine DC motor properties, and study tachogenerator functions and their use in feedback control systems.

3. Position control: design position feedback control systems for desired position tracking, and study the effect of feedback gain on system performance.

4. Velocity feedback control: design closed-loop control systems with velocity feedback, and study methods for reducing system tracking errors.

5. Stability: examine the behavior of an unstable system and reasons that cause instability, and design a speed regulating system.

6. P, I, and D control elements and PD control: study the concepts of proportional (P), integral (I) and derivative(D) control elements, examine the properties of proportional and derivative (PD) control, and design, build and test differentiators and integrators using op-amps.

7. PI control: examine the properties of proportional and integral (PI) control, design and build a PI controller, and study some applications of PI control.

8. PID control: learn the concept of proportional, derivative and integral (PID) control, and design and build a single-amplifier PID control system.

9. Frequency responses: study the frequency response method for evaluating system performance, and apply it to the compensation of a motor control system.

10. Frequency response of PI, PID and velocity feedback: investigate the effect of proportional, derivative, integral control and velocity feedback by frequency response methods.

11. Digital control fundamentals: understand the concepts of digital control, and implement A/D and D/A, motor control, position control, speed control, PID control using digital control.

12. Digital PID control: design and implement a digital PID controller for a DC motor.

**Program Outcomes:**
Program outcomes are the effectiveness measures of a course, which are grouped into three categories: 1. fundamentals, 2. specialists, and 3. citizenship.

Outcome 1.c: ability to design and conduct experiments, and analyze and interpret data.

Outcome 1.d: ability to effectively communicate technical material.

Outcome 2.c: design of systems containing both hardware and software elements.

Outcome 2.d: ability to specify, design, analyze and test an electrical/electronic system to meet a set of desired goals, within the context of a broader system application.

Outcome 2.f: specialized knowledge in one or more of the topical areas of electrical engineering: controls, communications, electrophysics, digital systems, or microelectronics.

Outcome 3.d: understanding of the ethical and professional responsibilities of an engineering practitioner or researcher.