ECE6554 - Adaptive Control (3-0-3)
School of Electrical and Computer Engineering
Georgia Institute of Technology

Instructor:	Patricio A. Vela
Office:	**VL E368** / TSRB 441
Phone:	**x44984** / x48749 (no voice-mail)
e-mail:	pvela@gatech.edu
Course Hours:	Tu/Th 12:05-13:25
Office Hours:	Tu 13:35-14:55, 16:35-17:55 @ VL C348
	or by appointment

Prerequisite:	ECE6550
Course Book:	Ioannou and Sun, *Robust Adaptive Control*, Prentice-Hall, 1996. discontinued but available online. *will not be the primary reference.*
Preferred Reading:	Hovakimyan, *Adaptive Control Notes*, on `t-square`.
Also Available:	Class lecture notes, on `t-square`.

Catalogue Description: Methods of parameter estimation and adaptive control for systems with constant or slowly-varying unknown parameters. MATLAB design projects emphasizing applications to physical systems.

Scope and Goals: The main goal of the course is to give a self-contained mathematical treatment of robust adaptive control theory for those interested in further research/investigation in the area. Throughout the course both theoretical and application aspects of robust adaptive model reference control design for uncertain dynamical systems will be presented.

Course Mechanics and Grading: The course meets two times a week, Tu/Th 12:05-13:25, and consists of homeworks plus a final project. The percentage of the total grade calculation for these two components will be decided as follows:

Homework:	60%
Project:	40%

The homeworks are intended to explore and reinforce the topics presented in class. While collaboration is encouraged regarding the homework material, all work to be turned in is expected to be individually completed. It is presumed that we are all operating under the Georgia Tech Honor Code.

I should be available during the designated office hours. If something should prevent me from fulfilling them as stated, then I will provide an alternative time. I will typically make an effort to be available for a short period after class for any questions that may arise.

The project will involve a written component and an oral presentation. It will be be assessed based

on both elements (60% written, 40% presentation). The project presentation and report should discuss:

- The particular adaptive control issue that is to be solved; in particular how does it extend beyond what was discussed in class or tie together some of the elements of the class in a new manner.
- The theory underlying the solution (the proof, if you will).
- A particular application of the theory.
- The results of applying the adaptive controller to the application.

Topical Outline: The course material is broken up into three segments which cover the following topics,

1. Background: Analysis and Dynamical Systems
   - Analysis of Solutions to Differential Equations.
   - Equilibria and Stability.
   - Invariant Sets.
   - Lyapunov Stability Theory and Performance Analysis.
   - Nonautonomous Systems.
   - LaSalle Extensions, Barbalat Lemma.
2. Model Reference Adaptive Control.
   - Direct and Indirect MRAC.
   - Robustness to Parametric/Non-Parametric Uncertainties.
   - Parameter Convergence: Persistency of Excitation.
   - Boundedness.
   - Distrubance Rejection.
3. Methods in Adaptive Control.
   - Adaptive Backstepping.
   - Adaptive Output Feedback Control.
   - Adaptive NeuroControl.
   - Examples of Adaptive Control.

Additional topics will be considered if time permits.

Other References:

- Hovakimyan, *Lecture Notes: Intelligent Control.* available on *t-square* and will be the main reference.
- Khalil, *Nonlinear Systems*, Prentice-Hall.

- Krstic, Kanellakopoulos, and Kokotovic, *Nonlinear and Adaptive Control Design*, John Wiley & Sons, 1995.

- Marino and Tomei, *Nonlinear Control Design: Geometric, Adaptive, Robust*, Prentice-Hall, 1995.

- Narendra and Annaswamy, *Stable Adaptive Control*, Prentice-Hall, 1989.

- *Adaptive Control: Stability, Convergence, and Robustness*, Sastry and Bodson, Prentice-Hall, 1994. available online.

- Slotine and Li, *Applied Nonlinear Control*, Prentice-Hall, 1991.

Additional Course Policies.

The late homework policy is that late homeworks will be accepted without notice, but will receive at minimum a 10% deduction (increasing with time). If notice is given prior to the due date of the homework and accepted, then the deduction may be waived. If the tardiness is due to sickness, please communicate as such (by phone, by e-mail, or howsoever you can). Once the solutions have been posted, then late homeworks will not be accepted, except as exempted due to prior communication.

If you have any special needs, feel free to discuss them with me.