SYLLABUS

AME 459: <u>Flight Mechanics</u>

Fall Semester, 2012
(updated March 10, 2012)

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Course Sections: 28829R

Course Unit: 3 Units

Prerequisite: Undergraduate senior level standing.
(Or with a special approval by the Instructor)

Class Hours: Tuesday and Thursday, 3:30 pm to 4:50 pm

Class Location: USC Waite Phillips Hall, WPH 207

Office Hours: 1:00 pm to 3:15 pm, on Tues and Thurs
- 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
Office Hours: TBD
Location: TBD
e-mail: TBD
Phone: TBD

Course Background:

This course will cover the applications of basic aerodynamics to aircraft and missile performance, power and thrust, stability and control and compressibility effects. The class assumes a basic understanding of fluid dynamics and flight vehicle performance. The class will cover the development of the equations of motion, aircraft static and dynamic stability, aircraft response to atmospheric disturbances, inertial coupling, and an introduction to classical feedback control and autopilots.

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 follow the basic structure of the text book starting with a brief overview/refresher of the first three chapters. Those chapters will have been covered by the students in previous classes in fluid dynamics, and basic flight mechanics. The class will begin in depth with chapter 4 on the equations of motion and will complete with chapter 8—an introduction to classical feedback control.

- **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 mechanics, stability and control. The focus will be on atmospheric flight. The lectures will follow the chapter sequence of the text; however, the lectures will contain significant material (i.e., PowerPoint slides), drawn from many reference books and technical papers. Lecture notes will be available before lectures via the ISE 459 course website on USC Blackboard.

- **Supplementary Reading**

  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.

Office Hours:

Office hours are from 1:00 – 3:15 pm, every Tues and Thurs. Students can come to Bldg: OHE, Room: 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:

- "*Dynamics of Atmospheric Flight*", by Bernard Etkin, John Wiley & Sons, Inc.
- "*Flight Stability and Automatic Control*", (2nd edition), by Robert C. Nelson, The McGraw-Hill Companies, Inc.
- "*Automatic Control of Aircraft and Missiles*" (3rd 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 AME459. 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 AME459 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 (~1/2 hour) quizzes will be given approximately 3 times 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 <u>absolute proven need</u> 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.

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

Week No	Date	Class Subject	Text Chapter	Comments
1	8/23 8/25	Introduction to Air Vehicle Stability and Flight Controls —including a brief history of aircraft development with an emphasis on stability and flight control—		Based on lecture notes
2	8/30 9/1	Review of Basic Aerodynamics, Propulsion and Flight Vehicle Performance	1,2,3	A quick refresher, assumes prior knowledge of these subjects
3	9/6 9/8	Aircraft Equations of Motion—axis systems, coordinate transformations, force and moment equations	4	
4	9/13 9/15	Aircraft Static Stability—control power, longitudinal static stability, static margin	5	
5	9/20 9/22	Aircraft Static Stability—lateral-directional static stability	5	Quiz #1, 9-22
6	9/27 9/29	Linearizing the Equations of Motion—small perturbation approximation	6	
7	10/4 10/6	Special Topics—coordinated turns, wake vortex, nose vortex, wing rock, departure and spin		Based on lecture notes and assigned reading
8	10/11	Midterm Exam (two hours)		
8	10/13	Aircraft Dynamic Stability—the spring-mass-damper analogy and Laplace transformation, roots in the complex plane	7	
9	10/18 10/20	Aircraft Dynamic Stability—dihedral effect, vertical tail sizing, Weissinger theory, and end-plates	7	
10	10/25 10/27	Aircraft Dynamic Stability—flying qualities, ground and in-flight simulation and the Cooper-Harper rating scale	7	
11	11/1 11/3	Special Topics—atmospheric disturbances, aircraft gust response and sensitivity		Based on lecture notes and assigned reading
12	11/8 11/10	Special Topics—Structural modeling and aircraft flexibility		Quiz #2, 11-10
13	11/15 11/17	Classical Feedback Control—transfer functions and block diagram algebra	8	
14	11/22	Classical Feedback Control—first order and second order systems and root locus and frequency response	8	
14	11/24	Thanksgiving Holiday		
15	11/29 12/1	Classical Feedback Control—stability augmentation and autopilots	8	
16	TBD	Final Exam (two hours)		Final Exam will be Tuesday, 13 December, 2-4 pm

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