# Syllabus – Small Unmanned Aircraft Systems Spring 2017

## Instructor

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## Text

Beard, McLain, *Small Unmanned Aircraft: Theory and Practice*,
Princeton University Press, 2012.
Princeton University Press, Wiki

## Supplemental Books

There are numerous texts to supplement the Beard and McLain text that can be found in the bibliography.

## Prerequisites

The primary prerequisite for this course is ECE/ME 5310 Control Systems. The student should be comfortable with matrices and state-space. Matlab and Simulink experience is extremely helpful.

## Objective

The objective of this course is to help you develop an understanding of flight control systems, flight dynamics, linearization, autopilot design, and state estimation.

## Grading

Grades in the course will consist of

- Midterm exam - 25%
- Weekly SUAS homework - 50%
- Final project - 25%

## Class Participation

The class is scheduled from 7:30 -8:45 am, on T,Th. Since we have a small class, I would like the lecture and computer sessions to be highly interactive. It is my expectation that you will read the material in the assigned chapters prior to the lecture and that you will come prepared to ask questions. Extra credit can sometimes be earned during class.

## Weekly Design Project

There are weekly project assignments. The idea is to develop a complete flight simulator by the end of the semester so it is critical that each assignment be done in order. Assignments are due at Noon on the day listed – mostly on Tuesday, but there are a few Thursdays so please check. Send an email with (1) the current status of your simulator, and (2) a movie of the screen showing the working simulator, or a zip file with the simulator. Late homework will be docked 2% for every weekday that it is late starting at noon the day it is due. (Spring Break, holidays, and weekends do not count towards

lateness). Students registered for 6930 are getting graduate credit and therefore are required to do more work as seen in the homework assignments.

## Midterm Exam

The midterm is more line a final and will be given after Chapter 10 and will cover chapters 1-10 of the UAV book.

## Quadcopter Project

Rather than having a final exam, we will implement some of the technology learned in this class on a commercial mini-quadcopter. There will be basic assignments for programming the drone that are not graded and then a project. The project will be a demonstration of a working system and a write-up of what you did, detailed enough so that someone else in the class could reproduce it. I does not have to be a formal document, but it should be well organized and understandable. Also include some of the challenges that you overcame. The Final demonstration and write-up are due by May 4, Noon via a video (or in person demo) of the working system with narration. Up to 5% bonus points will be awarded to students who provide successful flight demonstrations of their project during the last day of class. A very brief project proposal should be submitted in an email the week ***prior*** to the last day of class. This can simply be what you propose to accomplish and why if it's not obvious, but should be specific enough that one can easily tell if it is successful. Drones will be provided for your use, but should be turned back in by May 4. Depending on how many drones can be supplied will depend on if the project will be in groups or not. Grading for the project will be a function of complexity of the project, what was accomplished, and the write-up. However, a simple working system is more likely to get the more points than a non-working difficult problem. Also, more is expected of students enrolled in the 6930 class, so please consider that when determining a project.

### Schedule (subject to change)

| Week | Date | Subject | Reading | HW Due | 5930 | 6930 |
|---|---|---|---|---|---|---|
| 1 | Jan 10,12 | Intro/CoordinateFrames | Chapter 1-2 | | | |
| 2 | Jan 17,19 | Kinematics and Dynamics | Chapter 3 | Tues | 2.1 – 2.4 | 2.1 – 2.4 |
| 3 | Jan 24,26 | Forces and Moments | Chapter 4 | Tues | 3.1 – 3.4 | 3.1 – 3.4 |
| 4 | Jan 31, 2 | Linear Design Models | Chapter 5 | Tues | 4.1 – 4.3 | 4.1 – 4.3 |
| 5 | Feb 7, 9 | Autopilot Design | Chapter 6 | Tues | 5.1 – 5.7 | 5.1 – 5.9 |
| 6 | Feb 14, 16 | Sensor Models | Chapter 7 | Tues | 6.1 – 6.7 | 6.1 – 6.8 |
| 7 | Feb 23 | State Estimation | Chapter 8 | Tues | 7.1 – 7.4 | 7.1 – 7.4 |
| 8 | Feb 28, 2 | State Estimation | Chapter 8 | Tues | 8.1 – 8.2 | 8.1 – 8.2 |
| 9 | Mar 7 | SPRING BREAK | | | | |
| 10 | Mar 14, 16 | Nonlinear Design Models | Chapter 9 | Tues | 8.3 – 8.5 | 8.3 – 8.5 |
| 11 | Mar 21, 23 | Waypoint and Orbit following | Chapter 10 | Tues | 9.1 – 9.2 | 9.1 – 9.2 |
| 12 | Mar 28, 30 | Review(Tues), MidTerm | | Tues | 10.1 | 10.1 – 10.2 |
| 13 | Apr 4, 6 | Quad Kinematics and Dynamics | QuadNotes | Thurs | QuadSim | QuadSim |
| 14 | Apr 11, 13 | Quad Control, Quad RS | QuadNotes | Thurs | QuadControl | QuadControl |
| 15 | Apr 18, 20 | Quad Control | QuadNotes | Tues | RS-Setup | RS-Setup |
| | April 20 | Project proposal | | Thurs | Proposal | Proposal |
| 16 | Apr 25, 27 | Control, Flight Demos (Thurs) | QuadNotes | Thurs | QuadProj | QuadProj |
| 17 | May 4 | Projects due | | Thurs | QuadProj | QuadProj |