

Memorandum

To: The Faculty of the College of Engineering

From: The School of Aeronautics and Astronautics

Date: January 29, 2025

Re: New Undergraduate Course, **AAE 43200 Orbital Analysis**

The faculty of the School of Aeronautics and Astronautics have approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

Course no. **AAE 43200 Orbital Analysis**
Spring, Lecture, Cr. 3

Description: The objective of this course is to provide students with a basic understanding of the physics of spacecraft motion in space and the impact of perturbations in the near-Earth environment. It is also an introduction to the effective design of space missions by leveraging the gravitational and perturbation forces.

Reason: This introductory course provides engineering students with a preliminary knowledge of various topics needed for the design of space missions, particularly in the vicinity of the Earth. After a first introduction to the basic concepts of space missions, their life cycle, objectives, requirements, and constraints, the course covers the orbital physics as well as space perturbations analysis and modeling. Other necessary concepts, such as ground tracks, launch windows and geometry, and orbital maneuvers are also introduced to provide a broader perspective of the various aspects of space mission design.

This course represents the first dedicated experience for undergraduate students in orbital physics and prepares them for a more in-depth understanding of AAE 53200 while providing additional complementary material on orbital perturbations.

William A. Crossley
Uhrig & Vournas Head of Aeronautics and Astronautics
Professor of Aeronautics and Astronautics

Enrollment History – Previously taught as AAE 490 Orbital Analysis

		2016 Spring	2017 Spring	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Spring	2024 Spring	2025 Spring	Total
AAE 49000 Orbital Analysis	AAE - Aero & Astro Engineering	29	19	36	16	22	38	28	37	44	51	320
	AAEN - Aeronautics & Astronautics				1				2	2		5
	MECH - Mechanical Engineering	1										1
	PLSI - Planetary Sciences						1					1
		30	19	36	17	22	39	28	39	46	51	327

AAE 43200 - Orbital Analysis

1 Course Information

- Course number and title: AAE 43200 Orbital Analysis
- CRN: 28392
- Meeting days and times: Mon, Wed 4:30 PM – 5:45 PM
- Meeting location: Neil Armstrong Hall of Engineering (ARMS), B071
- Instructional Modality: Face-to-Face
- Credit hours: 3
- Prerequisites: AAE 20300, AAE 25100; previous or simultaneous experience in AAE 34000 is helpful but not required.

2 Instructors Contact Information

2.1 Basic Information

Prof. Andrea Capannolo

- Office: ARMS 3207
- Phone: (765) 496-4260
- Email: acapa@purdue.edu
- Office hours: Tue 4 - 5:30 PM, ARMS 3207

Maya Djurisic (TA)

- Email: mdjurisi@purdue.edu
- Office hours: Wed 2:30 - 4 PM, ARMS 3119

2.2 How to reach out

Students can reach out to the professor and to the TA for any matter related to the course (class, homework assignments, exams, logistics, etc.) through the following channels **(in order of preference)**

Piazza

The Q&A online tool “Piazza” is available (Signup link: <https://piazza.com/purdue/spring2025/aae490oa>) for asking non-urgent questions.

When using Piazza, please consider the following:

- The instructors will try to answer your questions as quickly as possible but assume up to five/six days may pass before receiving an answer.
- Before starting a new question, check if the same questions have already been answered.
- Piazza will allow students to reply to other students’ questions (that can be endorsed by the instructors), so you are highly encouraged to engage in discussions with your peers.

Office Hours

Instructors will be available at the designated time and location reported in the “Instructors Contact Information” section for urgent questions. You are also encouraged to show up on office hours for questions that have not been answered on Piazza for more than five days (excluding weekends).

Email

If you have urgent questions and cannot wait, you can reach out to the instructors by email. **Please, follow these guidelines thoroughly:**

- If you need an answer before a deadline, please send an email **at least 48 hours before the deadline**, otherwise a reply is not guaranteed.
- In the email subject, include “[S25 AAE490 OA]” to redirect your email to the right folder for the instructors, otherwise it may be missed.
- As a general rule, send questions related to homework assignments to the TA, and exam/class-related questions to the professor. If you don’t get an answer after 1 day, you may forward the same email to both the professor and the TA.
- If the question asked by email requires a long or elaborate answer, it is possible to ask for a one-on-one meeting, depending on the availability of the TA/Professor.

3 Course Description

The design and operation of spacecraft is a multidisciplinary endeavor covering many aspects of engineering. This course introduces the physics of the orbits and the space environment as well as mission trajectory analysis including constraints, launch windows, ground tracks, some communications and tracking, some constellations, relative motion and contingencies.

4 Learning Resources, Technology, and Texts

4.1 Learning resources

Textbooks

No textbook is required. Some resources may be mentioned in class for further information about the taught topics, when needed.

Lecture Slides

Lecture slides with blanks will be provided and made available on Brightspace. Notes taken by the professor in class, and supplemental handouts will also be uploaded on Brightspace after class. However, the notes and handouts are intended only to support the material presented in the lecture. Good lecture notes will be very important.

4.2 Software and web resources

FreeFlyer/MATLAB

A commercial software package (FreeFlyer) developed specifically for astrodynamics applications will be introduced. The software is accessible through Purdue’s “AppsAnywhere” (<https://appsanywhere.ecn.purdue.edu/>) In some occasions, you may also be required to develop your own programs and/or MATLAB scripts.

Brightspace

The course web page can be found on Brightspace at the following link: <https://purdue.brightspace.com/d2l/home/1208381>

4.3 Use of artificial intelligence (AI) or Large Language Models (LLM)

AI and/or LLM tools are accepted to the sole extent of aiding with the homework assignment writing, to enhance clarity in the presentation of the results. The use of AI/LLM is limited to the form of the text. Any exploitation of these tools for answering homework questions or in general affect the content of the answer will not be admitted.

5 Learning Outcomes

By the end of the course, students will be able to

- Apply basic technical knowledge about spacecraft trajectory design and mission architecture requirements
- Develop intuition about natural spacecraft orbital motion and basic astrodynamics
- Understand how the space environment interacts with and affects spacecraft motion
- Analyze the relationship between launch properties and orbits
- Determine orbit properties from ground track of satellites
- Design simple orbital maneuvers to move a spacecraft from one orbit to another.

6 Assignments

6.1 In-class Exams

- Three in-class exams are scheduled according to Section 8
- There **will not** be a final exam, and you will have a longer final Homework assignment as substitute (see Section 6.2)
- Exam rules will be explained during the week prior to the date when the exam will take place (both in class and on Brightspace).
- If students have a schedule conflict with an exam, the instructor must be notified within *the first two weeks of the semester* to discuss any make-up opportunity. This make-up opportunity can be discussed only for the following cases: university excused absences listed in <https://catalog.purdue.edu/content.php?catoid=15&navoid=18634#classes> notified by the Office of the Dean of Students; religious observances; or university-sponsored activities (e.g., out-of-state club activities representing the university) with a signed document by the supervisor/coach of the activity. After the first two weeks of the semester has passed, there is no guarantee of a make-up opportunity.

If students have emergency issues that fall under the university excused absences and cannot attend an exam, you must notify the instructor as soon as possible, but prior to the scheduled exam time via email. Prof. Capannolo should be notified of the university excused absence by the Office of the Dean of Students *within 1 week of the original exam date* to discuss any make-up opportunity.

6.2 Homework

- A Problem Set will be assigned every week on Friday, and due on the next Friday before 11:59 PM, with some exceptions:
 - If there is an in-class exam, the deadline for the homework delivery is postponed by one week
 - The final homework assignment will 3 weeks for delivery (2 weeks + 1 where the 3rd in class exam takes place).
- Problem Sets will be posted on Brightspace. Your solutions should be uploaded on Gradescope by the aforementioned deadline. Any format for your solutions is acceptable, as long as it is legible after the upload on Gradescope.

- After scores are returned, you will have two weeks for sending a regrade request. **Regrade requests will not be accepted for the Final Problem Set**
- Collaboration is allowed as far as such collaborative activities are limited to those stated in Section 9.2.
- As mentioned in Section 4.3, you can use AI and LLM only for improving the form of sentences and text in general, but it is strictly forbidden to use them for answering the questions in the Problem Set.

Submission Extensions & Late Submissions

Extensions of P-set submission deadlines may be requested if any of the university excused absences listed in <https://catalog.purdue.edu/content.php?catoid=15&navoid=18634#classes> is issued and the instructor is notified of that by the Office of the Dean of Students (ODOS). In such a case, the extension will be granted for the number of days specified in the issue. On the other hand, extension requests cannot be accommodated when the instructor is not notified of the university excused absence by the Office of the Dean of Students.

Late submissions after the deadline will be accepted with the following penalty:

- 20% score deduction within 0–24 hours past the deadline;
- 40% score deduction within 24–48 hours past the deadline; and
- 100% score deduction after 48 hours past the deadline.

Also, the following exceptions to the late submission rule apply:

- No late submission is accepted for last Problem Set (unless university excused absences apply)
- A “Late-submission pass” is available to everyone for the duration of the course. This pass will allow you a late delivery (within 48 hours) with no score penalty. The pass can be used only once within the semester. If not used, the pass will be converted into 4 extra points to add to the final grade. **The pass cannot be used for the last Problem set**

7 Grading Scale

Course grades will be determined on the basis of problem sets (70%) and exams (30%). The instructor reserves the right to define the final numeric ranges for letter grades. However, the numerical ranges will be based on, and will not be more stringent than, the standard scale (A: 90-100%, B: 80-89%, C: 70-79%, D: 60-69%, F: below 60%).

Be sure to solve and submit all the problem sets. Solving problem sets is crucial to solidify the understanding of the taught materials. This is reflected in the allocation of the percentages problem sets occupy in the overall grade.

8 Course Schedule

Table 1 provides the notional schedules for the topics to be covered, Exams, and Homework Assignments. Note that these schedules are notional and may be adjusted depending on the progress. Changes to these schedules will be communicated in class and/or on Brightspace.

Week #	Dates	Topics	Assignments P: “posted” (on Friday); D: “due” (by Friday 11:59 PM)	Academic events
1	01/13 - 01/17	Space Mission lifecycle; Keplerian dynamics	P:HW 1	
2	01/20 - 01/24	Keplerian dynamics	P:HW 2 - D:HW 1	MLK Day (Monday)
3	01/27 - 01/31	Keplerian dynamics	P:HW 3 - D:HW 2	

4	02/03 - 02/07	Keplerian dynamics	P:HW 4 - D:HW 3	
5	02/10 - 02/14	Orbital perturbations	P:HW 5 - D:HW 4	
6	02/17 - 02/21	(In-class exercise)	Exam 1	
7	02/24 - 02/28	Orbital perturbations	P:HW 6 - D:HW 5	
8	03/03 - 03/07	(No class)		Spring Break
9	03/10 - 03/14	Orbital perturbations; Space geometry	P:HW 7 - D:HW 6	
10	03/17 - 03/21	(In-class exercise)	Exam 2	
11	03/24 - 03/28	Space geometry	P:HW 8 - D:HW 7	
12	03/31 - 04/04	Space geometry	P:HW 9 - D:HW 8	
13	04/07 - 04/11	Orbital maneuvers	P:HW 10 - D:HW 9	
14	04/14 - 04/18	(In-class exercise)	Exam 3	
15	04/21 - 04/25	Orbital maneuvers		
16	04/28 - 05/02	Orbital maneuvers	D:HW 10	Quiet week
17	05/05 - 05/10	(No class)		Finals week

Table 1: Class Schedule

9 Policies

9.1 Attendance Policy

According to University Policy, “Students are expected to be present for every meeting of the classes in which they are enrolled.” The list of university excused absences can be found at <https://catalog.purdue.edu/content.php?catoid=15&navoid=18634#classes>. Students are responsible for class-related work missed because of any other unavoidable absences.

In-class lectures will not be recorded. When the instructor needs to substitute some in-class lectures by recorded lectures due to business trips, it will be communicated in class and on Brightspace.

9.2 Academic Integrity & Collaborations

Academic integrity is one of the highest values that Purdue University holds. Purdue prohibits “dishonesty in connection with any University activity” ([Purdue Academic Integrity](#)). Examples of academic dishonesty include: plagiarism, cheating, fabrication, lying, bribery, threat, and aiding academic dishonesty. If such academic dishonesty is detected, this will result, at the minimum, in a falling grade on the particular assignment and may result in a falling grade for the course. Additionally, instructors are encouraged to refer cases to the Office of the Dean of Students for adjudication and/or appropriate record keeping. If a student is found guilty, possible penalties include a warning, probation, probated suspension, suspension or expulsion.

In this course, collaboration with other students on assignments (problem sets and/or course projects) is allowed as far as such collaborative activities are limited to discussions on their interpretation of a problem, approaches to the solution, and/or structuring of your programming code. Learning from peer students can be a valuable addition to the educational experience. Plagiarism, such as copying someone else’s solution or code, is not acceptable. Each student is responsible for completing their own work; all submitted work must be independent from that of other students.

Students are encouraged to report potential violation of academic integrity to the instructor or to the Dean of Students at integrity@purdue.edu or via [Academic Dishonesty Incident reporting form](#).

9.3 Nondiscrimination Policy

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 their 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. Purdue's full Nondiscrimination Policy Statement can be found [here](#).

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](#).

9.4 Accessibility

Purdue University is committed to making learning experiences accessible. If you anticipate or experience physical or academic barriers based on disability, please let the instructor know so that we can discuss options. As detailed in [Procedures for Requesting and Implementing Curricular Accommodations](#), students should request accommodations far enough in advance (in general, several weeks before the semester begins or as soon as they know of their disability) to allow Disability Resource Center (DRC) adequate time to review the request and relevant documentation, to establish eligibility, and to determine a reasonable accommodation through an interactive process with the student. Contact DRC at drc@purdue.edu or 765-494-1247 for further assistance.

9.5 Mental Health & Wellness

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.

9.6 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 [Office of the Dean of Students](#) for support. There is no appointment needed and Student Support Services is available to serve students M-F, 8 AM-5 PM. Also, be aware of the following helpful links: [Student of Concern \(SOC\) reporting](#), [ACE Campus Food Pantry](#), [Critical Need Fund](#), and [Center for Advocacy, Response, and Education \(CARE\)](#).

9.7 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. Information about these changes will be available on Brightspace or via emails from the instructor.

Purdue University is actively preparing for natural disasters or human-caused incidents with the ultimate goal of maintaining a safe and secure campus. Please review the following procedures for our safety (for additional information, see [here](#)):

- To report an emergency, call 911.
- To obtain updates regarding an ongoing emergency, and to sign up for Purdue Alert text messages, view www.purdue.edu/ea.
- There are nearly 300 Emergency Telephone Systems throughout campus that connect directly to the Purdue Police Department (PUPD). If you feel threatened or need help, push the button and you will be connected to the PUPD.
- If we hear a fire alarm, we will immediately suspend class, evacuate the building, and proceed outdoors, away from the building. Use stairways only; do not use the elevator. Emergency Assembly Area of ARMS is the Engineering Mall area away from the building.
- If we are notified of a Shelter in Place requirement for a tornado warning, we will suspend class and shelter in the lowest level of this building, away from windows and doors.
- If we are notified of a Shelter in Place requirement for a hazardous materials release or an active threat such as a shooting, we will shelter in our classroom, shutting any open doors and windows, locking or securing the door, and turning off the lights.