AE 4531 – Aircraft Flight Dynamics

Course Syllabus

Fall Semester 2026

1. CLASS SCHEDULE

Lecture: 12:30 – 1:45pm Tuesday, Thursday
TBA

2. INSTRUCTORS

Dr. Jonathan Rogers, Professor, School of Aerospace Engineering
Office: Montgomery Knight 421B
Office Hours: TBA
Phone: (404) 385-1600
Email: jonathan.rogers@ae.gatech.edu

Office hours will be in person or virtually at the following link:
https://gatech.zoom.us/j/2499414718?pwd=NXg4VkJnVjVqcWVaM2lqSDhxTVE5Zz09

Teaching Assistant: TBA
Office Hours: TBA
Email: TBA

Grader: TBA
Office Hours: TBA
Email: TBA

3. COURSE DESCRIPTION

The topic of aircraft flight dynamics, stability, and control is critical to the overall design and analysis of aircraft in flight. Specifically, the subject is concerned with response of the airplane to both external and internal disturbances. Externally generated disturbances, such as wind gusts and turbulence, are caused by the atmosphere, and the airplane must be designed such that it has a built-in tendency to dampen motion caused by these disturbances and return to a nominal flight condition. Internally generated disturbances are caused by the pilot or automatic flight control system, and include control surface deflection, configuration changes (landing gear or flap extension/retraction), CG shift, and sweeping of the wing in-flight. A balance must be struck between airplane controllability, in which proper control response is generated from reasonable control inputs, and stability, which defines the aircraft's inherent tendency to maintain a given

flight condition in the presence of control disturbances. Achievement of a proper tradeoff between controllability and static/dynamic stability is one of the key reasons why flight dynamic analysis is an inherent part of the design process.

In contrast to airplane performance analyses where the airplane is essentially considered as a point mass, in stability and control analysis inertial reactions along and about all axes of the airplane play a role in determining its response to disturbances. The airplane is therefore assumed to be a three-dimensional body with six degrees-of-freedom: three translational, and three rotational. The response of the airplane of over periods of time from 10 to 60 seconds is of particular interest in stability analysis and handling qualities determination.

4. PREREQUISITE COURSES

AE 3030 Aerodynamics
With concurrency AE 3531 Control System Analysis and Design

5. COURSE TEXTBOOK

The official textbook for this course is:

> Etkin, B., Reid, L.-D., Dynamics of Flight: Stability and Control, Wiley, 3rd Edition, 1995, ISBN 978-0-4-7103418-6

Another good reference book on this subject is:

Schmidt, D., Modern Flight Dynamics, McGraw Hill, 2012, ISBN 978-0-07-339811-2.

It is highly recommended that students buy one of the books above, but it is not required. You will find it useful as a reference for additional reading throughout the semester and your career.

6. COURSE OBJECTIVES

At the end of this course, students will be able to:

1. Describe the relationships between airplane configuration design, flying qualities, and stability and control, and the engineering tradeoffs and balances that result particularly in terms of performance.
2. Apply Newton's laws to develop the nonlinear equations of motion for aerospace vehicles, accounting for the aerodynamic, gravitational, and thrust forces and moments.
3. Linearize nonlinear equations about a steady-state equilibrium condition.
4. Develop parameterized relationships for aerodynamic and thrust forcing functions in terms of non-dimensional and dimensional stability and control derivatives.
5. Determine equilibrium (trim) conditions for steady-state straight and level flight, turning flight, and symmetric pull-up flight.

6. Quantify static stability, dynamic stability, and dynamic response characteristics (frequencies, damping ratios, time constants) by developing and analyzing linear state-space models, eigenvalues, eigenvectors, and transfer functions.
7. Identify the standard airplane dynamic modes of motion (short period, Dutch roll, etc.), their reduced-order approximations, and the specific airplane characteristics which influence them.
8. Identify the various stability derivatives for fixed-wing aircraft and the aircraft components and parameters that drive their values.
9. Describe the design of aircraft stability augmentation systems (SAS) and identify the feedback loop structures for SAS and automatic flight control systems (AFCS) designs.

7. GRADING

Grades will be determined based on demonstrated proficiency on homework sets, two midterm examinations, and a final examination. The points associated with each graded event are shown below along with the associated letter grade. Note that this course is not graded on a curve.

Point Breakout:

Homework Sets (6)	= 400 points
Midterm Exam 1	= 150 points
Midterm Exam 2	= 150 points
Final Exam	= 300 points
Total	**= 1000 points**

Class participation: +, 0, -

Grading Scale:

A = 900-1000 Total Points
B = 800-899 Total Points
C = 700-799 Total Points
D = 600-699 Total Points
F = 0-599 Total Points

Occasionally, students will be offered the opportunity to obtain extra credit points. These points are added to the student's total while the total points for the course remains at 1000.

In borderline cases, the class participation score will be used to influence the final grade.

8. HOMEWORK SETS

Several homework sets will be issued during the semester. These problem sets are intended to deepen understanding of the material. Unless stated otherwise, homework sets are to be submitted before class begins on the due date. **Students are permitted to turn in 1 homework set up to 3 days late with no justification necessary. Otherwise, homework sets will not be**

accepted late. If you are exercising this option, email your homework submission to the TA and copy the grader and instructor.

Homework should be submitted online via Canvas. Draw a box around the final answer, and include proper units.

A sufficient amount of work must be shown for each problem on the homework. If sufficient work is not shown, points will be taken off.

9. ADDITIONAL INSTRUCTION

Supplemental instruction by the instructor or TA is a valuable resource available to any student having difficulty with a particular concept in the course. Get help when you have a problem! Be prepared to ask specific questions about concepts that are confusing or unclear. **Students are highly encouraged to attend office hours or make an appointment via email.**

10. OTHER CLASS POLICIES

> **Attendance:** Class attendance is required. In previous classes there has been a strong correlation between students who received good grades and students who attended class regularly.
>
> **Cell Phones and Electronic Devices:** Cell phones and computers ***should not be out during class***.

Students with disabilities will receive necessary accommodations. For details, please refer to the GT Disabilities Services' "Policies and Procedures" page located at this link: http://disabilityservices.gatech.edu/content/15/policies-procedures.

11. ACADEMIC DISHONESTY

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Review Georgia Tech's Honor Code and the student Code of Conduct.

Any student suspected of cheating or plagiarism on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

12. AI POLICY

Generative AI-based assistance, such as, but not limited to ChatGPT and Copilot, is comparable to collaboration with other people – for an individual assignment the use of generative AI is a violation of the Honor Code.

This course is designed to teach you how to do technical analysis, so all work you submit must be your own. You should never include in your assignment anything that was not written directly by you without proper citation (including quotation marks and in-line citation for direct quotes). This includes code written by AI that was used to generate results for an assignment, or using AI to assist in the writing of code.

Inclusion of anything you did not write in your assignments (prose or code) without proper citation will be treated as an academic misconduct case. If you are unsure if you have gone to far consider these two simple guidelines: (1) avoid hitting "copy" in a conversation with an AI assistant; (2) do not have both your assignment and the AI agent open at the same time. Avoid using tools that directly add content to your submission. Use of spell and grammar checkers are acceptable (and encouraged) for all assignments.

You MUST adhere to Georgia Tech's rules regarding the use of AI in courses. Here is the link to the current policy:

https://oit.gatech.edu/ai/guidance

13. ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services (404-894-2563) as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

14. STUDENT FACULTY EXPECTATIONS AGREEMENT

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. The Student-Faculty Expectations articulate some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.