

AE 4532-B — SPACECRAFT FLIGHT DYNAMICS

Course Syllabus—Fall 2026

The current version is a draft and will be finalized when the semester approaches.
All contents are also subject to change even during the semester.

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Office: ESM 207



Education: 2014, Ph.D., Aerospace Engineering Sciences, University of Colorado Boulder
2012, M.S., Aerospace Engineering Sciences, University of Colorado Boulder
2010, M.S., Aeronautics and Astronautics, University of Tokyo
2007, B.S., Mechanical and Aerospace Engineering, Nagoya University

Academic experience 2023 – Present, Associate Professor, Georgia Institute of Technology
2017 – 2023, Assistant Professor, Auburn University
2015 – 2017, Postdoctoral associate, Purdue University
2015, Postdoctoral associate, University of Colorado Boulder
2010 – 2014, Graduate Research Assistant, University of Colorado Boulder

Research experience Astrodynamics

- Computational and theoretical advancement for determining proximal dynamics in complex gravitational interaction
- Structural and thermal characterization of planetary bodies

State estimation for dynamical and geophysical properties
Photometric (VIS-IR) image processing
Planetary science

- Terrestrial-scale impact physics
- Statistical and stochastic processes on planetary surfaces
- Space weathering
- In-situ resource utilization
- Planetary defense
- Planetary exploration

Mission experience *Current*
ESA/Hera: Asteroid exploration/planetary defense mission
JAXA/Hayabusa2#: Asteroid exploration/planetary defense mission
NASA/Lucy: Jupiter Trojan explorer
NASA/VIPER: Lunar rover explorer
Past
ESA/Bepi-Colombo: Mercury explorer
JAXA/Hayabusa2: Asteroid sample return mission
JAXA/IKAROS: Solar sail exploration
JAXA/Hayabusa: Asteroid sample return mission
NASA/DART: Kinetic impact deflection mission
NASA/OSIRIS-REx: Asteroid sample return mission

Teaching Assistant: **TBD**

Course Lecture: 8:25 – 9:15 am, MWF

Course Location: Instructional Center 115

Office Hours: Hirabayashi: **TBD**
In-person in my office (ESM 207)
Other additional meetings upon request (including weekends).
GTA: **TBD**

Course outcomes: Cover fundamental material in orbit and attitude dynamics. Investigate various topics including orbits, maneuvers, interplanetary transfers, attitude coordinates, and attitude stability, among others. Throughout this course, students will develop an ability to formulate and solve flight dynamics problems through understandings of the following topics:

- Two-body problem
- Orbital elements
- Orbital transfers
- Interplanetary trajectory
- Kinematics
- Attitude dynamics
- Gravity gradient
- Advanced topics related to spacecraft orbital and attitude dynamics

Required Text: No required course textbooks

Optional Texts: Hanspeter Schaub and John L. Junkins, Analytical Mechanics of Space Systems
Howard D. Curtis, Orbital Mechanics for Engineering Students

Grading:	Bi-weekly Homework:	30%
	In-class session attendance:	10%
	Midterm Exam:	30%
	Final Exam:	30%
	Total	100%

- Homework is due at the designated time (11:59 pm) using online submission on Canvas. Any assignment turned in after a deadline is assigned to be a late submission.
- Late assignments may be turned in for half credit after the deadline passes. The deadline for late submissions is two weeks after the original deadline.
- Late submission exemption is allowed only when a letter from the Office of the Dean of Students is emailed to the instructor. No documents, including doctors' notes, are accepted to request a late submission exemption.
- Grades may be curved at the discretion of the instructor.
- In-class sessions are offered during the semester. Attendance at each session will be mandatory and checked. The total weight for in-class session attendance is 10%. In-class issues will not be recorded.
- An extra credit of 5% will be offered when 95% of you submit CIOS surveys.
- The midterm and final exams will offer an extra credit of 5% (2.5% for each).
- Any approaches not covered by this course will be considered incompliant and lead to zero credits. AI tools are allowed to use as long as they are GT-compliant. However, any inconsistent notations, terminology, and approaches with this course are considered, again, incompliant without exception.

Course materials: Pre-notes will be posted under Files/Pre-notes/ on Canvas (<https://canvas.gatech.edu/>). Each file will be shared before class, though contents may be corrected even after class (e.g., fixing typos and modifying notations). Important announcements will be sent

through Canvas; please be alert to these messages. Students will be responsible for any message or announcement posted to the class.

Lectures: Attendance in regular lectures is encouraged but not required. Students are expected to keep pace, as the homework assignments will be based on the current lectures. Lectures will be based on the pre-notes' contents, though support materials may be added for the planned topics. Post-class notes will not be shared except for disability requests, but recorded lectures will be posted in the Media Gallery. Some in-class activities may be planned without shared and recorded materials.

Exemption policy: **Any exemption request, including (but not limited to) late submission, exam-date change, and absence exemption, is allowed only when a letter from the Office of the Dean of Students is submitted to the instructor.** No other documents, including doctor's notes and medical records, are accepted to request a late submission exemption.

In-class sessions: **Multiple in-class sessions with mandatory attendance will be offered.** The session will include problems related to that week's lectures. Attendance in person is mandatory and checked, and grades will be recorded for attendance purposes. No recordings will be provided.

Communications: Email is a general communication tool, though the instructors will not accept inquiries about course materials, including assignments, via email. Discussions are always welcome in person or via virtual meetings. Additional office hours may be offered upon request based on the instructor's availability.

Honor Code: Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Review [the Student Code of Conduct](#) and [the Academic Honor Code](#), especially [Appendix A: Graduate Addendum to the Academic Honor Code](#). Students are expected to perform research in an ethical and responsible manner. All Doctoral and Master's Thesis students are required to take [the Responsible Conduct of Research training](#), and it is expected that students abide by the principles taught in that training while performing research for this thesis course. Allegations of scientific or scholarly misconduct are handled in accordance with the procedures outlined by [the Policy for Responding to Allegations of Scientific or Other Scholarly Misconduct](#).

Accommodations: If you need special accommodations, please contact [the Office of Disability Services \(ODS\)](#) to request them. Once I receive a notification from the ODS, I will contact you for a short meeting to discuss the requested accommodations, so this course can properly meet your needs.

Core IMPACTS: Not applicable.

Expectations: At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. [The Expectations of Advisors and Advisees](#) articulates some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

Course Topic Outline

The following table "tentatively" lists the topics planned for the course and exam dates, which are subject to change at any time. Instructors may attend academic conferences and mission science team meetings and cancel lectures while offering recorded ones.

Week	Date	Topic	Note
1	08/24	Kinematics – Vectors and matrices	
1	08/26	Kinematics – Coordinate frames	
1	08/28	Kinematics – Rotational matrices	
2	08/31	Kinematics – Combination of rotational matrices	HW1 assigned
2	09/02	Kinematics – Transport theorem	
2	09/04	In-class session/backups	Mandatory
3	09/07	Class canceled	Labor Day
3	09/09	Kinematics – Time evolution of rotational matrix	EPSC conference
3	09/11	Kinematics – Applications	HW1 deadline, EPSC conf.
4	09/14	Orbital mechanics – Orbital constants	HW2 assigned
4	09/16	Orbital mechanics – Orbit equation	
4	09/18	In-class session/Backups	Mandatory
5	09/21	Orbital mechanics – 2-dimensional orbital types	
5	09/23	Orbital mechanics – Eccentric anomaly	
5	09/25	Orbital mechanics – Kepler's equation	HW2 deadline
6	09/28	Orbital mechanics – Hohmann transfer	HW3 assigned
6	09/30	Orbital mechanics – Keplerian elements	
6	10/02	In-class session/Backups	Mandatory
7	10/05	Class canceled	Fall break
7	10/07	Orbital mechanics – 3-dimensional orbits	
7	10/09	Orbital mechanics – Applications	HW3 deadline
8	10/12	Review session	
8	10/14	Review session	
8	10/16	Mid-term exam	
9	10/19	Rigid-body dynamics – N-body dynamics	HW4 assigned
9	10/21	Rigid-body dynamics – Rotational and translational motion	
9	10/23	Rigid-body dynamics – Euler's equation	
10	10/26	Rigid-body dynamics – Moment of inertia	AAS/DPS conference
10	10/28	Rigid-body dynamics – Parallel axis theorem	AAS/DPS conference
10	10/30	In-class session/Backups	Mandatory, HW4 deadline
11	11/02	Rigid-body dynamics – Transformation of moment of inertia	HW5 assigned
11	11/04	Rigid-body dynamics – Torque free dynamics formulation	
11	11/06	Rigid-body dynamics – Concept of stability	
12	11/09	Rigid-body dynamics – Torque free dynamics stability	
12	11/11	Rigid-body dynamics – Applications	
12	11/13	In-class session/Backups	Mandatory, HW5 deadline
13	11/16	Coupling dynamics – Gravity gradient concept	HW6 assigned
13	11/18	Coupling dynamics – Gravity gradient dynamics formulation	
13	11/20	Coupling dynamics – Gravity gradient stability	
14	11/23	Class canceled	

14	11/25	Class canceled	Student recess
14	11/27	Class canceled	Thanksgiving break
15	11/30	Coupling dynamics – Applications	
15	12/02	In-class session/Backups	Mandatory
15	12/04	Review session	HW6 deadline
16	12/07	Review session	Final instructional class
XX	XX	Final exam	

Georgia Tech School of Aerospace Engineering Values



Integrity

I achieve excellence by embodying the highest ethical standards and communicating openly, authentically, and with humility.



Respect

I extend courtesy to everyone and promote a culture of inclusion, fairness, and equity.



Community

I am a global citizen and celebrate our collective achievements and contributions to the world around us.



Accountability

I take ownership of my actions and value the responsibility to honor public trust.



Adaptability

I embrace change as a path to progress, success, and innovation.

Discussion Points

1. **Honesty:** The School of Aerospace Engineering values the honesty and integrity of all community members. The academic honor code is an essential element of this value.

Georgia Tech Honor Challenge Statement: I commit to uphold the ideals of honor and integrity by refusing to betray the trust bestowed upon me as a member of the Georgia Tech community.

Honor Code: http://policylibrary.gatech.edu/student-affairs/academic-honor-code#Article_1:Honor_Agreement

2. **Well-Being:** The School of Aerospace Engineering values the complete well-being of all members of its community, which includes professional, physical, spiritual, emotional, and social dimensions. There are numerous resources to support the health and well-being of all community members: <https://gatech.instructure.com/courses/108574>.

3. **Mental Health Resources:**

Emergencies: You can either Call 911 or call Campus Police at 404.894.2500 <http://www.police.gatech.edu/>
Center for Assessment, Referral, & Ed. (CARE): <https://care.gatech.edu/> 404.894.3498 (Counselor On-Call)
Counseling Center: <https://counseling.gatech.edu/> 404.894.2575
Stamps Health Services: <https://health.gatech.edu/> 404.894.1420
Student Life and Dean of Students: <https://studentlife.gatech.edu/content/get-help-now> 404.894.6367
Victim-Survivor Support (VOICE): <https://wellnesscenter.gatech.edu/> 404-385-4464/(or 4451)
National Suicide Prevention Lifeline: 1.800.273.TALK (8255)
Georgia Crisis and Access Line: 1.800.715.4225

4. **Social Justice:** The School of Aerospace Engineering values social justice for all members of the Georgia Tech community and the larger society. Social justice means that everyone's human rights are respected and protected. We stand committed to the fight against racism, discrimination, racial bias, and racial injustice. Our shared vision includes social justice, opportunity, community, and equity. We believe that diversity and contributions from all our members are essential and make us who we are. We believe that our impact must reach beyond the classroom, research labs, our campus, and the technology we create, but we must also improve the human condition where injustice lives. We will continue to work to understand, value, and celebrate all people and create an inclusive educational and work environment that welcomes all.

As a matter of policy, Georgia Tech is committed to equal opportunity, a culture of inclusion, and an environment free from discrimination and harassment in its educational programs and employment. Georgia Tech prohibits discrimination, including discriminatory harassment, based on race, ethnicity,

ancestry, color, religion, sex (including pregnancy), sexual orientation, gender identity, national origin, age, disability, genetics, or veteran status in its programs, activities, employment, and admissions.

<http://policylibrary.gatech.edu/equal-opportunity-nondiscrimination-and-anti-harassment-policy>