**MAE 495/589/621 Multi-Rotor Aerial Vehicles**

## Course Information

Course Title: Multi-Rotor Unmanned Air Vehicles

Credit Hours: 3

Semester/Year: Fall 2024

Meeting Days/Times: Tues, Thurs 4:30–5:45PM

Room Location: 2207 Engineering Building III

## Instructor

Prof. Farhan Gandhi

Office Hours Tues, Thurs 3:30–4:30PM

Email: [fsgandhi@ncsu.edu](mailto:fsgandhi@ncsu.edu)

<https://mae.ncsu.edu/people/farhan-gandhi/>

## Teaching Assistant(s)

## Course Text(s)

No required textbook. Comprehensive notes provided in class.

Supp. Resource: Principles of Helicopter Aerodynamics (2nd Ed), by J. Gordon Leishman

## Course Description

There has been tremendous recent interest in multi-rotor aerial vehicles for Urban Air Mobility (or Advanced Air Mobility), to facilitate the movement of people, cargo, goods and packages in urban/suburban areas. This course covers aerodynamics, operation, flight controls, and key design elements of this class of vehicles. Additionally, special topics including interactional aerodynamic, acoustics, vibration, and fault-tolerance of these aircraft will also be covered. Students taking this course will gain an excellent overall understanding of multi-rotor aerial vehicle technologies, key analysis methods, and have a strong foundation to pursue research or employment in this exciting and dynamic field.

## Prerequisite

This is a senior-level/introductory-graduate MAE course. Students should have senior level standing in Mechanical/Aerospace Engineering or permission of instructor.

## Course Requirements (Grading Criteria)

Grades will be based on 6-7 homework assignments, worth a total of 50% of the total grade, with the remainder divided between a mid-term exam (25%) and a final exam (25%). Homework assignments will require computation, so competency with a programming language/environment (MATLAB, FORTRAN, C++, etc.) is expected. **Students registered for the graduate version (MAE 589) will have additional problems on some homework assignments, an extra assignment, and additional take-home problems on exams.**

## Course Objectives (Topics Covered)

Students will develop an understanding of and analysis proficiency on the following topics:

**Rotor Actuator Disk/Momentum Theory**

**Blade Element Theory in Hover**

**Hybrid Blade-Element Momentum Theory**

**Omega-Square Model**

**Blade Element Theory in Forward Flight**

**Individual Rotor and Multi-Rotor Controls for a Quadcopter**

**Multicopter Trim in Hover, Forward Flight, and Climb**

**Multi-Rotor Controls for Hexacopters and Octocopters**

**Rotor Sizing, and Fixed- and Variable-Pitch Multicopters**

**Flight Controllers for Multi-Rotor Aerial Vehicles**

**Multi-Rotor Aerial Vehicle Performance**

**Special Topics: Interactional Aerodynamics**

**Special Topics: Acoustics of Multi-Rotor Aerial Vehicles**

**Special Topics: Vibratory Loads of Multi-Rotor Aerial Vehicles**

**Special Topics: Fault Tolerance of Multi-Rotor Aerial Vehicles**