**UNMANNED AERIAL SYSTEMS**
TOPICS IN INTELLIGENT SYSTEMS ENGINEERING
**ENGR-E 399/599**
Sections: 13737 & 13736


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| **Instructor:** | Dr. Or Dantsker<br>Department of Intelligent Systems Engineering |
| **Office:** | Luddy Hall, Room 4064 |
| **Email:** | odantske@iu.edu |
| **Office Hour:** | By appointment (please email to make an appointment) |
| **TA:** | Caeden Taylor<br>caedtayl@iu.edu |
| **Office Hour:** | By appointment (please email to make an appointment) |


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| **Website:** | http://canvas.iu.edu |
| **Class Time:** | Tuesday, Thursday 3:55 PM–5:10 PM |
| **Location:** | Luddy Hall 4010 Fab Lab<br>*(unless otherwise noted in Course Schedule)* |

## COURSE DESCRIPTION

This project-based course will teach students about Unmanned Aerial Systems (UAS), specifically the underlying the physics, dynamics, control, and guidance of fixed-wing electric unmanned aircraft. In the lab component, students will work in teams to interface, control, and debug autopilot sensors (inertial measurement, airspeed, etc.) and aircraft hardware (servo actuators and propulsion system) using a microcontroller, incrementally integrating the physical hardware into a basic autopilot.

## REQUIRED MATERIALS

The required course materials include:

Book:

Small Unmanned Aircraft: Theory and Practice
By Randal W. Beard and Timothy W. McLain.
ISBN: 9780691149219
Princeton University Press, 2012

Available as eBook through IU Library (link next page)

https://kg6ek7cq2b.search.serialssolutions.com/ejp/?libHash=KG6EK7CQ2B#/search/?searchControl=title&searchType=title_code&criteria=TC0000571295
https://ebookcentral.proquest.com/lib/iub-ebooks/reader.action?docID=832065

Readings

- [Canvas] Selected readings from:

Introduction to Flight
By John D. Anderson, Jr.
McGraw-Hill Series in Aeronautical and Aerospace Engineering

- [Canvas] Other selected readings from other sources.

## TEAMS

Some of the coursework will be team-based and some will be individual-based. Students are expected to organize themselves into teams of 3 or 4.

- Meet in class (Luddy 4010 Fab Lab) on Thursday, January 16 at 3:55pm ET and find 2-3 others to form into a team.
- Once you have formed a team, 1 team member should email me and the TA (odantske@iu.edu, caedtayl@iu.edu) the names of all the team members.
- If you are unable to find a team, please email me and I will assign you to one.

## GRADING COMPONENTS

The following evaluation breakdown will be used to determine your final grade in the course:

| **Evaluation Method** | **Percentage** | |
|---|---|---|
| **Section:** | **E399** | **E599** |
| Individual effort *(individual participation)* | 20% | |
| Peer evaluation | 10% | |
| Lab session submissions *(group)* | 24% (6 × 4%) | |
| Group project presentation *(group)* | 10% | |
| Homework submissions *(individual)* | 36% (6 × 6%) | 24% (6 × 4%) |
| Grad term paper *(for 599 students only)* | - | 12% |
| Total | 100% | |

See the end of this document for the Course Schedule for the labs and assignments for each week.

## GRADING STANDARDS

I will grade your work according to my expertise in the field, and your adherence to the instructions for each assignment. If you believe that you should have earned a higher grade than what you received, you can appeal. Send me an email outlining exactly what you think you should have received and why. Your appeal should provide evidence to support your case. To be considered, appeals must be received within two weeks of the time the grade is posted on Canvas.

Your final letter grade will be based on the following cutoff points. There will be no rounding up.

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| A+ | 98% and above |
| A | 93 – 97.9% |
| A- | 90 – 92.9% |
| B+ | 87 – 89.9% |
| B | 83 – 86.9% |
| B- | 80 – 82.9% |
| C+ | 77 – 79.9% |
| C | 73 – 76.9% |
| C- | 70 – 72.9% |
| D+ | 67 – 69.9% |
| D | 63 – 66.9% |
| D- | 60 – 62.9% |
| F | under 60% |

## LATE ASSIGNMENTS

Late assignment will not be accepted without prior approval or proper documentation. If an assignment is submitted after the deadline, it will receive a score of 0%.

## STATEMENT ON ACADEMIC MISCONDUCT

Students will be expected to uphold and maintain academic and professional honesty and integrity as outlined in the IU Code of Student Rights, Responsibilities, and Conduct (https://studentcode.iu.edu/). Cases of academic misconduct will be handled according to the student disciplinary procedures described in IU's policies. The consequences for cheating are severe.

## TURNITIN NOTICE

"Students agree that by taking this course all required written assignments may be subject to submission for textual similarity review to Tunitin.com for the detection of plagiarism. All submitted papers will be included as source documents in the Turnitin.com reference database solely for the purpose of detecting plagiarism of such papers. Use of the Turnitin.com service is subject to the Usage Policy posted on the Turnitin.com site."

## RELIGIOUS OBSERVANCE

In keeping with university policy, accommodations will be made for observance of religious holidays. Students are required to email the instructor to request accommodations at least 2 weeks in advance of the anticipated accommodation date. For more information on the policy on accommodations for religious observances, please see: https://vpfaa.indiana.edu/policies/bl-aca-h10-religious-observances/index.html#reasonForPolicy.

## DISABILITY SERVICES FOR STUDENTS

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among others, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services for Students (http://studentaffairs.indiana.edu/disability-services-students/index.shtml) for information on arranging for accommodations. I cannot provide any accommodations without documentation from Disability Services for Students, and thus students in need of accommodations are highly recommended to contact the Disability Services early.

## TITLE IX AND PREVENTING SEXUAL MISCONDUCT

As your instructor, one of our responsibilities is to help create a safe learning environment on our campus. Title IX and our own Sexual Misconduct policy prohibit sexual misconduct. If you have experienced sexual misconduct, or know someone who has, the University can help. If you are seeking help and would like to speak to someone confidentially, you can make an appointment with the IU Sexual Assault Crisis Service (SACS) at 812-855-8900, Counseling and Psychological Services (CAPS) at 812-855-5711, or contact a Confidential Victim Advocate (CVA) at 812-856-2469 or osvpva@indiana.edu.

More information about available resources can be found here:
http://stopsexualviolence.iu.edu/help/index.html

It is also important that you know that the University policy require me to share with the campus Deputy Title IX Coordinator or IU's Title IX Coordinator certain information brought to my

attention about potential sexual misconduct. In that event, they will work with a small number of others on campus to ensure that appropriate measures are taken and resources are made available to the student who may have been harmed. Protecting a student's privacy is of utmost concern, and all involved will only share information with those that need to know to ensure the University can respond and assist.

## ANSWERS TO QUESTIONS AND DISCUSSION OF PROBLEMS

If you have any questions about the course, readings, assignments, lab work, or any other course-related matter, please feel free to contact me via email (odantske@iu.edu). In particular, if you think you might have a problem meeting an assignment deadline, you must send an email to explore options before the deadline. In addition, if you have any questions about your grade or would like to discuss other aspects of the course requirements, please contact me.

## COURSE SCHEDULE

Note: This is a general guide; the exact schedule is likely to change over time. All deadlines are in U.S. Eastern Time Zone (ET).

| Week | Dates | Tuesday Session | Thursday Session | Assignments |
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| **1** | Jan. 14, 16 | *Virtual Lecture:* Introduction, syllabus, readings, assignments<br><br>**Zoom Link:**<br>https://iu.zoom.us/j/84300722856?pwd=rRB2600prF07DGwR83buepEcptLWTW.1<br><br>Meeting ID: 843 0072 2856<br>Password: 921660 | *Class:* Team formation *(in Fab Lab)*<br>*Video Lecture:* Systems Engineering by Dr. Adam Ragheb from Blue Origin (on Canvas) | Homework 1 – summary and response to video lecture<br>Due date: Jan. 22, 11:59 PM ET via Canvas |
| **2** | Jan. 21, 23 | *Lecture:* Aircraft basics | *Reading:* Basic fluids and aerodynamics (Selected readings from Anderson) | Homework 2 – aerodynamics and aircraft basics.<br>Due date: Jan. 30, 11:59 PM ET via Canvas |
| **3** | Jan. 28, 30 | *Lecture:* Aerodynamics, Flight Mechanics, and Performance | *Lab:* Arduino session 1 – Setup | Lab Arduino session 1 code + submission<br>Due date: Feb. 5, 11:59 PM ET via Canvas<br><br>Grad term paper proposal (E599 only)<br>Due date: Feb. 6, 11:59 PM ET via Canvas |
| **4** | Feb. 4, 6 | Class: Team meetings to discuss group project/presentations. | *Lab:* Arduino session 2 – Inertial measurement, logging, and servos | Lab Arduino session 2 code + submission<br>Due date: Feb. 12, 11:59 PM ET via Canvas<br><br>Group topic presentation proposal<br>Due date: Feb. 13, 11:59 PM ET via Canvas |

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| **5** | Feb. 11, 13 | *Lecture:* Sensors and Instrumentation | *Lab:* Arduino session 3 – External Sensors | Lab Arduino session 3 code + submission<br>Due date: Feb. 19, 11:59 PM ET via Canvas<br><br>Homework 3 – Flight mechanics, performance, and sensors<br>Due date: Feb. 20, 11:59 PM ET via Canvas |
| **6** | Feb. 18, 20 | *Lecture:* Aircraft stability and control | *Lab:* Ardunio session 4 – PIDs and stabilization | Lab Arduino session 4 code + submission<br>Due date: Mar. 6, 11:59 PM ET via Canvas |
| **7** | Feb. 25, 27 | *Lecture:* Aircraft design | *Lecture:* Coordinate frames, kinematics, and dynamics | Homework 4 – Aircraft design<br>Due date: Mar. 4, 3:55 PM ET via Canvas – handed in before class. |
| **8** | Mar. 4, 6 | *Lab:* Aircraft build (lab session #5) | *Lab:* Aircraft build (continued) | |
| **9** | Mar. 11, 13 | *Lab:* Aircraft instrumentation | *Lab:* Aircraft instrumentation and flight controller code (lab session #6) | Lab session deliverable 5<br>Due date: Mar. 13, 3:55 PM ET – handed in by the end of class. |
| | Mar. 18, 20 | **SPRING BREAK** | | |
| **10** | Mar. 25, 27 | *Lab:* Aircraft instrumentation and flight controller code (continued)<br><br>**Zoom Link:**<br>TBD | *Guest Lecture:* Aircraft Propulsion and Space & Flight Testing by Dr. Andrew Freeborn, USAF Test Pilot School | Lab session 6 - no deliverable. |
| **11** | Apr. 1, 3 | *Lab:* Aircraft instrumentation and flight controller code (continued) | *Lab:* Aircraft instrumentation and flight controller code (continued) | |
| **12** | Apr. 8, 10 | *Lab:* Aircraft instrumentation and flight controller code (continued) | Class: Team work on group project/presentations | |

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| **13** | Apr. 15, 17 | Virtual Guest Lecture: Intro. to Reinforcement Learning for UAVs (1 of 2) by Dr. Jonathan Ponniah<br><br>**Zoom Link (for both days):** | *Virtual Guest Lecture:* Intro. to Reinforcement Learning for UAVs (2 of 2) by Dr. Jonathan Ponniah | |
| **14** | Apr. 22, 24 | *Guest Lecture:* TBD by Moiz Vahora, Boeing Commercial Aircraft<br><br>**Zoom Link:**<br>TBD | *Guest Lecture:* Intro to Flight Test by Cody Hydrick, Lockheed Martin Aeronautics<br><br>**Zoom Link:**<br>TBD | Homework 5 – Lessons learned & reflections<br>Due date: Apr. 29, 12:00 PM ET via Canvas |
| **15** | Apr. 29, May 1 | Aircraft flight testing<br>***Class held at field 15 min North of Luddy***<br><br>or<br><br>5 Group topic presentations (~20 min each) | Aircraft flight testing<br>***Class held at field 15 min North of Luddy***<br><br>or<br><br>5 Group topic presentations (~20 min each) | Project presentation submission.<br>Due date: Apr. 29, 11:59 PM ET via Canvas<br><br>Homework 6 – Flight testing analysis<br>Due date: Apr. 1, 3:55 PM ET – handed in the beginning of class. |
| **16** | Apr. 6, May 8 | **FINALS WEEK** | | Grad term paper<br>Due date: May 8, 11:59 PM ET via Canvas |