

Course Information

- **AAE 59000 – Satellite constellations**
- **CRN: 23555**
- **Meeting day(s) and time(s): 3:00 pm – 4:15 pm, Tuesdays and Thursdays, Seng Liang Wang Hall of Electrical and Computer Engineering 2555**
- **Instructional Modality: Lecture**
- **Course credit hours: 3.00**
- **Prerequisite: AAE 490 – Orbital Analysis, AAE 532 – Orbit Mechanics or equivalent. Familiarity with a coding language is also required, for instance Matlab.**

Instructor and Teaching Assistant Contact Information

David Arnas (Instructor)

- Office Location: ARMS 2015
- Office Phone Number: 765 494 3344
- Purdue Email Address: darnas@purdue.edu
- Office hours: 4:30 pm – 5:30 pm, Tuesdays.

TBD (Teaching Assistant)

- Purdue Email Address:
- Office Location:
- Office hours:

Course Description

The design and operation of satellite constellations and formation flying is a multidisciplinary endeavor covering many aspects of engineering. This course introduces the relative dynamics of satellites and their application to the design and study of formation flying and satellite constellations. To that end, this course covers orbital perturbations near the Earth, station keeping definition and related maneuvers, relative dynamics and formation flying, definition of classical satellite constellations, and analytical satellite constellation theory.

Learning Resources, Technology & Texts

- No textbook is required. Class notes and supplemental handouts will be available on Brightspace. However, the notes and handouts are intended only to support the material presented in the lecture. Good lecture notes will be very important.
- Brightspace will be used for you to upload biweekly homework and exams.
- You will be required to develop your own programs using MATLAB scripts or other coding language.

Learning Outcomes

On completing this course you shall be able to:

- Analyze orbital perturbations and their effects on satellite orbits.
- Define station keeping control and related orbital maneuvers.
- Design and analyze simple formation flying architectures, with special emphasis in tandem formations.
- Review classical satellite constellation designs and their importance in past, current, and future space missions.
- Introduction to satellite constellation theory and its application to design and mission analysis.

Assignments

Assignments	Due	Points
Homework	Throughout the semester	70
Exam 1	February 20 th , 2025	10
Exam 2	March 25 th , 2025	10
Exam 3	April 24 th , 2025	10
		Total: 100

- *Homework and exams have two very different purposes, covering different aspects of the material:*
 - *Homework will focus on the development and application of the material presented to specific problems in engineering related with astrodynamics, flight dynamics, formation flying, and satellite constellations. This means that homework will be heavy reliant on numerical computation and analysis. Its purpose is to develop practical engineering skills required in astrodynamics and serve as a first experience into writing technical reports.*
 - *Exams, on the other hand, will focus on the theoretical foundation of the material covered as well as its understanding. Their aim is to develop a deeper understanding of the concepts covered and what their implications are.*

As a result, homework, although helpful to better understand the exam material, should not be regarded as practice problems for the exam because both have a very different nature.

- *Homework will be assigned biweekly and posted on Brightspace. You will upload your completed homework on Gradescope. Homework is due before the start of the lecture on the due date stated on the specific homework. All the scripts used to solve these assignments should be created by you in the coding language of your preference. The homework report must be written in a word processing software (i.e. Word, LaTeX, QuarkXPress, or similar), and properly organized and structured as if it were a technical report. It should also contain a copy of all the scripts created to solve the assignment in one or several appendixes at the end of the document or in the specific problem they are used. These scripts must be properly commented and with a clear definition of variables. No homework will be accepted late or with a deficient presentation.*
- *Exams 1, 2 and 3 will cover part of the course material and will take place in the dates indicated in the assignments table above during normal lecture hours.*

Grading Scale

Grades are based on performance in exams and homework. Assigned grades are A, B, C, D, F.

Attendance Policy

This course follows Purdue's academic regulations regarding attendance, which states that students are expected to be present for every meeting of the classes in which they are enrolled. Attendance to in-person classes is advisable but not compulsory, and it will not alter the final grades of students. Guidance on class attendance related to COVID-19 are outlined in the [Protect Purdue Pledge for Spring 2024](#) on the Protect Purdue website.

Academic Guidance in the Event a Student is Quarantined/Isolated

If you must miss class at any point in time during the semester, please reach out to me via email so that we can communicate about how you can maintain your academic progress. If you find yourself too sick to progress in the course, notify your adviser and the instructors via email. We will make arrangements based on your particular situation. Please note that, according to [Details for Students on Normal Operations for Spring 2024](#) announced on the Protect Purdue website, "individuals who test positive for COVID-19 are not guaranteed remote access to all course activities, materials, and assignments."

Course Schedule

Week	Topic & Readings	Assignments
Week 1	<i>Introduction; Review of orbital mechanics</i>	<i>Homework 1</i>
Week 2	<i>Orbital perturbations</i>	
Week 3	<i>Orbital perturbations (continuation)</i>	<i>Homework 2</i>
Week 4	<i>Orbital perturbations (continuation)</i>	
Week 5	<i>Station keeping</i>	<i>Homework 3</i>
Week 6	<i>Station keeping (continuation)</i>	<i>Exam 1</i>
Week 7	<i>Formation flying</i>	<i>Homework 4</i>
Week 8	<i>Formation flying (continuation)</i>	
Week 9	<i>Formation flying (continuation)</i>	<i>Homework 5</i>
Week 10	<i>Spring Break</i>	
Week 11	<i>Satellite constellations</i>	<i>Exam 2, Homework 6</i>
Week 12	<i>Satellite constellations (continuation)</i>	
Week 13	<i>Satellite constellations (continuation)</i>	<i>Homework 7</i>
Week 14	<i>Satellite constellations (continuation)</i>	
Week 15	<i>Satellite constellations (continuation)</i>	<i>Exam 3</i>
Week 16	<i>Applications of constellation theory</i>	

* Schedule and assignments subject to change. Any changes will be posted in the learning management system.

Classroom Guidance Regarding Protect Purdue

Any student who has substantial reason to believe that another person is threatening the safety of others by not complying with Protect Purdue protocols is encouraged to report the behavior to and discuss the next steps with their instructor. Students also have the option of reporting the behavior to the [Office of the Student Rights and Responsibilities](#). See also [Purdue University Bill of Student Rights](#) and the Violent Behavior Policy under University Resources in Brightspace.

Academic Integrity

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available on our course Brightspace table of contents, under University Policies.

Nondiscrimination Statement

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. More detail on the [Nondiscrimination Policy Statement](#) is included in Brightspace.

The School of Aeronautics and Astronautics is also committed to a climate of inclusion; if you need to report an issue of hate or bias, you may use the link at the top right of our page here: <https://engineering.purdue.edu/AAE/aboutus/Diversity/index.html>

Accessibility

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let us know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247. More details are available on our course Brightspace under Accessibility Information.

Mental Health/Wellness Statement

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try [WellTrack](#). Sign in and find information and tools at your fingertips, available to you at any time.

If you need support and information about options and resources, please contact or see the [Office of the Dean of Students](#). Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc. sign up for free one-on-one virtual or in-person sessions with a [Purdue Wellness Coach at RecWell](#). Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is completely free and can be done on [BoilerConnect](#). If you have any questions, please contact Purdue Wellness at evans240@purdue.edu.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact [Counseling and Psychological Services \(CAPS\)](#) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours. CAPS also offers resources specific to COVID-19 on its [website](#). Topics range from "Adjusting to the New Normal" to "How to Talk with Professors about Personal Matters."

Basic Needs Security

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students 8:00 a.m. - 5:00 p.m. Monday through Friday. Considering the significant disruptions caused by the current global crisis as it related to COVID-19, students may submit requests for emergency assistance from the [Critical Needs Fund](#).

Emergency Preparation

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your [@purdue.edu](#) email on a frequent basis.