

## SYLLABUS

### **AME 532a: Flight Vehicle Stability & Control**

Spring Semester, 2014  
(updated October 17, 2013)

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- Course Sections:** 28896R and 29066R  
**Course Unit:** 3 Units  
**Prerequisite:** AME 459, Flight Mechanics or equivalent is recommended preparation.  
(Or with a special approval by the Instructor)  
**Class Hours:** Tuesday and Thursday, 5:00 pm to 6:20 pm  
**Class Location:** USC Olin Hall (OHE 100B)  
**Office Hours:** 2:00 pm to 5:00 pm, on Tuesdays and Thursdays
- Meetings with students may be held in on-campus office
  - Students may drop by during posted office hours for informal visits; however, significant meetings/discussions should be arranged in advance and appointment times set by phone or e-mail.

**Teaching Assistant:** TBD

#### **Course Background:**

This course will cover the applications of control system design to aircraft and missiles. The class assumes a basic understanding of fluid dynamics, flight vehicle performance and basic air vehicle static and dynamic stability. The class will cover the application of classical and state space control design to contemporary aircraft controls. The class will employ MATLAB, SimuLink and the Controls Tool Box to problems of inner loop control augmentation, autopilot design and autonomous flight. The design challenges will include atmospheric disturbances, inertial coupling.

#### **Course Components:**

Students' learning experience in this course will come from three (3) interrelated components:

- **Textbook Reading**

The class will use the textbook, —Introduction to Aircraft Flight Mechanics, by Thomas R. Yechout. The class will second half of the book which concentrates on control system and autopilot design. The first half of the book covering aerodynamics, performance, and flight mechanics will be briefly reviewed to insure all students understand this background

material. The majority of the class will focus on chapters 8, 9 and 10 plus additional supplemental material.

- **Classroom Lecture**

Lectures will discuss the relevant theories, methodologies, processes, tools, and practice used in the aerospace industry to understand and analyze aerospace vehicle flight control. The lectures will cover Yechout chapters 8-10 and will bring in additional material (i.e., PowerPoint slides), drawn from many reference books and technical papers. Lecture notes will be available before lectures via the ISE 532 course website on USC BlackBoard.

- **Supplementary Reading and Projects**

Additional reading assignments from various reference resources will be given throughout the semester as additional required reading. All students are encouraged to prepare for the lectures by reading the assigned chapter and any additional required reading prior to the lecture. There will be two projects: F-16 CAS Design, and a Lear Jet Autopilot Design.

**Office Hours:**

Office hours are from 2:00 – 5:00 pm, every Tuesday and Thursday. Students can come to OHE 430M for face-to-face meetings. Students are also encouraged to meet with TA during the TA office hours.

**Required Textbook:**

- *Introduction to Aircraft Flight Mechanics*, by Thomas R. Yechout, the AIAA Education Series, Copyright 2003

Recommended Reference Books:

- *Aircraft Control and Simulation*, by Brian L. Stevens and Frank L. Lewis, John Wiley & Sons, Inc.
- *Flight Stability and Automatic Control*, (2<sup>nd</sup> edition), by Robert C. Nelson, The McGraw-Hill Companies, Inc.
- *Automatic Control of Aircraft and Missiles* (3<sup>rd</sup> edition), by John H. Blakelock, John Wiley & Sons, Inc.

The instructor may recommend additional reading materials and website reference resources during the semester whenever appropriate.

**Course Website:**

Students' learning of this course is supplemented by use of the UCS Blackboard instruction system (<https://blackboard.usc.edu/>). All registered students have access to this website and should go to AME532. The course website structure is implemented to support the specific organization of the course instruction as described in this syllabus. All students should browse around the entire site to familiarize themselves with various areas and functions of this course website.

- Announcements -- important announcements of this course.

- Syllabus – contains an up to date copy of the class syllabus.
- Assignments – each homework and reading assignment will be posted along with dates for quizzes and exams.
- Content – pdf copies of lecture slides.
- Discussions – a place for the students to share their thoughts about interesting subjects with the class
- Groups -- all communication tools, including emails and roster.
- Websites – links to reference material.

### **Course Grading:**

Students will be graded according to the following scheme:

- 10% -- Classroom/Lecture Participation
- 30% -- Homework
- 10% -- Quizzes
- 20% -- Mid-Term Exam
- 30% -- Final Exam

Each of the above grading components is described in more details below.

### **Grading Components:**

- **Classroom/Lecture Participation (10%)**

The intent is for AME532 to be an involved class. Class participation is more than just counting the attendance (which is also important). The students are encouraged to ask questions, to complete reading assignments and to participate in classroom discussions. On occasion topics for research will be noted and the students will post their discussion in the Blackboard Discussion section.

- **Homework (30%)**

Homework will constitute 30% of the student's total grade. Homework assignments will be posted on a regular basis—almost every week, with the exception of exam weeks. Students are expected to submit homework on time. Late homework will not be accepted unless there is a valid and credible excuse.

- **Quizzes (10%)**

Short (~1 hour) quizzes will be given twice throughout the semester to test understanding of recent lecture and text assignment material. In total these quizzes will constitute 10% of the semester grade.

- **Mid-Term Exam (20%) and Final Examination (30%)**

Both the mid-term and the final will follow the same format. The mid-term exam will be part **closed book**—testing for understanding of fundamental concepts. This portion will be limited to the materials that have been discussed in classroom lectures. Answers will require an essay response but should be made brief and point specific. They often require only short answers

that show your comprehension of the concepts, definitions, and approaches. Part of the exam will be **open book**—for problem solutions where fundamental formula and data from the text may be required.

Make-up exams will only be offered, when there is absolute proven need by the student.

Should you have to miss your exams, an individual makeup exam will be scheduled with the instructor.

**Academic Integrity:**

"The Viterbi School of Engineering adheres to the University's policies and procedures governing academic integrity as described in SCampus. Students are expected to be aware of and to observe the academic integrity standards described in SCampus, and to expect those standards to be enforced in this course."

**Students with Disabilities:**

Any Student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m. - 5:00 p.m., Monday through Friday. The phone number for DSP is (213)740-0776.

**Course Schedule (subject to change):**

*The Instructor reserves the right to change this schedule and topics during the semester.*

Week No	Date	Class Subject		Text Chapter	Comments
1	1/14, 1/16	Course Objectives. Introduction to flight control design—including a brief history of aircraft development with an emphasis on stability and flight control.		1-3	Based on lecture notes
2	1/21, 1/23	Review of Equations of Motion, Flight Mechanics and Aircraft Static and Dynamic Stability, Transfer Functions, Linear Algebra and Block Diagram Algebra		4-7	A quick refresher, assumes prior knowledge of these subjects
3	1/28, 1/30	Root Locus Analysis and Frequency Response		8	
4	2/4, 2/6	Introduction to the use of MATLAB in the remainder of this class			<b>Quiz #1</b>
5	2/11, 2/13	Subsystem Models—actuators, sensors, atmospheric disturbances		Additional Material	Based on lecture notes and assigned reading
6	2/18, 2/20	Longitudinal Stability Augmentation and Command Augmentation		9	Assign F-16 FBW control design case study using MATLAB
7	2/25, 2/27	Lateral Directional Stability Augmentation and Command Augmentation		9	
8	3/4, 3/6	<b>2/28, Midterm Exam (two hours)</b>	<b>3/1 Return Midterm exam</b>		
9	3/11, 3/13	<b>F-16 Control Design, Case Study</b>		Additional Material	Assign Lear Jet autopilot design case study using MATLAB
10	3/18, 3/20	<b>NO CLASS—SPRING BREAK</b>			
11	3/25, 3/27	Longitudinal Autopilot Design		9	
12	4/1, 4/3	Lateral Directional Autopilot Design		9	
13	4/8, 4/10	Learjet Autopilot Design, Case Study		Additional Material	<b>Quiz #2</b> , Based on lecture notes and assigned reading
14	4/15, 4/17	Self Adaptive Autopilots and		Additional Material	Based on lecture notes and assigned reading
15	4/22, 4/24	State Space Modeling Autonomous Operations—trajectory management		Additional Material	Based on lecture notes and assigned reading
16	4/29, 5/1	An Introduction to Digital Control, State Feedback Design, State Observer and Optimal Control		Additional Material	Based on lecture notes and assigned reading
17	9-May	<b>Final Exam (two hours)</b>			I need to confirm 5/9 but this is the most likely date.