

SYLLABUS

**AME 459 – Flight Mechanics**

Fall Semester, 2017

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| <b>Course Sections:</b>    | 28829R   |
| <b>Course Unit:</b>        | 3 Units  |
| <b>Prerequisite:</b>       | Undergraduate senior level standing  |
| <b>Class Hours:</b>        | Fridays, 1300-1550 PT  |
| <b>Class Location:</b>     | Kaprielian Hall, KAP 163   |
| <b>Office Hours:</b>       | Fridays, 1600-1900 PT <ul style="list-style-type: none"><li>• Meetings with students may be held in the on-campus office</li><li>• Students may drop by during posted office hours for informal visits. However, prior appointments should be arranged via phone or e-mail for lengthy meetings/discussions.</li></ul> |
| <b>Teaching Assistant:</b> | TBD  |

## **Course Background**

This course will cover the applications of basic aerodynamics to atmospheric flight vehicles performance, power and thrust, stability and control, and compressibility effects. The class assumes a basic understanding of fluid dynamics, and 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, 2<sup>nd</sup> Edition. The class will follow the basic structure of the text book starting with a brief overview/refresher of the first three chapters on Basic Aerodynamics, Basic Performance, and Aircraft Performance. The class will begin in depth starting with Chapter 4, where the Aircraft Equations of Motion will be explained and derived, and concluding with Chapter 8, where an introduction to the Classical Feedback Control will be provided.

- **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, and stability and control. The focus will be on fixed-wing, atmospheric vehicles. The lectures will follow the chapter sequence of the text. However, the lectures will contain significant material, drawn from many reference books and technical papers, as well as industry standards of practice. Lecture notes will be made available before the lectures via the AME 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 1600 to 1900 PT every Friday evening. Students can come to Bldg OHE, Room 430M for face-to-face meetings. Students are also encouraged to meet with the TA with prior arrangements.

## **Required Textbook**

- “*Introduction to Aircraft Flight Mechanics*”, Second Edition, by Thomas R. Yechout, the AIAA Education Series, Second Edition, Copyright 2014.

Additional Reference Material:

- “*Dynamics of Atmospheric Flight*”, by Bernard Etkin, John Wiley & Sons, Inc.
- “*Flight Stability and Automatic Control*”, (2<sup>nd</sup> edition), by Robert C. Nelson, The McGraw-Hill Companies, 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 will be implemented to support the specific organization of the course instruction, as described in this syllabus. All students should browse 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 – A pdf copy of the 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 system.

- 10% – Class 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 may 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 without a valid and credible excuse.

- **Quizzes (10%)**

A short quiz (45-60 minutes) will be administered on two occasions during the semester to test the students understanding of covered lecture material and work assignments. In total, these quizzes will constitute 10% of the semester grade.

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

Both the Mid-Term and Final-Term exams will adopt a common format, namely a Closed Book section and an Open Book section. The Closed Book section is designed to test the student's comprehension of fundamental concepts, and will be limited to materials already covered in the classroom lectures. The answers are typically brief and illustrate basic understanding of concepts and principles. The Open Book section is designed to test the student's understanding and application of methods, formulas, and data from the text book and/or lectures notes. Make-up exams will only be offered when there is a compelling and an absolutely unavoidable need, such as urgent health matter. Should you have absolutely no other choice but to miss your exam, a prior arrangement may be made with the instructor for a makeup exam.

## **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 without exception.

## **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 and hand-delivered to the instructor as early in the semester as possible. DSP office is located in STU 301 and may be reached at (213)740-0776.

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

| Week | Date   | Class Topic   | Chapter | Comments   |
|------|--------|---|---------|--|
| 1    | 25 Aug | Introduction to Air Vehicle Stability and Flight Controls, including a brief history of aircraft development          |         | Lecture notes and related references only        |
| 2    | 01 Sep | Review of Basic Aerodynamics, Propulsion and Flight Vehicle Performance   | 1, 2, 3 | A quick refresher, assumes prior basic knowledge |
| 3    | 08 Sep | Flight Vehicle Performance, Aircraft Equations of Motion, axis systems/transformations, force & moment equations      | 3, 4    |  |
| 4    | 15 Sep | Aircraft Static Stability, including control power, longitudinal static stability, static margin                      | 5       |  |
| 5    | 22 Sep | Aircraft Static Stability, including lateral-directional static stability   | 5       | Quiz #1  |
| 6    | 29 Sep | Linearizing the Equations of Motion, including small perturbation approximation                                       | 6       |  |
| 7    | 06 Oct | Review / Mid Term Prep  |         |  |
| 8    | 13 Oct | Special Topics, including coordinated turns, wake vortex, nose vortex, wing rock, departure, and spin                 |         | Mid Term Exam                                    |
| 9    | 20 Oct | Aircraft Dynamic Stability, including spring-mass-damper, Laplace transformation, and roots in the complex plane      | 7       |  |
| 10   | 27 Oct | Aircraft Dynamic Stability, including dihedral effect, vertical tail sizing, Weissinger theory, and end-plates        | 7       |  |
| 11   | 03 Nov | Aircraft Dynamic Stability, including flying qualities, ground and in-flight simulation, and the Cooper-Harper rating | 7       |  |
| 12   | 10 Nov | Special Topics, including atmospheric disturbances, aircraft gust response and sensitivity                            |         | Lecture notes and related references only        |
| 13   | 17 Nov | Special Topics, including structural modeling and aircraft flexibility  |         | Quiz #2  |
| 14   | 24 Nov | Thanksgiving Holiday  |         |  |
| 15   | 01 Dec | Classical Feedback Control, including transfer functions, block diagram algebra, root locus, and frequency response   | 8       |  |
| 16   | 08 Dec | Review / Final Prep   |         |  |
| 17   | 13 Dec | Final Exam (1100-1300PT)  |         | Final Exam                                       |