

AE6356 Syllabus

Spacecraft Attitude, 3 Graduate Credits

Lectures: Tuesday/Thursday, 5:00-6:15 pm, Instructional Center Room 209*

*unless indicated otherwise

Instructor Information

Instructor
E. Glenn Lightsey

Email
glenn.lightsey@gatech.edu

Office Hours & Location
Tuesday 6:30-7:15 PM, John Lewis Student Center
Thursday 8:00-9:00 PM EDT, Canvas Zoom Link

Teaching Assistants
Mason Starr
Shan Selvamurugan

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Wednesday 1:00-2:00 PM EDT, Canvas Zoom Link

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	36%
In-Class Midterm Exam	Midway through semester	32%
Take-Home Final Exam/Project	Last week of class	32%

Description of Graded Components

Homework: Consists of 6 assignments which are due every two weeks throughout the semester. Each assignment contains 6 problems, and each problem is worth 1% of your final grade. AI may be used to assist with the homework, in which case give attribution and attach prompts and replies (see AI policy section).

In-Class Midterm Exam: The midterm exam will be given approximately midway through the semester. It is a closed book exam to be worked within a class period. A single page of notes prepared by the student may be brought to the exam. For distance learning students, the exam will be taken at your computer using the Honorlock system.

Take-Home Project/Final Exam: The final exam is a take-home project which has a 1-week time to completion for the in-person class and 2-week deadline for the distance learning class. 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. AI may be used to assist with the take-home project, in which case give attribution and attach prompts and replies (see AI policy section).

Grading Scale

Letter grades are based on a straight average plus optional statistical curve. If the class average is 85 or higher, uncurved 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 more than one half standard deviation above the mean will receive an A. Grades that are more than one half standard deviation below the mean will receive a B. Grades that are more than 1.5 standard deviations below the mean will receive a C, and grades that are more than 2.5 standard deviations below the mean will receive a D or F.

Extra Credit Opportunities

Extra credit assignments are not expected but could be given to the class on a case-by-case basis in addition to regularly assigned work. Examples of possible extra credit assignments would be to re-work missed problems on the midterm exam, work optional additional homework problems, write a report on a topic that is relevant to the class, etc. Please contact the instructor if you want to discuss possible opportunities for extra credit.

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.
- (3) Christian, Fundamentals of Spacecraft Optical Navigation, Wiley, 2024.

Course Website and Other Classroom Management Tools

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 are 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. Active participation is essential for understanding major concepts and contributing to the learning of others.

Absences related to personal illness, 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.

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 and web sites) is expected and encouraged; when this occurs cite any external referenced material that is used in the homework solution. When code is used to solve a problem, it should be attached as part of the solution, and the student's name, class (AE 6356 Spacecraft Attitude), and date must be included in the leading comments. This attests that the code is the student's own and has not been copied from other sources.

The use of AI and LLMs to help with homework problems and the take-home project is allowed. The role of AI should be to enhance learning but not to replace it. When AI is used, an acknowledgement statement must be included in the assignment along with a copy of the prompt and AI response. Using AI or LLMs without attribution is a violation of the class AI policy (see AI policy section) and the Georgia Tech Honor Code.

The midterm exam and take-home project are intended to measure the learning of individual students; therefore receiving assistance from other 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.

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 due date without an excused extension is late. Late homework will be deducted 1 full problem per fraction of day late. Any homework turned in more than one week late is not counted.

Students in the distance learning section receive a standard 1-week extension 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 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.

Student Use of Mobile Devices in the Classroom

Mobile Devices (laptop computers and tablets) may be used 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.

AI Use Policy

Als and LLMs are allowed in this class to assist you with learning the material. The recommended way to use an AI is as a learning assistant and not as an “answer key”. For this class, you may use any AI tool of your choice, and you may use it to support your study of the material, check homework answers, help write and debug code, and augment your capabilities during the take-home project. AI is not required to complete the course, but it is assumed that you have access to it and that most students are using it.

When AI is used, no partial credit is awarded if the answer is incorrect, regardless of whether or not the AI provided the answer.

If Als or LLMs are used on any work that is turned in for grading, you must acknowledge it with a statement on each problem and include a PDF printout of your prompts and the AI response which is attached as an Appendix section to the homework. The lack of such a statement on any problem will be interpreted that AI was not used on that problem.

Using Als or LLMs to perform tasks that were used in your solution and not attributing them in your submitted work is a violation of the Georgia Tech Honor Code in this class, which will be reported to the Office of the Dean of Students for adjudication. Any violation of this AI Use Policy could result in a lower grade or other academic discipline. Don't let this happen to you!

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](http://policylibrary.gatech.edu/student-affairs/academic-honor-code#Article%20I:Honor%20Agreement)

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): <https://healthinitiatives.gatech.edu/well-being/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	Date	Topic	Homework
1	T 8/25	Introduction	H1 assigned
2	R 8/27	Rotations 1	
3	T 9/1	Rotations 2	
4	R 9/3	Rotations 3	H1 due, H2 assigned
5	T 9/8	Rotations 4	
6	R 9/10	Rotations 5	
7	T 9/15	Dynamics 1	
8	R 9/17	Dynamics 2	H2 due, H3 assigned
9	T 9/22	Dynamics 3	
10	R 9/24	Dynamics 4	
11	T 9/29	Dynamics 5	
12	R 10/1	Dynamics 6	H3 due
13	T 10/6	(Fall Break holiday, no class)	
14	R 10/8	Midterm Review, Q&A	
15	T 10/13	Midterm Exam in class	H4 assigned
16	R 10/15	Estimation 1	
17	T 10/20	Estimation 2	
18	R 10/22	Estimation 3	
19	T 10/27	Estimation 4	H4 due, H5 assigned
20	R 10/29	Estimation 5	
21	T 11/3	Estimation 6	
22	R 11/5	Control 1	
23	T 11/10	Control 2	H5 due, H6 assigned
24	R 11/12	Control 3	
25	T 11/17	Control 4	
26	R 11/19	Control 5	
27	T 11/24	(Thanksgiving no class)	H6 due
28	R 11/26	(Thanksgiving no class)	
29	T 12/1	Final Project Handout/Overview	Final Project assigned
30	R 12/3	Final Project Work Day (no class)	
31	T 12/8	Last Class Day (no class)	Project Due
32	T 12/15	Final Project Due for distance learning section	

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 honesty and integrity of all members of our community. An important element of this value is the academic honor code.

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