AEE472: Synthesis of Aerospace Systems
Syllabus — Spring 2025

Catalog Description

Design, launch, and testing of a rocket carrying a payload weighing 4.4 lbs to a target apogee of 10,000 ft Above Ground Level (AGL). The design of the rocket will incorporate a thrust vector control system (TVC) and commercial-off-the-shelf (COTS) solid rocket propulsion system.

Instructor Information

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Reference Textbooks

- Anderson, J.D., Fundamentals of Aerodynamics (5th Ed.), McGraw-Hill, 2010.
- Anderson, J.D., Aircraft Performance and Design, McGraw-Hill, 1999.
- Corke, T.C., Design of Aircraft, Prentice Hall, 2003.
- Lennon, A., R/C Model Aircraft Design, Air Age, Inc., 2002.

- Newman, D., Interactive Aerospace Engineering and Design, McGraw-Hill, 2002.
- Ross, D., Flying Models, Aeronautical Publishers, 2015.
- Simons, M., Model Aircraft Aerodynamics (4th Ed.), Special Interest Model Books, 2002.

Prerequisite

AEE427 — Vehicle Performance and Dynamics

Course Learning Objectives

This course is the capstone senior design experience in Aerospace Engineering. At the end of the course, students will be able to:

- Design, build, and launch an aerospace vehicle and document its design and performance. (outcomes 1, 2, 3, 5)
- Formulate and apply new tools and techniques that are derived from material learned in other courses in the curriculum. (outcomes 1, 7)
- Synthesize analytical, experimental, and computational techniques into design. (outcomes 1, 2, 6)
- Understand the role of ethics in engineering practice. (outcome 4)

Course Learning Objective Measurement and Assessment

The final grade will be computed using:

- Conceptual Design Review report 10%
- Preliminary Design Review report 15%
- Final Design Review report 15%
- Final Design report 15%
- Flight demonstration 15%
- Oral presentation 15%
- Progress reports 5%
- Industry Mentor review 5%

- Professional conduct 5%

Numeric scores will be translated into letter grades with the following table:

100–93.0	A
92.9–90.0	A-
89.9–87.0	B+
86.9–83.0	B
82.9–80.0	B-
79.9–77.0	C+
76.9–73.0	C
72.9–70.0	C-
69.9–60.0	D
below 60	F

Students will be asked to fill in an evaluation form covering course content and instructor effectiveness in conveying course objectives. This feedback will be used to improve the effectiveness of the course in the future.

Project Requirements

The project will follow the requirements and constraints of the International Rocketry Engineering Competition (IREC). These requirements are as follows:

General Guidelines for Design and Flight Operations

1. All propellant used must be non-toxic which means that no special treatment of the propellant is required for safe operation
2. National flight safety standards such as regulations defined by the FAA must be followed at all times

Payload Regulations

1. The launch vehicle must carry a payload of no less than 4.4 lbs
2. The payload can be assumed as part of the vehicle while calculating stability
3. The vehicle does not have to be stable without the presence of the payload
4. The payload should not affect the vehicles launch trajectory and the successful recovery
5. The payload will be weighed before each launch and will be within 2% of the 4.4 lbs
6. The payload needs to be separate from that of the launch vehicle meaning that it should be removable from the vehicle itself

Launch Vehicle Tracking and Altitude Logging

1. The vehicle shall contain a Global Positioning System (GPS) that will allow for the team to track the vehicle during all phases of flight
2. The vehicle shall contain a barometric pressure altimeter that will allow for the team to know the final apogee of their flight

Project and Safety Updates

1. The team will update the teaching staff every couple weeks with information on progress
2. These progress checks will involve the team meeting with the teaching staff to discuss all relevant progress and safety measures taken when completing tasks
3. During the checks the team will outline all future plans as well as safety procedures for each task
4. At the progress checks the teaching staff will evaluate the team's safety and suggest changes

Flight Tests

1. For all flight tests the team must meet with the teaching staff prior to the launch to discuss flight plans
2. The flight plans will include the following
    a. A detailed safety plan which includes all safety measures will be developed
    b. All clearance needed from the FAA will be discussed at these meetings
    c. The teaching staff will evaluate all plans for the launch as well as the team's preparedness for the launch
    d. Test site weather conditions will also be evaluated
    e. The teaching staff will evaluate all trajectory and red-zone calculations

Course Web Information

The information for this course is available on the SU Blackboard website. From time to time, course resources will be posted there, and it also provides a launching point for all lectures and design reviews. The syllabus posted there is the latest for the course and will supersede any previous versions.

Attendance Policy

The University policy on classroom attendance states that “Attendance is expected in all courses at Syracuse University.” It is essential that you attend all scheduled classes and activities. If you miss several classes for illness or other personal reasons, see the Student Records office for an official excused absence. If you must miss a class for a sporting event, field trip, etc., you MUST submit an absence request that is signed by your coach, advisor, etc. before you miss the class. It is a federal requirement that students who do not attend or cease to attend a class to be reported at the time of determination by the faculty. We will use “ESPR”

and “MSPR” in Orange Success to alert the Office of the Registrar and the Office of Financial Aid.

Academic Integrity

Syracuse University’s Academic Integrity Policy reflects the high value that we, as a university community, place on honesty in academic work. The policy defines our expectations for academic honesty and holds students accountable for the integrity of all work they submit. Students should understand that it is their responsibility to learn about course-specific expectations, as well as about university-wide academic integrity expectations. The policy governs appropriate citation and use of sources, the integrity of work submitted in exams and assignments, and the veracity of signatures on attendance sheets and other verification of participation in class activities. The policy also prohibits students from submitting the same work in more than one class without receiving written authorization in advance from both instructors. Under the policy, students found in violation are subject to grade sanctions determined by the course instructor and non-grade sanctions determined by the School or College where the course is offered as described in the Violation and Sanction Classification Rubric. SU students are required to read an online summary of the University’s academic integrity expectations and provide an electronic signature agreeing to abide by them twice a year during pre-term check-in on MySlice. Specifically for this course:

- All work is to be done as a team, and collaboration is encouraged on all reports.
- It is imperative that you provide appropriate citations.

All violations of the Policy will be reported to the Academic Integrity Office.

Disability-Related Accommodations

If you believe that you need academic adjustments (accommodations) for a disability, please contact the Office of Disability Services (ODS), visit the ODS website: https://disabilityresources.syr.edu/, located in Room 309 of 804 University Avenue, or call (315) 443-4498 or TDD: (315) 443-1371 for an appointment to discuss your needs and the process for requesting academic adjustments. ODS is responsible for coordinating disability-related academic adjustments and will issue students with documented Disabilities Accommodation Authorization Letters, as appropriate. Since academic adjustments may require early planning and generally are not provided retroactively, please contact ODS as soon as possible.

Diversity and Inclusion

Syracuse University values diversity and inclusion; we are committed to a climate of mutual respect and full participation. Our goal is to create learning environments that are usable, equitable, inclusive and welcoming. If there are aspects of the instruction or design of this course that result in barriers to your inclusion or accurate assessment or achievement, any student is invited to meet with the instructor to discuss additional strategies beyond accommodations that may be helpful to your success.

Religious Observances Notification and Policy

SU religious observances notification and policy, found at http://hendricks.syr.edu/spirituallife/index.html, recognizes the diversity of faiths represented among the campus community and protects the rights of students, faculty, and staff to observe religious holidays according to their tradition. Under the policy, students are provided an opportunity to make up any examination, study, or work requirements that may be missed due to a religious observance provided they notify their instructors by the academic drop deadline. For any observances occurring before the academic drop deadline, students must notify faculty at least two academic days in advance. An online notification process is available for students in My Slice / StudentServices / Enrollment / MyReligiousObservances / Add a Notification.

Course Schedule

- Conceptual Design Review (CDR) February 5, 2026 (or TBD)
    - A review and proposal of a design, using an engineering
- Preliminary Design Review (PDR) February 19, 2026 (or TBD)
    - Preliminary CAD Assembly of the final vehicle as it stands at the time of the review
- Scaled Down Vehicle Launch As soon as deemed ready [Will require a smaller FDR for the scaled down vehicle to validate safety protocols and gain approval to launch from Professor]
    - Test Flights of scaled down model completed for data collection and analysis

- Final Design Review (FDR) April 16, 2026 (or TBD)
    - Two test flights performed as of review; data analyzed and added to presentation for sake of discussion and going over what went well, what could've gone better
- Flight demonstrations April 29, 2026 (or TBD)
    - Final test flight of the full-scale vehicle targeting 10,000 feet AGL
    - Won't conflict with main flight demo day
- Poster Presentation April 28, 2026
- Final report due May 1, 2026

Project Sub-Lead Descriptions

Safety and Testing – Responsible for the oversight of Safety Procedures "Mission Control". Check with all groups if the test flight is a go or no go.

Avionics and TVC Algorithm - Responsible for the oversight of the electronics and code that operates the TVC Mechanisms

Structural Design - Responsible for the oversight of the CAD design and Model of the rocket.

Flight and Recovery – Responsible for the oversight of theoretically simulating and predicting all flight paths of the rocket. This will include red-zone radius.

Avionics and TVC Algorithm - Responsible for the oversight of all onboard electronic hardware and software

Disclaimer: Each sub-system lead will be responsible for the oversight of their respective sub-system but will have assistance from all the other team members during day-to-day work and design.

Work Execution Plan

Tasks	Subsystem Team Involvement				
1. Conceptual Design Phase	**Flight & Recovery**	**Avionics & TVC Algorithm**	**Propulsion & TVC Mechanism**	**Structural Design**	**Safety & Testing**
1.1. Identify IREC mission and Syracuse University Requirements	X	X	X	X	X
1.2. Develop itemized cost schedule estimates.	X	X	X	X	X
1.3. Conduct preliminary trajectory and performance calculations.	X		X		X
1.4. Draft safety procedures and requirements for all test flights	X				X
1.5. Develop a conceptual design for all sub-system, identifying its' use and implementation plan	X	X	X	X	
1.6. Prepare and present Conceptual Design Review Presentation	X	X	X	X	X
2. Preliminary Design Phase					
2.1. Conduct trade studies on COTS parts and identify design options	X	X	X	X	X
2.2. Create preliminary CAD assemblies scaled down and final vehicles.				X	
2.3. Perform stability and trajectory simulations	X				

2.4. Update Safety documentation for prototype testing.					X
2.5. Prepare and present Preliminary Design Review Presentation	X	X	X	X	X
3. Scaled Down Vehicle Launch Phase					
3.1. Manufacturing and assemble the scaled prototype	X	X	X	X	X
3.2. Integrate electronics and code the recovery system, gimble, and data collection sub-systems.	X	X	X		
3.3. Conduct test flights and record data					X
3.4. Analyze test data and update models, accordingly, repeating prior steps as necessary	X	X	X	X	X
4. Final Design Review Phase					
4.1. Finalize CAD and system design for the full-scale vehicle.				X	
4.2. Integrate and test final electronics and software for the full-scale vehicle.	X	X	X		
4.3. Manufacture and assembling final prototype(s)	X	X	X	X	
4.4. Prepare and present Final Design Review Presentation	X	X	X	X	X
5. Flight Demonstration Phase					
5.1. Conduct two flight tests, updating designs between the two flights as needed.	X	X	X	X	X
6. Final Report					

6.1. Prepare and present Final Report	X	X	X	X	X

Cost Projection

This section will go over the overarching cost analysis of the project as it is expected to be laid out over the semester. A large burden of material cost can be subsidized by excess materials from various entity's donations around Link Hall [Aluminum stock, 3D Printing filament, etc.]. The primary costs for the project that will need to be sourced will come from purchasing commercial off-the-shelf rocket motors for both the scaled down and full-scale flight vehicles. We expect to conduct somewhere between 5 and 10 flights of the small-scale vehicle and 3 launches of the full-scale vehicle; the budget table below reflects those costs in terms of the number of motors expected to be purchased.

Item Name	**Unit cost**	**Quantity to be purchased**	**Total Cost**	**Purpose and Rationale**
FSV Motor		3		Primary launch motors
SSV Motor		10		Scaled-down launch motors
Primary Vehicle Microcontroller	$22.88	2	$45.76	Primary vehicle control and data collection computer