UNIVERSITY OF MARYLAND at COLLEGE PARK
Department of Aerospace Engineering

ENAE 642 - Atmospheric Flight Control

Instructor
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Office Hours: Wed 1-2:30

Lectures
Tu Th 12:30-1:45, JMP 1222

Course Description
Application of modern multivariable control and estimation techniques to aerospace ight vehicles, including fixed and rotary wing aircraft, missiles, and micro-air-vehicles. Fundamental trade-offs between controller complexity and performance requirements, and translation of handling quality specifications into requirements for control system designs.

Prerequisites: ENAE 403 Aircraft Flight Dynamics (or equivalent), ENAE 641 Linear System Dynamics (or equivalent).

Grading Policy
There will be four to six problem sets in this course (40%) two quizzes (40%) and a final project (20%). The quizzes will be closed book but open notes. Late homework assignments will not be accepted. Many homework assignments will require the use of MATLAB to perform simulations.

Homework Policy
Problem sets will typically be due 1-2 weeks after they are assigned. Each homework will be distributed through the ELMS/Canvas website http://elms.umd.edu and will consist of 4-5 problems including several computer (MATLAB) problems. **Note: Homework will not be accepted after 12:30pm on the nominal due date (at the start of class).**

Course Text and References
There will not be a required text for the course, however you may find the following references useful:

- R. C. Nelson, **Flight Stability and Automatic Control**, McGraw Hill, Inc., 2nd Edition, 1998
- S. Skogestad, I. Postlethwaite, **Multivariable Feedback Control**, Wiley, 2nd Edition, 2005
- D. S. Naidu, **Optimal Control Systems**, CRC Press, 2003
- B. Stevens and F. Lewis, **Aircraft Control and Simulation**, John Wiley and Sons, Hoboken, NJ, 2nd Edition, 2003

Software and Computer Labs
Homework will typically require use of software for numerical solution of differential equations. You may choose to use any software package (MATLAB, Maple, Mathematica, etc..) however it is highly recommended that you use MATLAB. The latest version is available in the various computer labs on campus: `http://www.it.umd.edu/Labs/`. In addition, the student version is available by purchase though the bookstore.

Collaboration Policy
The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism, which can be obtained at http://www.shc.umd.edu/. Students are encouraged to discuss homework problems in groups, however all submitted solutions, either written or MATLAB, must represent the individual's own work. As an example, it is not permitted to submit as your own work answers obtained by running someone else's MATLAB code.

Course Outline

Week	Topic	Description
1-2	Introduction	History of aircraft flight control systems, certification of aerospace control systems, control system types, review of aircraft and missile flight dynamics, handling qualities, modeling of atmospheric disturbances, ride quality analysis, translation of performance specifications into open and closed loop requirements, sequential loop closure techniques
3-5	Optimal Output Feedback Control	Review of LQR/LQG control and Kalman filter design, static and fixed structure controllers, static and LQ optimization, output LQ techniques, static H1 control, regulator/tracking/model following control designs, performance index modifications
6-11	Robust Control: Analysis and Synthesis	Metric, normed and inner product spaces, signal and system spaces and norms, Lyapunov equations, linear matrix inequalities (LMIs), design specifications and fundamental trade-offs, LFTs, nominal performance, unstructured uncertainty models, robust stability analysis and H2 /H1 synthesis via Ricatti and LMI machinery
12-13	Adaptive and Nonlinear Control	Overview of gain scheduling techniques, feedback linearization, dynamic inversion for linear and nonlinear flight dynamics
14	Project presentations	in-class
15	Final project (written) due	Tuesday, May 10th, 2016