

**EE 5466 Adaptive Control System Design**  
**University of Colorado at Denver and Health sciences Center**  
**Electrical Engineering Department**

Term Fall 2008

Time MW: 4:00-5:15 pm

Location: Pl 114

Office hours: MW 3:00-3:50

Instructor: Dr M. Radenkovic

Office: NC 2522C

Phone: 303-556-3616

**Catalog description:** Basic concept in adaptive feedback control. Overview of application areas. Stability of nonlinear systems and hyperstability approach to the design of adaptive controllers. Passivity concept and Liapunov stability. Design of model reference adaptive systems, selftuning regulators, stochastic adaptive and dual control systems. Computer based design applications. Emphasis will be placed on design projects.

**Prerequisites:** EE 4136 or EE 4276.

**Instructor's comments:** Required background includes following topics:

- Linear algebra
- Feedback systems, system stability, controller design
- Discrete time systems
  - Unit impulse response, convolution
  - Linear system stability
  - Z-transform, system transfer function
  - Frequency response analysis
  - Fourier transform
  - Signal sampling
  - Transient response analysis
- Probability and statistics
  - Cumulative distribution function, probability density function, conditional densities, expected values and moments, independent random variables, uniform and Gaussian distribution
  - Pairs of random variables, marginal PMF and PDF, sums of random variables, CLT, Markov and Chebyshev inequality.

**Course objectives:** the objective of this course is to introduce students to fundamental principles of adaptive systems with particular emphasis on adaptive feedback loops. Emphasis is given to adaptive model reference control, self tuning regulators, predictive and dual control.

**Required texts:** K. Astrom, and B. Wittenmark, Adaptive Control, Addison Wesley, 1995.

G.C. Goodwin, K.S. Sin, Adaptive filtering, prediction and control, Dover Publications.

**Assignments and examinations:** Following are components of the course grade

Project 1	30%
Project 2	30%
Final exam	30%
Homework's	5%
Attendance	5%

Normally the course grade is based on an absolute scale, i.e., score above 90 is reserved for A-, and A grades. In borderline cases the instructor reserves the right to make adjustment (either up or down) in the final letter grade. Attendance is mandatory; however if you miss class, then it is your responsibility to get the handouts, covered material and assignments from a fellow student, not me. You will get my assistance in this regard only in the case of justified/documentated absence from class. Attendance will be checked at the beginning of a class, randomly throughout the semester. Make up exams and project extensions will be given only in the case of documented circumstances beyond your control. For example such documentation may include letter from a doctor, employer, etc.

Homework's are components and subsections of the projects and final exam. If you do understand all of the homework, you will successfully complete your projects and exam. Homework is due at 4:00 pm, one week from the date it is assigned. Normally late homework is not accepted. Same exceptions apply as for make up exams. You can miss three homeworks and still get your 5%. It is in your best interest to complete all of the homeworks. Graded homework and projects can be picked up from a designated box placed in the front room of NC 2522C. For graded final exam student should see me during office hours, or make an appointment. Final exam is held during the finals week. Exact date is determined by the campus, and posted on the UCD web site.

You will be held to commonly accepted standards of clear communication on any material (project, exams, homework, etc.) you hand in. Be sure to be neat and write in complete sentences.

Grading is based on performance; there are no "contract grades", nor are there grades based on "special effort" or on submission of "special projects". Work for "extra credit" will be neither assigned nor accepted. Note that request for partial regrading will generally result in a regrading of the entire work.

**Academic honesty:** it is assumed that you understand and scrupulously observe professional standards of honesty. Collaboration to enhance understanding is fine and encouraged, but cheating in any form will not be tolerated. Individually graded material must be individual efforts. Avoid the merest hint of plagiarism. The university “Academic honor code and discipline policy” (see the UCDHSC Downtown Denver Campus 2007/08 catalog, p. 47) applies to this course.

**Tentative course outline:** the following schedule is not absolute, it is a framework that the class will work from;

#### Topic

- Introduction to adaptive control; simple servo problem (2 class periods)
- Identification of a scalar system (1 class period)
- Identification of linear systems; the least squares method, the projection algorithm (2 class periods)
- Convergence and persistent excitation (2 class periods)
- Nonadaptive and adaptive model reference control; pole placement controller (4 class periods)
- Direct and indirect adaptive control (2 class periods)
- Identification of stochastic systems; extended least squares algorithm (2 class periods)
- Optimal prediction and minimum variance controller (1 class period)
- The stochastic adaptive problem and dual control (2 class periods)
- Global stability and convergence of adaptive controllers; Liapunov stability; Passivity and hyperstability (3 class periods)
- Design for robustness in the presence of unmodelled dynamics (3 class periods)
- Universal stabilizers (1 class period)
- Practical issues and implementation; commercial products and applications (4 class periods)
- Open problems and future trends (2 class periods)
- Final exam- time: week of finals

**Office hours:** TR: 3:00-3:50 pm. Individual arrangements will be made upon request for students wishing to meet outside office hours.

Students called for military duty: “if you are a student in the military with the potential of being called to military service and/or training during the course of the semester, you are encouraged to contact your school/college”.

Eventual changes to this policy will be announced in writing.