AE 199 - Illinois Space Society High Powered Rocketry Class
Fall 2018 (2 Credit Hours)

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Phone: (763)370-2427

Class Hours: TBD
Office Hours: TBD

Course Website: Please reference the Compass 2g for any course related information. All slides and homework assignments will be posted on Compass.

Textbook: There is no textbook for this course. There is a wiki that will contain information for everything that you need for this course. Link: TBD

Objectives: The AE199: Illinois Space Society High Powered Rocketry Class is designed to introduce incoming students to high powered rocketry and other useful skills needed to succeed in technical projects as well as within the aerospace industry. At the end of the semester, students will:

- Understand the specific components that make up a rocket
- Design, build, and launch a high powered rocket
- Develop their own functioning Arduino based payload
- Correctly integrate their payload into the vehicle
- Collect data that fulfills or fails their mission objectives
- Develop the skills to use the following software: Open Rocket, CAD: NX 12.0, ANSYS (regular loading and thermal simulations), and MATLAB

Grade Breakdown:
- Homework: 25%
- Class/Lab Attendance: 20%
- Rocket Launch Attendance: 5%
- In Class Exercises: 20%
- Final Report/Presentation: 30%

Homework: There will be a homework assignment or homework activity that are assigned after every class. These homework assignments are not meant to take a large amount of time and have been specifically tailored to make sure students are able to
apply the concepts they learned in class to real life applications. All of the homeworks should build off of one another and will be applicable for the high powered rocketry project. Students can check the due dates for all of the homework assignments in the class outline below.

**High Powered Rocketry Project:** In order to apply all of the skills taught in lecture, students will be able to build their own high powered rocket. This project will be a 7 to 8 week project and all of the work will be primarily done in class. Office hours will be held in the Talbot Student Labs (18A and 18C) to allow for students to come in and work on their rockets if they need to do more work out of class. There will be 6 teams, each team consisting of five members. The team breakdown will look as follows:

- **Project Manager** (1 student) - This student will be responsible for managing their team and making sure that all of the work is being done on schedule. They will manage the timeline as well as keep track of the team members progress and the tasks that still need to be completed. The project manager needs to ensure there is proper communication between the structures and recovery team and the payload team. They are also responsible for making sure the final report and presentation tasks are equally distributed throughout the team and are submitted on time.
- **Structures and Recovery** (2 students) - This team will focus on building the rocket, specifically the three main sections: upper airframe, payload, and the booster. They will be responsible for integrating the parachutes, the electronics, as well as the payload along with the basic rocket. If you like very hands on projects involving tools, then this is the team for you.
- **Payload** (2 students) - The payload team will focus on developing the payload. The payload has to be something that incorporates an Arduino. This team will make sure all of the wiring is correct along with the code working as intended. They will work closely with the structures team to ensure that the payload is directly integrated with the rocket. If you enjoy/want to learn programming or circuitry, then this is the team for you.

Students will be launching their High Powered Rockets in early November. There will be a final report and final presentation where students have to give an overview of their vehicle, payload, and results that they obtained from the test flight. ANSYS, CAD, and Open Rocket models should be included in this presentation and the results obtained from them should also be included.

**In Class Quizzes:** In order to make sure that students are coming to class and to labs, there will be occasional in class quizzes which cover topics learned in previous classes. These will include multiple choice/fill in the blank questions that should be relatively easy to solve if the student has attended previous lectures.
## Course Outline - Fall 2018

<table>
<thead>
<tr>
<th>Week</th>
<th>Class/Lab</th>
<th>Topic</th>
<th>Homework</th>
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<tbody>
<tr>
<td>1</td>
<td>Class</td>
<td><strong>INTRODUCTION</strong>&lt;br&gt;<strong>Goals:</strong> Introduction to the course and course topics.&lt;br&gt;<strong>Topics Covered:</strong>&lt;br&gt;● Go over the syllabus for the class&lt;br&gt;● General Rocketry Overview - Types of rockets, types of engines, basic breakdown of a rocket.&lt;br&gt;● Rocket forces breakdown</td>
<td><strong>Written homework assignment:</strong> Introduction to Rocketry (Compass)&lt;br&gt;● It will cover the basics that were covered in class&lt;br&gt;● Students will also be able to say what they want to learn/know by the end of the course&lt;br&gt;<strong>Due Date:</strong> Next Lecture</td>
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<tr>
<td>1</td>
<td>Lab</td>
<td>No Lab</td>
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<tr>
<td>2</td>
<td>Class</td>
<td><strong>ROCKETRY COMPONENTS</strong>&lt;br&gt;<strong>Goals:</strong> Provide an in depth look at what components go into each section of the rocket and the overall rocket structure.&lt;br&gt;<strong>Topics Covered:</strong>&lt;br&gt;● Nose cone purpose and shape determination&lt;br&gt;● Components that are stored within the upper airframe&lt;br&gt;● Electronics that are stored in the coupler&lt;br&gt;● Motor, attachment mechanisms, and fins on the booster tube&lt;br&gt;● Motor classification and different levels of certification.&lt;br&gt;● Materials used to create the rocket and the components</td>
<td><strong>Written homework assignment:</strong> Rocketry Components and Placement (Compass)&lt;br&gt;● Assignment focusing on rocket components/forces/considerations. All of the topics covered in class that day&lt;br&gt;<strong>Due Date:</strong> Next Lecture</td>
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<tr>
<td>2</td>
<td>Lab</td>
<td>No Lab</td>
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<tr>
<td>3</td>
<td>Class</td>
<td><strong>OPEN ROCKET TUTORIAL</strong>&lt;br&gt;<strong>Goals:</strong> To teach the students how to use OpenRocket&lt;br&gt;<strong>Topics Covered:</strong>&lt;br&gt;● Now that the students know the components of a rocket, this class will be a step by step walkthrough on how to use</td>
<td><strong>Activity based homework assignment:</strong> Learning to use Open Rocket (Compass)&lt;br&gt;● Through this homework students will be able to download Open Rocket and design a</td>
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### OpenRocket
- Understanding what Cg and Cp are and why they are important for your rocket.

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<tr>
<th>Date</th>
<th>Activity</th>
<th>Details</th>
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| 3    | Lab      | **OPEN ROCKET LAB (EWS LAB)**  
**Goals:** Students will be able to apply the Open Rocket skills they learned in class.  
**Activity:** Given a set of specific requirements, students will work in teams of 2-3 to design the most optimal rocket for the design requirements given.  
**Due Date:** Next Lecture |
| 4    | Class    | **FIN, PARACHUTE, & BLACK POWDER SIZING**  
**Goals:** Understand how to size different components of a rocket. Divide students into groups for rocket project.  
**Topics Covered:**  
- Sizing a nose cone  
- Sizing of parachutes  
- Black powder sizing  
- Motor type decisions  
**Written homework assignment:** Sizing Fins and Parachutes (Compass)  
- Students will be able to apply the topics they covered in class to this homework assignment. They will be able to properly size fins and parachutes as well as explain their motor selection decision.  
**Due Date:** Next Lecture |
| 4    | Lab      | **OPEN ROCKET LAB (EWS Lab)**  
**Goals:** Students will be able to apply the Open Rocket skills they learned in class.  
**Activity:** With the rocket students developed the week before, they should redesign their fins and parachute sizes based on what was learned in class. After the activity is completed, students will begin working on the Open Rocket for their high powered rocket in their group. |
### ALTIMETER OVERVIEW

**Goals:** Students will be able to understand:
- How using Open Rocket and other factors (i.e. payload mass/volume constraints, structure considerations as a result of payload) impact decisions for technical projects.
- How to program and understand an altimeter.

**Topics Covered:**
- ISS technical project will be used as an example to portray design considerations.
- An altimeter overview will be given. Students will understanding the syntax of the Altimeter as well as how to collect data from it.

**Written homework assignment:** Altimeter Overview (Compass)
- Students will be able to apply what they learned in class to the homework. This homework is solely based on working with Altimeters.
- Student will also begin to develop list of arduino based payloads for their rocket (altimeter, thermometer, humidity sensor, sound meter, data logger)

**Due Date:** Next Lecture

### ROCKET PROJECT OPEN ROCKET DEVELOPMENT (EWS Lab)

**Goals:** Students will be able to apply the Open Rocket skills they learned in class.

**Activity:**
- Students will apply all of the skills they have learned throughout the past 5 classes and labs to developing an Open Rocket model for their rocket.

### ARDUINO

**Goals:** Students will be able to understand the basics of how to use and begin to program an Arduino

**Topics Covered:**
- Installing Arduino software
- Detailing inputs/outputs of microcontroller
- Arduino code syntax

**Activity based homework:**
Students will download the Arduino software on their computers and will be able to make a servo spin. They need to demonstrate this at the beginning of the next lecture. This assignment will be done with their high powered rocketry teams.
- Allow for people to work on teams for a homework assignment. This
| 6   | Lab | **ARDUINO LAB**  
**Goals:** This lab is geared to making sure that students understand how to code a basic function in an Arduino.  
**Activity:**  
- Work on the Arduino homework. If done by this time, the students can begin developing an idea for what they want to do for their payload that incorporates an Arduino. |
| 7   | Class | **APPLYING ARDUINO TO OTHER PROJECTS**  
**Goals:** Students will be able to understand the basics of how to use and begin to program an Arduino. They will also learn how to apply it to projects outside of the course.  
**Topics Covered:**  
- Make sure that all homework assignments have successfully passed the test.  
- Demo past arduino projects (MORRTE - ISS NASA Student Launch rover)  
- Offer Resources for the students to learn (books, sites, YouTube playlist)  
**Activity based homework:**  
- Students should work on developing their fin dimensions by Lab 8  
- Students should begin to work on their Arduino payload. There will be a checkpoint on progress at the beginning of Lab 8  |
| 7   | Lab | **ROCKET CONSTRUCTION/PAYLOAD DEVELOPMENT LAB (Student Project Lab-TL 18A or DCL Project Lab)**  
**Goal:** The goal of this lab is to allow for students to begin working on their rocket.  
**Activity:**  
- Cut upper airframe, coupler, |
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<th>Class/Lab</th>
<th>Activity</th>
<th>Due Date</th>
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| **8 Class** | **COMPUTER AIDED DESIGN TUTORIAL (EWS LAB)**  
**Goal:** To provide students with enough CAD knowledge/skills that they can successfully apply it to their project.  
**Topics Covered:**  
- Basics of sketching/extruding/revolings, gotta talk assemblies too  
- Applications to aerospace/rocketry - class will work through designing a basic rocket on CAD  
**Activity based homework:**  
- Students should work on developing their fin dimensions by Lab 8  
- Students should begin to work on their Arduino payload. There will be a checkpoint on progress at the beginning of Lab 8  
**Due Date:** Lab 8 |
| **8 Lab** | **ROCKET CONSTRUCTION/PAYLOAD DEVELOPMENT LAB (Student Project Lab-TL 18A or DCL Project Lab)**  
**Goal:** The goal of this lab is to allow for students to continue working on their rocket.  
**Activity:**  
- Assemble motor casing with epoxy  
- Cut fin slots on booster  
- Continue building payload sled  
- Continue to work on the payload |
| **9 Class** | **COMPUTER AIDED DESIGN TUTORIAL (EWS LAB)**  
**Goal:** To provide students with enough CAD knowledge/skills that they can successfully apply it to their project.  
**Topics Covered:**  
- Basics of sketching/extruding/revolings  
- Applications to 3D printing rocketry components - specifically the ones they need  
**Activity based exercise:**  
Students must finish the CAD files that need to be 3D printed for their sleds. The instructor will set up a time before Lab 10 to cut the fins and 3D print the CAD files. This homework is entirely team based.  
**Due Date:** Beginning of Lab |
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<th>for their rocket’s avionics sled.</th>
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<td>● Applications to laser cutting components.</td>
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<td>9</td>
<td>Lab</td>
<td><strong>ROCKET CONSTRUCTION/PAYLOAD DEVELOPMENT LAB (Student Project Lab-TL 18A or DCL Project Lab)</strong></td>
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<td><strong>Goal:</strong> The goal of this lab is to allow for students to continue working on their rocket.</td>
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<td><strong>Activity:</strong></td>
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<td>● Epoxy fins onto booster</td>
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<td>● Progress further with developing the avionics sled</td>
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<td>● Further develop the payload</td>
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<td>10</td>
<td>Class</td>
<td><strong>SOLDERING TUTORIAL (Student Project Lab-TL 18A or DCL Project Lab)</strong></td>
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<td><strong>Goal:</strong> The goal of this class is to allow for students to learn how to properly solder for their project.</td>
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<td><strong>Topics Covered:</strong></td>
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<td>● Proper use of iron/procedures for soldering</td>
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<td>● Soldering exercise (coupler wiring)</td>
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<td>Activity based homework: Students will work on finishing the rocket construction (team exercise). If the team is behind, there are extra work sessions during office hours where they can continue to work.</td>
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<td><strong>Due Date:</strong> End of Lab 10</td>
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<td>10</td>
<td>Lab</td>
<td><strong>ROCKET CONSTRUCTION/PAYLOAD DEVELOPMENT LAB (Student Project Lab-TL 18A or DCL Project Lab)</strong></td>
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<td><strong>Goal:</strong> The goal of this lab is to allow for students to finish working on their rocket.</td>
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<td><strong>Activity:</strong></td>
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<td>● Finish rocket construction by the end of this lab</td>
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<td>11</td>
<td>Class</td>
<td><strong>ANSYS (STRESS) TUTORIAL</strong></td>
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<td><strong>Goal:</strong> The goal of this class is to allow for students to understand how to create a stress model through ANSYS.</td>
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<td><strong>Topics Covered:</strong></td>
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<td>Activity based homework: This activity allows students to work in ANSYS. They will insert a specified CAD model and will be given a set of</td>
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| Lab  | Reserved lab for extra build time (if launch is delayed). If it is not delayed then we will do the following: **Activity:** Work on the homework assigned in Lecture 11. |
| Class | **ANSYS (THERMAL) TUTORIAL**  
**Goal:** The goal of this class is to allow for students to understand how to create a thermal simulation through ANSYS.  
**Topic Covered:**  
- Step by step process of creating a thermal simulation.  
- Introduction to basic fluids on ANSYS  
**Activity based homework:**  
This activity allows students to work in ANSYS. They will insert a specified CAD model and will be given a set of instructions on how to apply loads, create meshes, etc.  
**Due Date:** Beginning of Lecture 13 |
| Lab  | **ANSYS (THERMAL & STRESS) LAB**  
(Student Project Lab-TL 18A or DCL Project Lab)  
**Goal:** The goal of this lab is to allow for students to understand how to create a thermal simulation as well as stress model through ANSYS.  
**Activity:**  
- Step by step process of creating a stress model and thermal simulation with the students following along. This will be a different example than the one done in class. |
| Class | **MATLAB Tutorial**  
**Goal:** The goal of this class is to allow for students to understand how to begin using MATLAB.  
**Topic Covered:**  
- Writing scripts, variables, built in functions |

**Written homework assignment:** It will be one problem that is TAM derived or based on Professor Bodony’s AE 199 homework.
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<th>Date</th>
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<th>Activity</th>
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| 13   | Lab  | MATLAB Lab (Student Project Lab-TL 18A or DCL Project Lab)  
**Goal:** The goal of this lab is to allow for students to apply the MATLAB skills they learned in class  
**Activity:**  
- Cover an example problem that could be similar to something included on the homework |
| 14   | Class | TECHNICAL WRITING TUTORIAL/COURSE OVERVIEW  
**Goal:** The goal of this class is to allow for students to learn about the etiquette that comes along with professional technical writing. They should apply these skills to their reports.  
**Topic Covered:**  
- Technical writing tips and tricks  
- Recap the skills gained throughout the course  
- Obtain feedback from the students. |
| 14   | Lab  | REPORT/PRESENTATION WRITING SESSION  
**Goal:** Students will work on their presentations and reports with their groups to make sure they are ready to present by the next class.  
**Activity:**  
- Report/presentation writing session |
| 15   | Class | FINAL PRESENTATIONS  
**Goal:** Students will present the work that they have done throughout the semester.  
**Topic Covered:**  
- Final Presentations! |