**Course Title**: Flight Dynamics and Control of Vertical Lift Vehicles

**Course Overview**: This course provides a modern perspective on the vertical lift flight dynamics and control, with specific applications to rotary-wing vehicles. Modeling and simulation methods will be presented to predict the the motion of a rotorcraft in generalized maneuvering flight. The course includes a treatment of modern automatic control system design to meet desired stability, handling quality, and performance specifications, as well as to enable fully autonomous fight. Computer simulations of conventional helicopter (UH-60) and tiltrotor (XV-15) configurations will be provided to students and used to apply those concepts presented in theory.

**Instructor**: Umberto Saetti, Assistant Professor, Alfred Gessow Rotorcraft Center, University of Maryland (saetti@umd.edu)

**Syllabus:** The course consists in 12 1.5h sessions (9 lectures and 3 laboratory sessions). To provide students with real-life problem experience, flight simulation models of conventional helicopter and tiltrotor configurations will be made available to students in MATLAB and/or Julia.

1. *Lecture 1*: Course Introduction and Review of Fundamentals in Vertical Flight Aerodynamics.
2. *Lecture 2*: Modeling of the of Rotorcraft Flight Dynamics.
3. *Lecture 3*: Trim, Linearization, and Model-Order Reduction.
4. *Lecture 4*: Dynamic Modes of Motion in Hover and Forward Flight.
5. *Lab 1:* Dynamic Analysis of a Simple Helicopter Model.
6. *Lecture 5*: Intro to Rotorcraft Flight Control Design.
7. *Lecture 6*: Modern Flight Control Design I: Explicit Model Following.
8. *Lab 2*: Implementation of Explicit Model Following Flight Control Law.
9. *Lecture 7*: Modern Flight Control Design II: Dynamic Inversion.
10. Lab 3: Implementation of Dynamic Inversion Flight Control Law.
11. *Lecture 8*: Stability, Handling Quality, and Performance Specifications.
12. *Lecture 9:* Model Stitching/Tiltrotor Modeling and Simulation.

**Assessment**: Report.

**References**:


- Course notes provided.
- Padfield, G. D., "Helicopter Flight Dynamics: Including a Treatment of Tiltrotor Aircraft," Wiley, 3rd Edition, 2018, ISBN: 978-1-119-40105-6.
- Tischler, M. B. et al., "Practical Methods for Aircraft and Rotorcraft Flight Control Design: An Optimization-Based Approach,", AIAA Education Series, 2017, DOI: https://doi.org/10.2514/4.104435.
- Stevens, B. L., Lewis, F. L., and Johnson E. N., "Aircraft Control and Simulation: Dynamics, Controls, Design, and Autonomous Systems," Wiley, 3rd Edition, 2015, ISBN: 978-1-118-87098-3.