ENEE 765 **ADAPTIVE CONTROL** (Tue Thu 3:30-4:45, Fall 2007, in EGR 1104)
Instructor: P. S. Krishnaprasad (krishna@umd.edu; 301-405-6843). Office is in A.V. Williams Building – room 2233. Office Hours: M 4:00-6:00 and Tue 5:00-7:00.

Feedback, adaptation and learning are essential elements in biological and engineered systems. Rigorous understanding of these processes is a subject of continuing study. This is a course on the *general principles of adaptive control and learning*, concentrating on deterministic aspects. Some of the salient aspects of adaptive control systems include: (a) automatic variation of gain parameters in feedback loops according to specific adaptation rules; (b) on-line identification (i.e. learning) of parameters of a system as a precursor to using knowledge of parameter estimates in control laws; (c) nonlinear dynamics in the *combination* of system (plant) and adaptive controller. These are also salient aspects of a class of signal processing algorithms known as *adaptive filters* which play an important role in biology, communication technology and robotics.

In this course, we will develop the subject of system identification (i.e. learning a model from empirical data) to the level necessary to understand and analyze the behavior of adaptive control schemes such as model reference adaptive control and self tuning regulators. Questions of convergence, stability, and robustness will be the main focus. We will discuss various analytical methods central to the subject. Methods from perturbation and averaging theory will be developed. Results from advanced stability theory will be developed and applied to the analysis of adaptation schemes. The design of input signals to extract information on system properties will be discussed. Methods from machine learning theory will be presented. Some applications and practical considerations will also be covered.

Additional Topics: We will explore some examples from biology, NMR, and some techniques from statistical learning theory.

Course Prerequisite: Background in control theory and mathematical maturity (ordinary differential equations, stability analysis). Familiarity with the material in ENEE 663 (system theory) and ENEE 661 (nonlinear control) would be an asset. Contact instructor for further information.

References: *No required textbook.*
(a) P. S. Krishnaprasad, *Lecture Notes on Adaptive Control,* 2001/2005/2007 (will be on-line).
(b) Recent papers on machine learning.
(c) H. K. Khalil, *Nonlinear Systems*, Prentice Hall, 3rd ed., Englewood Cliffs, 2002.
(d) S. Sastry and M. Bodson, *Adaptive Control: Stability, Convergence and Robustness*, Prentice Hall, 1989-1994 (available now as a free downloadable item from http://www.ece.utah.edu/~bodson/acscr/index.html).
(e) S. Sastry, *Nonlinear Systems: Analysis, Stability and Control*, Springer, NY, 1999.

Grading: A Semester Project will determine the grades.