ASEN 3128
Aircraft Dynamics

Syllabus

Lecture: AERO 120* Tues, Thurs 1:00 2:15 pm
Lab: AERO 141* Wed 12:40 am 2:30 pm, 2:45 4:35 pm
(*online/Zoom for Jan 11-Jan 20, 2022 due to temporary remote learning switch for Spring 22 start)

Professor Nisar Ahmed
Office: AERO 265 Phone: (303) 492-0286 Email: nisar.ahmed@colorado.edu
Office Hours: TBD.

Professor Morteza Lahijanian
Office: AERO 267 Phone: (303) 735-5443 Email: morteza.lahijanian@colorado.edu
Office Hours: TBD.

Teaching Assistants and Teaching Fellows

TA Ofer Dagan ofer.dagan@colorado.edu
Office Hours: TBD

TF Roland Ilyes roland.ilyes@colorado.edu
Office Hours: TBD

TF Kyle Li

TF Alfredo Restrepo

Required: *Dynamics of Flight: Stability and Control*, Bernard Etkin and Lloyd Reid, John Wiley and Sons. 3rd Ed., 1996
Supplemental:

Overview

This course covers the key ideas that enable: (i) an understanding of how aircraft work and tools for quantitative analysis, and (ii) design methods to achieve specified dynamical behavior. Because aircraft exist in many different forms, and new designs continue to be developed, the focus is on the common principles that underlie atmospheric flight, so that a solid basis can be formed for future work in most any direction. Concrete treatment of these ideas, tools, and methods is provided through working problems individually and in assigned groups, consisting of analysis, simulation, and design problems, including development of MATLAB simulation models for two very different vehicles: a quad-copter and a conventional airplane.

In their full expression, aircraft dynamics possess astounding complexity. It is a tribute to the

obtained, leading to clear insights and design principles. While these concepts are not inherently difficult, they do lie outside most common experience, and they depend on new nomenclature and strange notation that can seem overwhelming at first. **It is only through diligent and careful use of this new language that the underlying simplicity can be grasped and conveyed on exams; mastery of the language of aircraft dynamics is perhaps the most important predictor for success in the course.**

The course has been designed to develop a conceptual grasp of the key ideas below, and to demonstrate proficiency in using these concepts to solve problems, construct and validate simulations, and to explain behaviors and results obtained**. In particular, engineering reasoning skills using these concepts are stressed in assignment solutions and examinations**. The key learning objectives are:

Vector mechanics

- Vector representation in coordinate frames
- Change of coordinate frame representation (coordinate rotation)
- Relative motion, frame derivatives
- Change of derivative frame: velocity rule

How aircraft dynamics models are created and what the terms mean

- 3D rigid body translational model
  - Kinematics
  - Dynamics, external forces
  - Effects of wind
- 3D rigid body rotational model
  - Kinematics, Euler angle attitude representation
  - Dynamics, Euler moment equations, external moments
- External forces and moments
  - Aerodynamic effects
  - Control effects
  - Steady flight conditions, trim states

How aircraft dynamics models are simulated

- State space models

- Matlab integration
- Good naming and commenting habits

How dynamical behavior is understood and specified

- Linearization
- Decoupling
- Stability derivatives
- Modal solutions
- Stability characterizations
- Modal specifications

recorded, this is a poor substitute for your own lecture notes. Questions are encouraged during lectures, and will be prompted often.

Homework Homework problems provide individual practice in solving problems of varying difficulty and sometimes will also involve computing. Collaboration on homework is allowed (copying is not); however, students are encouraged to use homework as a means to ensure their individual mastery of the subject. In-class group problem-solving and labs will allow for considerable collaborative learning opportunities.

Reading Quizzes These will cover the reading material, lectures, and portions of the lab assignments. **Quiz grades will contribute to your individual course grade and are designed to encourage you to come to class and lab prepared.** They will consist of true-false and multiple-choice-style questions similar in format to questions that will be on the exams.

Lab Assignments These provide first-hand experience employing the reading and lecture material. They consist of analysis and computation exercises, simulation development, and simulation use to address aircraft stability and control design problems. Assignments will be carried out in small groups. Students are expected to use these assignments and the associated group learning opportunities to

diagrams or extensive discussion of results, must be acknowledged at the end of your assignment. Lab assignments are not formal reports. Specific requirements for what to submit are given with each assignment.

9. Deadlines Deadlines must be enforced to ensure fairness and to enable timely grading. Late assignments are subject to a 20% penalty per day. (E.g. 0-24 hours late = 1 day penalty) except

B-, C+	Demonstrates good understanding of most key concepts, with few major quantitative errors.
C	Demonstrates adequate understanding of the material to proceed to the next level; sufficient quantitative work.
C	Does not demonstrate adequate understanding of the material to proceed to the next level, or makes persistent quantitative errors.
D	Very little understanding is evident, consistently poor quantitative work.
F	Unsatisfactory performance.

In this course, students will be graded on a positive/ system that is, graders will assess whether responses provided by students reflect knowledge, understanding and reasoning processes that **meaningfully contribute** to answering questions posed on assignments. Empty and

drawing, etc.) are easily seen through and will not suffice. This subject is difficult and non-