Space Instrumentation for Life Detection

3 credit hours, letter or S/U grading

INSTRUCTORS

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How to contact us: It is our intent to be as accessible as possible. If you need to reach out, first please review: 1) this syllabus, 2) the FAQ on the Canvas site, 3) contact us by text message between the hours of 8 am and 10 pm Eastern Time (ET), or 4) send us an email, which could take >24 hours for a response.

Office Hours
To ensure we are logged on, please ping us first via text messages and let us know you're coming. We will hold virtual office hours (Tue 2-2:45 pm, Richard; Friday 1:20-2 pm, Chris).

Synchronous Class Activity Time
Tue/Thu 12:30-1:45 pm, assigned room: ~~Skiles 314~~ → We have moved to *Guggenheim 244*.

Course Description
This course will cover the interdisciplinary foundations of space instrument development focusing on the search for life beyond Earth. Both non-contact and destructive methods of sample analysis, including fluid handling, and analytical methods for detecting life as we know it and don't know it, will be covered in the context of specific mission scenarios. Environmental and engineering challenges will be addressed as well as common solutions; examples include autonomy, radiation resistance, thermal control, and data analysis methods such as machine learning. Group projects will involve modifying, building, or modeling a life detection instrument or supporting hardware.

Enrollment is restricted via permits. Please contact the course instructor for more information.

Course Topics & Goals
- Astrobiology & Approaches to In Situ Life Detection
- Space Instrument Development Process: Mission Science to Flight Hardware
- Planetary Protection & Contamination Control
- Non-Contact Analytical Methods for Sample Interrogation
- Destructive Methods for Sample Analysis
- Sample Handling & Fluidics
- Thermal Environment & Regulation
- Radiation Resistance: Hardware, Software, Reagents
- Virtual Prototyping for Space Instruments
- Rapid Prototyping for Space Instruments
- Electrical Systems and Control
- Machine Learning and Autonomy
- Potential special topics:
    - Seeking Life as We Know It With Single Molecule Sequencing
    - Strategies for Seeking Life as We Don't Know It
    - Flying On Other Words
    - Particle Size, Shape, and Mobility: From Aerosols to Cells
    - Non-Dimensional Parameters for Life Detection Missions

  - Platforms for Instrument Validation (Lab, Balloon, Rocket, Cubesat, ISS, AUVs, etc.)
  - Special topics/guest lectures
- Group project: design and prototype a virtual or physical life detection instrument, or enhance an existing life detection instrument capability.
- Possible integration of cubesat project for long-term monitoring of microbial growth and evolution.

Course Mode
This course is expected to run mainly in an in-person mode with a mixture of lecture, lab, and occasional synchronous online activities (guest lectures). The course will utilize CANVAS supplemented by Google Drive and/or LabArchives for additional support. Students will require access to a webcam, microphone, and internet connection for online synchronous activities.

Course Textbook
There is no textbook for this course. All materials will be provided via Canvas. Students are responsible for checking Canvas regularly.

Assignments
Assignments will include problem sets as well as individual and group projects, culminating in creating a prototype space instrument (virtual or physical) and/or integrating new capabilities into existing instrumentation. Assignments, homework, and quizzes will be assigned and submitted digitally through the Canvas website; some will be individual and some will require group activities. There are no tests nor final exams in this course. There will be an assignment due on the final instructional day of the term.

Extensions may be granted in cases where extenuating circumstances prevented the student from reasonably completing an assignment on time. Examples include illness, emergencies, family situations, and institute excused absences. The Office of the Vice President and Dean of Students can assist students with documented emergencies by contacting professors on behalf of the student. You can get more information on this process here: https://studentlife.gatech.edu/content/class-attendance

If you have internet or technical difficulties that prevent you from uploading to Canvas on time, please send a text message or email to the TA and instructor immediately to document this, and then upload as soon as you are able.

Group projects (report and presentation) due dates may include the final two instructional days of the semester, 12/5 and 12/6.

Attendance
This class will include both asynchronous and synchronous activities, including group activities, which are a critical part of the learning process. Active participation is expected and will contribute toward your final grade.

More than 1 unexcused absence during the semester will result in a deduction in your attendance grade for that absence. Note that institute approved absences do not count, and reasonable accommodation and exception will be made for illness and emergencies. NOTE: **If you are ill, please do not attend any in person activities.** Your health takes priority and your fellow students will thank you for not exposing them. In this case, contact the instructors to develop a plan to get back on track.

Students may need to miss synchronous activities due to personal emergencies such as being hospitalized or being in a car accident. The Office of the Vice President and Dean of Students can assist with contacting professors in these situations via the link provided in the previous section. These absences will not be considered unexcused, and we will make reasonable accommodations to assist you.

If you ever find yourself in any situation in which an unexpected personal challenge is preventing you from performing your best in the course, please reach out so we can come up with a plan for you.

Pre-Requisites

This course is intended for experienced undergraduates or graduate students. Specialized engineering knowledge and/or a wide range of aeronautics/astronautics, planetary science, astrobiology, or other background knowledge is helpful.

GRADING
Grades will be calculated as follows:

- Class Participation – 15%
  - Attendance, participation in discussions, and the completion of in-class exercises
- Individual Assignments – 40%
  - Assignments will be based on a combination of in-class exercises and written assignments
  - Assignments will be posted on and submitted through Canvas
  - Assignments must be posted by the due date and time to be eligible for full credit. A late period for late assignments will last until 6pm the day after the due date, with a 10% deduction applied to any assignment turned in during this late period. Any assignments turned in after the late period will receive a 0.
- Final group project – 45%

COURSE ETHICS
Academic dishonesty is not tolerated in any form. Students are expected to uphold high ethical standards including adherence to the Georgia Institute of Technology Honor Code (https://osi.gatech.edu/content/honor-code), Academic Regulations and Student Regulations.

Below are some guidelines to help you understand what constitutes appropriate academic behavior:

- Students are not permitted to review or use materials from previous semesters. This includes the use of old assignments.
- Students are permitted and encouraged to work collaboratively on assignments and seek help from one another, but the work that is turned in as an individual assignment must be the student's own work. Copying another student's work is not permitted.
- On group assignments, students are expected to do their fair share of the work. If there is an instance where a student is not contributing to a group project, the team members should notify the instructor as soon as possible.
- Plagiarism of any kind is not permitted. Plagiarism includes reproducing the words or visual/graphical expressions of others without clear attribution and citation.

TIPS FOR SUCCESS
I will do my part to make this course a success. However, being successful will require you to do your part as well. Here are a few tips to help you be successful in this course.

- Participate fully in all activities!
- Use the office hours. If you are not available at one of these times, contact us and we will find an alternate time. Office hours are a great time to get help with homework, ask questions about the material covered in class, discuss your own performance in the course, or just to come and chat. These are a resource for you, and I encourage you to use it!
- Your peers are a resource – talking out an assignment with a classmate can be a fantastic tool to enhance learning for all parties. Explaining your thought process to someone else is often helps your brain organize and synthesize information.
- Make sure you contribute to your group projects. These are designed to help you learn the material. Plus, your peers are the first of your future professional network. Don't start off with a bad impression!

STUDENTS WITH ACCOMODATION NEEDS
Your experience in this class is important to me. If you have already established accommodations with the Office of Disability Services, please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course.

If you have not yet established services through Disability Services, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), please contact the Office of Disability Services at 404.894.2563 or dsinfo@gatech.edu or disabilityservices.gatech.edu.

Disability Services offers resources and coordinates reasonable accommodations for students with disabilities and/or temporary health conditions. Reasonable accommodations are established through an interactive process between you, your instructor(s) and Disability Services. It is important to the Georgia Institute of Technology to create inclusive and accessible learning environments consistent with federal and state law.

Georgia Tech School of Aerospace Engineering Values

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.

   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

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 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

COVID-19 Safety
GT Safety Guidelines: https://health.gatech.edu/tech-moving-forward
Current guidance is summarized at the site above and please continue to follow the site above and other Institute communications in case changes occur.

3. **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

AE/EAS 4803/8803 Space Instrumentation for Life Detection (Fall 2022) Schedule (2022-11-28)

Legend	
	Lecture
	Deliverable Due
	Group Work
	Other

Week	Date	Day	Type	Mode	Code	Description	Notes
1	23-Aug	Tue	Lecture	In Person	L01	Introduction to Astrobiology & Life Detection	D01 Assigned
	25-Aug	Thu	Lecture	In Person	L02	Instrument Measurement	
2	30-Aug	Tue	Deliverable	Canvas	D01	A Simple Life Detection Instrument	
	30-Aug	Tue	Lecture	In Person	L03	How to Make Life and Populate Planets	
	1-Sep	Thu	Lecture	In Person	L04	The Search for Extra-Terrestrial Genomes (SETG), Part I	
3	6-Sep	Tue	Lecture	In Person	L04	SETG Part II	D02 Assigned
	8-Sep	Thu	Lecture	In Person	L05	Detecting Evolution	
4	13-Sep	Tue	Deliverable	Canvas	D02	DNA Sequencing	D03 Assigned
	13-Sep	Tue	Lecture	In Person	L06	Solid State Single Molecule Detection Part 1	
	15-Sep	Thu	Lecture	In Person	L07	Solid State Single Molecule Detection Part 2	
5	20-Sep	Tue	Deliverable	Canvas	D03	Life or False Positive	D04 Assigned
	20-Sep	Tue	Lecture	In Person	L08	Space Instrument Development: Concept to MIsson	
	22-Sep	Thu	Lecture	In Person	L09	Planetary Protection	
6	27-Sep	Tue	Lecture	In Person	L10	Group Projects & MATLAB Tutorial	Project Ideation Survey
	29-Sep	Thu	Lecture	In Person	L11	Aerosols in Astrobiology	Rank Projects (by Sunday)
7	4-Oct	Tue	Lecture	In Person	L12	Project Selection and Work Session	Group Work Session
	4-Oct	Tue	Deliverable	Canvas	D04	Solid State Nanopore (& ROC analysis)	
	6-Oct	Thu	Lecture	In Person	L13	Bits and Bytes: Command, Control, and Data Handling	
8	11-Oct	Tue	Group	Online	G01	Group Status Reports	
	13-Oct	Thu	Group	Online	G02	Group Project Verbal Updates & Work Session	
9	18-Oct	Tue	No Class			Fall Break	
	20-Oct	Thu	Guest Lecture	Online	GL01	Allison Fox on SHERLOC	
10	25-Oct	Tue	Guest Lecture	Online	GL02	Stacy Weinstein Weiss on Europa Clipper, Mission Proposal to Flight	
	27-Oct	Thu	Group	Online	G03	Group Status Reports and/or Work Session	
11	1-Nov	Tue	Guest Lecture	Online	GL03	Eric Hinterman on MOXIE	
	3-Nov	Thu	Group	Online	G04	Group Status Reports and/or Work Session	
12	8-Nov	Tue	Guest Lecture	Online	GL04	Ziqin Ni on Planetary Mass Spec	
	10-Nov	Thu	Guest Lecture	Online	GL05	Pablo Sobron on Impossible Sensing, Entrepreneurship, Bridging Space and Earth Application	
13	15-Nov	Tue	Group	Online	G05	Group Status Reports and/or Work Session	
	17-Nov	Thu	Guest Lecture	Online	GL06	Hiro Ono (and possibly Morgan Cable) on EELS	
14	22-Nov	Tue	Group	Online	G05	Group work time / BioX2 launch attempt #1	
	24-Nov	Thu	No Class			Thanksgiving	
15	29-Nov	Tue	Review	In Person	N/A	Course Review and Kahoot Game	
	1-Dec	Thu	Deliverable	In Person		Final Group Project Presentations	
16	6-Dec	Tue	Deliverable	In Person		Final Group Project Presentations	
			Deliverable	Canvas		Final Group Project Report	

Legend			
Lecture	In Person	LXX	Lecture Description
Deliverable	Canvas	DXX	Deliverable Description
Group	In Person/Online	GXX	Group work
Guest Lecture	Online Only	GLX	Guest Lecture: Description

Notes Lecture and Group activities are during nominal 12:30 pm to 1:45 pm Class Time
Group meetings can be Online or In Person (if Group Members agree) after the first two sessions.
Brief feedback survey (part of participation grade) is expected after every lecture.