Syllabus for Adaptive Control EML 6351

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Lecture Hours:

TA: none

Office Hours

Required Textbook: None.
Supplemental Textbooks:

1. **Stable Adaptive Control and Estimation for Nonlinear Systems: Neural and Fuzzy Approximator Techniques** by Jeffrey T. Spooner, Manfredi Maggiore, Raúl Ordóñez, and Kevin M. Passino
2. **Nonlinear and Adaptive Control Design** by Miroslav Kristic, Ioannis Kanellakopoulos, Petar Kokotovic**,** John Wiley and Sons, 1995.
3. **Stable Adaptive Systems** by K. Narendra and Annaswamy, Dover, 1989.
4. **Adaptive Control Tutorial** by P. Ioannou and B. Fidan, 2006.
5. **Adaptive Approximation Based Control** by J. Farrell and M. Polycarpou, 2006.
6. **Neuro-Fuzzy Control of Industrial Systems with Actuator Nonlinearities** by F. Lewis, J. Campos, and R. Selmic, 2002.

Course Overview: This course is intended to introduce students to control methods that can be applied to uncertain nonlinear systems. A Lyapunov-based framework is used as the baseline approach for the synthesis and analysis of the developed controllers. To compensate for uncertainty in the system, students will be introduced to topics including: repetitive learning control, model reference adaptive control, Lyapunov-based adaptive control, Neural Network function approximation methods, composite and modular adaptive control, concurrent learning, adaptive critic-based reinforcement learning control, and deep neural networks. The content will be mathematical with illustrative examples taken from general engineering systems. Introduction to Nonlinear Control (or a baseline understanding of Lyapunov-based design and analysis methods) is a prerequisite. The student will also be expected to be able to use some simulation software (e.g., Matlab) to complete class projects.

Course Content:

1. Introduction
    Early Results
    Certainty equivalence
    Matching Condition
2. Model Reference Adaptive Control
3. Lyapunov-Based Adaptive Control
4. Bounding of the parameter estimates (Projections, e modification, sigma modification)
5. Transient performance
   Composite Adaptive, Persistence of Excitation, Least Squares, Modular Adaptive Control, Concurrent Learning
7. Neural Network Systems
8. Deep Neural Networks
9. Adaptive Critics (Reinforcement Learning)
10. Research Topics

Exams: There will be two tests and a series of simulation projects. The tests will be take-home tests. The due date for the tests are March 1st and April 25th. All exams will be cumulative but will emphasize the most recently covered material.

Attendance: Not required but highly encouraged. All students are responsible for all material presented in class. Office hours will not be used to compensate for class absence.

Late/Makeup Policy: Make-up exams will be given only for special circumstances that are pre-approved by the instructor.

Academic Honesty: All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a student at the University of Florida and to be honest in all work submitted and exams taken in this class and all others. All students should review the University's honor code policy you will be held to it.

Simulations can be done in collaboration with other students. However, no simulation code for the projects should be transmitted between students. You should develop the code yourself, and tune the controller yourself, with just verbal discussion/collaboration between classmates.

Course Grading: Homework may be assigned (in class problems and take home problems) and not graded. Solutions will be posted. Simulations of each new adaptive control method will be assigned and graded. If you do not attempt the homework and simulations on your own and if you just review the solutions after the fact or copy from your friends, you are not serious about learning. A lack of understanding will be reflected in the exams.

Exams (2) 66% (33% each) + Simulation Projects (total 34%) = Total 100%