AE4806 Syllabus

Space Hardware Laboratory, 3 Undergraduate Credits

General Information

Description

A spacecraft subsystem and payload experimental laboratory course.

Pre- &/or Co-Requisites

Pre-requisite: AE3330 Introduction to Aerospace Vehicle Performance

Course Goals and Learning Outcomes

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

- Identify and characterize the major hardware subsystems of a robotic spacecraft mission
- Understand the basic physical principles of the most common spaceborne remote sensing instruments
- Understand and implement general spacecraft telemetry, command and data handling concepts on representative satellite hardware systems
- Know how to test and evaluate the performance of a representative spacecraft subsystem component (power, attitude control, positioning, etc.)
- Understand the fundamentals and logistics of basic spacecraft communications
- Safely work with electrical hardware and testing equipment
- Interact with hardware components through low level software protocols (UART, I2C, SPI)
- Effectively communicate technical information in both oral and written formats
- Work effectively in a team environment

Course Requirements & Grading

Assignment	Date	Weight (Percentage, points, etc)
Quizzes	Sept, Oct, Nov	20%
Lab	Weekly 3-hr lab	60%
Final Project	Final exam period	10%
Student Peer Review	Weekly	10%

Extra Credit Opportunities

Extra credit assignments may be presented to the class on a case-by-case basis in addition to the regularly assigned work. Examples of possible extra credit assignments would be to re-work activities, conduct a more in-depth study of a particular topic, create new content, etc. Please contact the instructor if you want to discuss possible opportunities for extra credit.

Description of Graded Components

Quizzes: Three 45-minute quizzes are planned at approximately monthly intervals to reinforce the material covered in the lectures, labs, and reading/tutorial material.

Laboratory assignments: The weekly lab sessions will be led by the course instructor and/or graduate teaching assistants (GTAs), and will consist of a mixture of instruction, demonstrations, and assignments.

The assignments will focus on using a series of hardware kits specifically designed for the course, and will involve both hardware and software experiments designed to provide practical experience to material covered in the weekly lecture. Students will work in teams to conduct the laboratory experiments, and will submit reports/writeups each week that will be graded.

Final Project: A final project will take the place of a final exam, and will be due at the same time the final exam would have been scheduled for the course. The final project can be team-based, and will focus on a topic that encompasses skills and knowledge developed in the laboratory assignments.

Student Peer Review: Student peer reviews will be conducted periodically throughout the semester. The students will judge their team members contributions to the lab assignments, participation in the team and ability to work well within the team. Attendance at labs and lectures will also factor into this grade component.

Grading Scale

At Your final grade will be assigned as a letter grade according to the following scale:

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

Full credit is awarded for solutions that are correct and demonstrate an understanding of the concepts of the problem. Partial credit is given for solutions that, while incorrect, demonstrate some knowledge of the concepts.

Course Materials

Course Text

Required Text: Malloy, D., Exploring BeagleBone, 2nd Edition, 2019 (online version via GT library)

Optional Text: Rees, W.G., Physical Principles of Remote Sensing, 2012 (online version via GT library)

Optional Text: Elachi, C., and van Zyl, J., Introduction to the Physics and Techniques of Remote Sensing, 3rd edition, 2021.

Optional Text: Wertz, J., Everett, D., Puschell, J., Space Mission Engineering: The New SMAD, Microcosm, 2011.

Optional Text: Schowengerdt, R., Remote Sensing - Models and Methods for Image Processing (3rd Edition), 2006

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 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 is essential for understanding major concepts and contributing to the learning of others. It is expected that students attend all lectures and lab sessions in their entirety. The laboratory sessions and quizzes are mandatory in-person activities, so absences from these course activities will result in no credit being given for missed activities.

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. 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) is expected and encouraged; when appropriate cite any referenced material that is used.

Use of homework solutions from prior semesters (if/when applicable) is **not** allowed.

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

Lab assignments are due at the designated time using online submission on Canvas. Any assignment turned in after collection is late. Late homework assignments may be turned in during the advertised grace period (usually 48 hours) for half credit. Any homework turned in after this is not counted.

Excused absences (see above) may be a justification to receive an extension on an assignment. Please contact the instructor as soon as you know of a schedule conflict if this applies to you. Under special circumstances and at least two weeks of advance coordination with the professor, labs may be rescheduled for an individual. Labs missed due to illness or other emergencies can be made up, but must be supported by appropriate documentation coordinated through the Dean of Students. The professor reserves the right to grant special dispensations when deemed appropriate.

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.

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 allowed. 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.

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): 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 provides a tentative list the topics to be covered in the course, and are subject to change. Any changes to the outline will be discussed in class, and updated versions will be uploaded as necessary to Canvas.

Wk	Lecture/Lab Topic	Example Lab Assignment
1	Spacecraft design and subsystems overview	Review of spacecraft elements; introduction of the satellite kit
2	Elements of spacecraft structure design	Assemble hardware kit; subsystem checkouts
3	Working with electronics	ESD training, soldering training, staking, conformal coating, harnessing
4	Power generation and distribution	Solar cell characterization (IV curve), assess power usage of a set of components, estimate a power budget and validate with experiment
5	Onboard computing architectures	Simple OS architectures; write a simple routine using cFS
6	Low-level sensor protocols	Connect and control a device using UART, I2C, or SPI; diagnose with a logic analyzer
7	Thermal control	Assess component thermal state with a TIR imager; implement simple heat controller with tape heaters
8	Telemetry	Assemble simple ground station receiver using gnuradio; assemble simple housekeeping packet from
9	RF communications	Using a low-cost comms system (on an unlicensed open freq band, or coax), transmit some basic formatted commands
10	Attitude determination and control	Single reaction wheel control; sun-tracking with a simple photo-diode;
11	Guidance, navigation, and control	Basic IMU integration, or GPS positioning
12	Physical principles of remote sensing - I	Imagers, magnetometers, lidar, others…
13	Physical principles of remote sensing - II	Imagers, magnetometers, lidar, others…
14	Data processing	Gather data from a payload experiment and performing analysis (e.g., image classification, FFT, etc.)
15	Environmental testing	Thermal cycling, vacuum testing, vibration testing