AE6356 Syllabus

Spacecraft Attitude, 3 Graduate Credits

Fall 2026, CRN 94501

Instructor Information

Instructor	Email	Office Hours & Location
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General Information

Description

Attitude representations, dynamics, estimation, and control. Spacecraft attitude sensors and actuators. Attitude determination and control topics applied to spacecraft and space missions. Special cases and applications.

Pre- &/or Co-Requisites

Undergraduate-level rigid body dynamics. For example, AE 2220 Dynamics or equivalent.

Many of the assignments require use of Matlab. While prior experience using Matlab is not required, familiarity with Matlab and numerical programming is assumed.

Course Goals and Learning Outcomes

Upon completion of this course, the student should be able to:

- Understand different attitude representations and convert between them
- Understand the principles of operation of common spacecraft attitude sensors and actuators, and model them in a feedback control system
- Estimate spacecraft attitude from sensor measurements using various methods
- Apply different algorithms to perform spacecraft attitude control
- Simulate spacecraft attitude motion and control system performance

Course Requirements & Grading

Assignment	Date	Weight
Homework	6 total assignments due every 2 weeks	42%
In-Class Midterm Exam	Midway through semester	23%
Final Exam/Project	Last week of class	35%

Description of Graded Components

Homework: Consists of 6 assignments which are due every two weeks throughout the semester. Each assignment contains 7 problems, and each problem is worth 1% of your final grade.

In-Class Midterm Exam: The midterm exam will be given approximately midway through the semester. It is an open-book, open-notes exam which typically consists of 2 problems to be worked within a class period.

Final Exam/Project: The final exam is a Project which has a 1-week time to completion. The final exam synthesizes the elements of the course in a single spacecraft attitude design problem. The final project will be handed out approximately one week before the end of the semester. The final project is completed individually without consultation with other students or persons outside of class.

Some of the assignments require Matlab to solve. In this case, you are expected to write functions to solve various problems. Include any Matlab scripts or session logs you use with your name and date printed on them, indicating that it is your own work. If you use AI tools like ChatGPT or Gemini to help you find the answer or write code to any problem, include your AI chat session with your prompts and its responses in your submitted homework. Homework that is generated by AI tools and submitted without attribution will be treated as cheating.

Grading Scale

Letter grades are based on a straight average plus statistical curve. Letter grades will be assigned according to the following scale:

A	90-100%
B	80-89%
C	70-79%
D	60-69%
F	0-59%

If the class average is below 85, a statistical curve will be used to determine grades. Grades that are higher than one half standard deviation above the mean will receive an A. Grades that are higher than one half standard deviation below the mean will receive a B. Grades that are lower than this will receive a C, D, or F depending on score. The in class and remote learning sections will have grades determined separately.

Course Materials

Course Text

Required Text: Markley and Crassidis, Fundamentals of Spacecraft Attitude Determination and Control, Springer, 2014. Reading and homework will be assigned from this text.

Additional Materials/Resources

The following textbooks may be helpful as optional references for this course:

(1) Schaub and Junkins, Analytical Mechanics of Space Systems, 4th edition, AIAA, 2018.
(2) Hughes, Spacecraft Attitude Dynamics, Dover, 2004.

Course Website

Course materials will be posted online to Canvas (https://canvas.gatech.edu/). Important communications to the class will be sent through the Canvas system; please be alert to these messages. Students will be held responsible for any message or announcement that has been posted to the class for more than 24 hours.

Course Expectations & Guidelines

Academic Integrity

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. For information on Georgia Tech's Academic Honor Code, please visit http://www.catalog.gatech.edu/policies/honor-code/ or http://www.catalog.gatech.edu/rules/18/.

Students are required to report any suspected violation of the Honor Code to the Instructor whether or not they were directly involved in the incident.

Any student suspected of cheating or plagiarizing on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404)894-2563 or http://disabilityservices.gatech.edu/, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Attendance and/or Participation

Classroom attendance, either in person or remotely, is strongly encouraged but not required. Active participation is essential for understanding major concepts and contributing to the learning of others.

Absences related to personal illness or emergency, or career development (e.g. presenting a paper at a conference or scheduled job interview) are considered excused. A written note (doctor's note for illness or email for professional event) must be provided as documentation. Please contact the instructor as soon as you know of a schedule conflict if this applies to you. Please see the Institute Absence Policy - https://catalog.gatech.edu/rules/4/ for more information.

Use of Mobile Devices in the Classroom

Mobile devices (laptop computers and tablets) may be used during lectures in class to enhance your learning experience, provided they are used in support of the class and are not a distraction to you or your classmates. Viewing materials unrelated to the class and doing homework in class is not permitted. Cell phones should be set to silent mode during class. If you must answer a phone call during class, please step outside so as not to disturb the class.

Collaboration & Group Work

Discussions with other students about how to solve homework problems are allowed and encouraged; however, all work turned in must be the student's own original work.

The use of outside references (e.g. textbooks) is expected and encouraged; when this occurs cite any external referenced material that is used.

The use of outside references (e.g. textbooks and online resources) is allowed and encouraged on homework; cite any external referenced material that is used when this occurs.

Use of homework solutions from prior semesters (if/when applicable) is not allowed and is considered cheating. Use of online homework services like Chegg to complete assignments is not allowed and is considered cheating.

The midterm and final exams are intended to measure the learning of individual students; therefore receiving assistance from individuals during exams is not allowed.

Exams and projects must be taken individually. Communication by any means with others about the exam is prohibited during the exam and until everyone in the class has completed the exam. Communicating, copying work, or receiving advance notification about the exam problems is a violation of the Georgia Tech Honor Code.

Academic violations may be penalized with a failing grade and reported to the Office of Student Integrity.

On the use of AI tools to Solve Problems in this Class

AI tools like ChatGPT and Gemini are rapidly becoming capable of solving sophisticated engineering problems like those taught in this class. Like any other resource that is available to you (e.g. Matlab), these tools can be used to improve your understanding and to help you catch mistakes. These tools are allowed in this class to assist you with completing your homework and learning. The recommended approach is to solve the problem first by hand without AI assistance and then use the AI tool if you wish to check your solution and to provide additional insight.

If you use an AI tool to obtain your solution to a problem in this class, you are required to give attribution and to include a printout of your prompt and the response you received in your submitted assignment with your name and date on it. Using external sources-including AI tools-without giving proper attribution is a violation of the Georgia Tech Honor Code.

Students are fully responsible for the accuracy of any answers submitted on assignments. If an AI tool provides an incorrect answer which is used by the student as their solution, partial credit will not be awarded on any part of that problem.

Extensions, Late Assignments, & Re-Scheduled/Missed Exams

Homework assignments are due at the designated time using online submission on Canvas. Any assignment turned in after collection is late. Late homework will be deducted one grade point (out of 7 total points) for each day late. Any homework turned in after one week late is not counted.

Students in the distance learning section will receive a standard 1-week delay on all assignment and exam due dates.

Excused absences (see Attendance and Participation section) may be a justification to receive an extension on an assignment or to re-schedule an exam. Please contact the instructor as soon as you know of a schedule conflict if this applies to you.

Student-Faculty Expectations Agreement

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. See http://www.catalog.gatech.edu/rules/22/ for an articulation of some basic expectation 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.

Additional Syllabus Components

Honesty:

The School of Aerospace Engineering values honesty and integrity of all members of our community. An important element of this value is the academic honor code.

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_I:Honor_Agreement

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 members of our community: https://gatech.instructure.com/courses/108574

Mental Health Resources:

Emergencies: 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): 404-385-4464/(or 4451)
National Suicide Prevention Lifeline: 1.800.273.TALK (8255)
Georgia Crisis and Access Line: 1.800.715.4225

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 in the fight against racism, discrimination, racial bias, and racial injustice. Our shared vision is one of social justice, opportunity, community, and equity. We believe that the diversity and contributions from all of 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 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, on the basis of 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

Course Schedule

The following outline lists the topics to be covered in the course and tentative dates for exams. Changes to the outline will be discussed in class, and updated versions will be uploaded as necessary to Canvas.

Lecture	Topic	Homework
1	Introduction	H1 assigned
2	Attitude Determination and Control Overview	
3	Euler's Theorem	
4	Quaternions	
5	Rodrigues Parameters	
6	Attitude Rates	
7	Star Sensors	H1 due, H2 assigned
8	Sun Sensors	
9	Magnetometers	
10	Magnetic Control	
11	Matlab Simulations	
12	Momentum Management	
13	Momentum Wheels	H2 due, H3 assigned
14	CMGs	
15	Gravity Gradient Torque	
16	Gravity Gradient Dynamics	
17	Gravity Gradient Stabilization	
18	Catch up lecture	
19	Midterm Review, Q&A	H3 due
20	Midterm Exam in class	
21	Wahba's Problem	H4 assigned
22	Quest	
23	Attitude Estimation	
24	Attitude Kalman Filter 1	
25	Attitude Kalman Filter 2	
26	Gyroscopes	H4 due, H5 assigned
27	Attitude Kalman Filter Example	
28	Spacecraft Attitude Control	
29	Single Input Single Output (SISO) Attitude Control	
30	Linear Quadratic Regulator (LQR) Attitude Control	
31	Multi Input Multi Output (MIMO) Systems	
32	Spacecraft Attitude Regulation	H5 due, H6 assigned
33	Sliding Mode Control	
34	Nonlinear Controllers	
35	Constrained Attitude Pathfinding	
36	Phase Plane Analysis	
37	Nonlinear Thruster Control	
38	Final Project Handout, Q&A	H6 due, Final Project Assigned
	Work on Final Project, no class	
	Work on Final Project, no class	
	Final Project Due, no class	Final Project Due
39	Final Day, Class Feedback	