

AER1202: ADVANCED FLIGHT DYNAMICS DYNAMICS, STABILITY AND SIMULATION

Dr. Longhao Qian

Fall 2026

Acknowledgement: These slides were developed with reference to course materials by Professor Hugh H. T. Liu.

► **Instructor**

Dr. Longhao Qian

longhao.qian@mail.utoronto.ca

Curriculum

This graduate-level course covers fixed-wing aircraft flight dynamics, with a focus on stability and control. Its purpose is to develop a comprehensive skill set for fixed-wing aircraft flight simulation, stability analysis, and flight-control design.

What is this course for?

You may enroll in this course if you want:

- ▶ to learn about fixed-wing aircraft dynamics
- ▶ to study flight-specific stability and control
 - ▶ with a focus on advanced, state-space-based flight-control methods.
 - ▶ advanced skills in Simulink-based flight simulation and control design.

What would you gain from this course?

- ▶ After this course, as a graduate-educated professional in aerospace science and engineering, you should be able to perform quantitative analysis of an aircraft's dynamic behaviour and the systematic design of flight-control systems to improve its dynamic performance.
- ▶ If it sounds cool and valuable, this course is for you.

AER1202 vs AER302

Graduate Flight Dynamics vs Undergraduate Flight Dynamics

contents	AER1202	AER302
dynamics	✓	✓
performance		✓
stability and control concepts	✓	✓
- classical flight control	✓	✓
- modern flight control	✓	
simulation	✓	

Table 1: Advanced vs Fundamental Flight Dynamics

The overlapping materials account for approximately 30% of the total content.

Learning Guide

- ▶ Prerequisites
 - ▶ AER301 - Dynamics (classical Newtonian mechanics), or equivalent
 - ▶ AER372 - Control Systems, or equivalent [self study: appendix]
 - ▶ AER302 - Aircraft Flight, or equivalent [review, 30% overlap]
 - ▶ Matrix Theory, Linear Algebra
 - ▶ MATLAB and Simulink [There is a dedicated lecture on Simulink]
- ▶ Course Materials
 - ▶ course presentation handouts
 - ▶ H.H.-T. Liu, *Analytical Aircraft Flight* (eBook version of CUP, selected chapters)

Contents

Every Wednesday, 14:00–17:00, in AS158

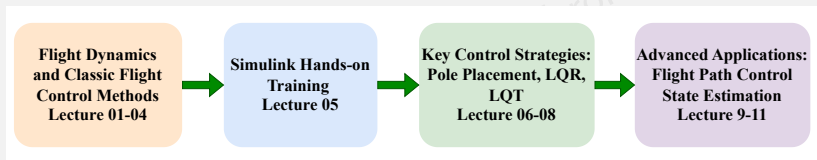
Introduction

1. Frame Definitions and Flight Kinematics
2. Flight Dynamics and Linearization
3. Flight Stability and Control Using Linearized Aircraft Model
4. Classical Feedback Flight Control
5. Flight Simulation with Simulink
6. Closed-loop Pole Placement
7. Linear Quadratic Regulator and Tracking (LQR and LQT)
8. Control Robustness
9. Aircraft Trajectory Control
10. State Estimation
11. Advanced Topics in Flight Control

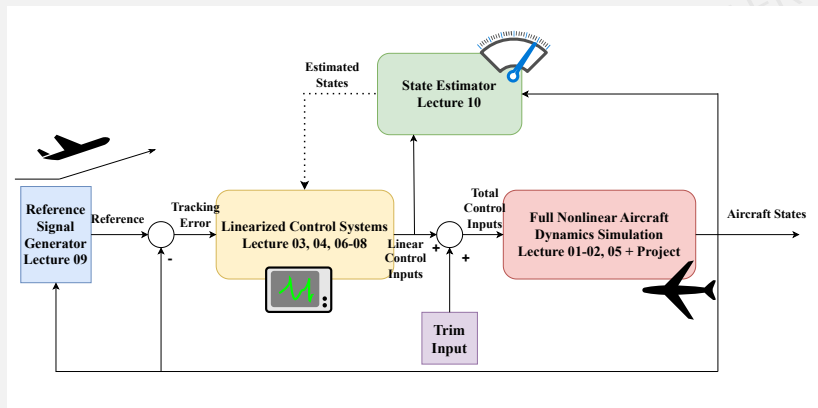
Grading

Assignments (including computational programs)	60%
Final Individual Project	40%

Content Distribution



Purpose of the Course: Closing the Loop



Prerequisites for MATLAB

- ▶ MATLAB R2025b or later is required for this course. You may use the U of T-provided MATLAB licence or install MATLAB on your personal computer.
- ▶ This course assumes basic knowledge of MATLAB programming. If you are unfamiliar with MATLAB, please review it before the course begins. Tutorials and documentation are available on the MathWorks website.

Timetable

Date	Topic	Tutorials	Assignments
Sept. 16	Lect01		
Sept. 23	Lect02		A1 (10%) assigned
Sept. 30	Lect03	T1	
Oct. 7	Lect04		A1 due A2 (15%) assigned
Oct. 14	Lect05	T2	
Oct. 21	Lect06		A2 due A3 (15%) assigned
Oct. 28	Fall break		
Nov. 4	Lect07	T3	Project assigned
Nov. 11	Lect08		A3 due A4 (20%) assigned
Nov. 18	Lect09		
Nov. 25	Lect10	T4	
Dec. 2	Lect11		A4 due
Dec. 9	Project Q&A		
Dec. 16			Project due (tentative)

Assignments Policy

1. Late policy: all assignments are due at 23:59 on the designated date. You have **ONE** late-submission allowance during the course. When this allowance is used, the assignment grade is multiplied by the coefficient defined below. After the allowance has been used, subsequent late assignments are not accepted and receive a grade of **0**. Documented exceptional circumstances are handled separately and do not use this allowance.
2. The coefficient is calculated as follows:

Assignments Policy

Late Submission Coefficient

Late submissions are accepted for at most **24 hours** after the deadline. The coefficient c decreases linearly from 1 (on time) to 0 (24 hours late), and is applied by multiplying it by the grade you would have otherwise received:

$$c(t) = \max\left(1 - \frac{t}{24}, 0\right), \quad t = \text{hours late}$$

t (hours late)	0	6	12	18	24
$c(t)$	1.00	0.75	0.50	0.25	0.00

Submissions more than 24 hours late receive a grade of **0**, the same as if the deadline had been missed entirely.

Assignments Policy

1. Generative AI policy: follow the University of Toronto's official guidelines on the use of generative AI in coursework. Any use of generative AI in an assignment must be disclosed in the submission, including the tool used and a brief description of how it was used.
2. If documented exceptional circumstances (e.g. a medical or family emergency) prevent you from meeting a deadline, contact the instructor and your graduate unit as soon as possible. Formal extensions are governed by School of Graduate Studies (SGS) and graduate-unit procedures.

Project Policy

1. The project deadline is tentatively scheduled for December 16, 2026. The final deadline will be announced separately. Once confirmed, it is a **HARD** deadline; project reports submitted after the deadline will not be accepted.
2. The format is an individual project; no collaborations are allowed.
3. Follow the University of Toronto's official guidelines on the use of generative AI in coursework. Any use of generative AI in the project must be disclosed in the submission, including the tool used and a brief description of how it was used.

After-class Communications

1. Office hours: upon request, I will arrange a time to discuss course materials and assignments. Please email me to schedule a time.
2. We prefer to communicate via Quercus.