MAE 142
Dynamics and Control of Aerospace Vehicles (4 units)

Class/Laboratory Schedule: four hours of lecture, eight hours of outside preparation.
12 hours/week total

Course Coordinator(s): Mark Anderson

Textbooks/Materials:

1. Ashish Tewari, Atmospheric and Space Flight Dynamics, Birkhäuser, 2007
2. Ashish Tewari, Advanced Control of Aircraft, Spacecraft and Rockets, Wiley, 2011

Catalog Description: The dynamics of vehicles in space or air are derived for analysis of the stability properties of spacecraft and aircraft. The theory of flight, lift, drag, Dutch roll and phugoid modes of aircraft are discussed. Optimal state space control theory for the design of analog and digital controllers (autopilots).

Prerequisites: MAE 104 and MAE 143B or ECE 171A, or consent of instructor. Enrollment restricted to engineering majors only.

Course Type: Required

Course Objectives:

1. To review the modeling of the dynamics of rigid bodies in 3-dimensional space.
2. To enable students to extend such models to aerospace systems such as aircraft, spacecraft, helicopters, and rockets, and to learn how to estimate the unknown state variables based on sensor measurements.
3. To teach spacecraft attitude determination, rocket launch control, and the design of aircraft stability augmentation system.
4. To introduce the tools of state-space control theory, and to apply such tools to the control of aerospace vehicles.

Course Topics:

1. Navigation and geospatial position.
2. Kinematics: direction cosines, Euler angles, quaternions, velocity.
3. Dynamics: rigid bodies in translation, rotation.

4. Forcing functions: gravity-gradient torques, airfoils, aerodynamic forces, magnetic torques.
5. Linearization: Taylor series, state-space models.
6. Linear systems: controllability, observability, state estimation, attitude estimation, pole assignment.
7. Design of autopilots for linearized models of lateral and longitudinal aircraft motion.
8. Design of attitude control for spacecraft.

Last Updated: 9th June 2025