

AE8803-ROM Syllabus - Fall 2024

Low-Gravity Fluid Mechanics, 3 Graduate Credits [**DRAFT SYLLABUS**]

General Information

Description

Introduction to microgravity and partial-gravity science and technology, with an emphasis on the theory and simulation of low-gravity liquid/gas flows. Students will conceptualize, design, and build their own 2U microgravity payload for Zero-G Corp.'s parabolic plane during the second half of the semester.

Pre- &/or Co-Requisites

Pre-requisite: AE4342 / 4321-22 or equivalent space systems engineering course

Others: A strong background in calculus and fluid mechanics (e.g. AE6009 Viscous Fluid Flows) is highly recommended.

Course Goals and Learning Outcomes

Upon completion of this course, the student should:

- Understand the unique characteristics and operational environment of different microgravity facilities and how different payloads fit in them
- Master the theory behind capillary flow statics and dynamics in low-gravity environments
- Understand the challenges of low-gravity fluid control in key space technologies
- Write and understand detailed aerospace system requirements for microgravity payloads
- Be familiar with the life cycle of a microgravity payload
- Conduct system sizing analyses and trade studies
- Effectively communicate technical information in both oral and written formats
- Apply engineering design to produce solutions that meet specified needs with consideration of safety, technical constraints, and human factors

Instruction & Logistics

Instructor

Dr. Álvaro Romero-Calvo (alvaro.romerocalvo@gatech.edu), ESM 203B

Teaching Assistants

TBD

Schedule

Lectures: 5:00-6:15 pm Tuesday and Thursday, Allen Sustainable 110.

Virtual meeting link: TBD

Office Hours

Instructor: TBD

TAs: TBD

Please, email the instructor and TAs during standard business hours (9 am to 5 pm, Monday to Friday). Include both TAs in your emails and be respectful of their time: they are also students.

Course Requirements & Grading

Assignment	Date	Weight
Lab/Homework Assignments	Due every two weeks for the first half of the semester	30%
Concept Design Review	Oct. 1	5%
Preliminary Design Review	Oct. 24	10%
Concurrent Design Review	Nov. 7	15%
Flight Readiness Review	Nov. 26	20%
Final Report	Dec. 3	20%

This class does not have a final exam.

Extra Credit Opportunities

Extra credit assignments will 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 conduct a more in-depth study of a particular topic, create new content and present it to the class, etc.

Description of Graded Components

Homework Assignments: Consists of bi-weekly assignments which are due throughout the semester. Each assignment is based on the material covered in class.

- Most lab assignments will be due two weeks from publication, although some assignments needing more time may have extended due dates.
- Any assignment turned in after collection is late. Late lab assignments may be turned in during the grace period (24 hours) for half credit. Any lab turned in after this is not counted.
- Completed lab assignments will be submitted via Canvas using a LaTeX-generated PDF file written in accordance with the proposal writing guidelines discussed in class. Deductions will be made for improper lab assignment format.

Group Project: Students enrolled in the course will have the opportunity to fly their own 2U microgravity payload onboard Zero Gravity Corp's parabolic plane. Payload designs are up to the students and should ideally reinforce the fluid-mechanics aspects of their graduate research. The project is sponsored by the NASA TechFlights program.

Four group presentations are scheduled during the semester to provide an update on the progress of the work and receive feedback on it. The instructor and reviewers will make an effort to expose you to the same questions and comments that you may expect in a professional microgravity payload development process.

Although, by default, every team member gets the same grade, the instructor may modify individual grades by +-20 pts with respect to the baseline when the individual work carried out by the student exceeds or does not meet the expectations. Earning credit on a team presentation is contingent upon attending the presentation.

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. Final grades may be curved based on overall class performance.

Course Materials

Textbooks

- Recommended: A.D. Myshkis , V.G. Babskii , N.D. Kopachevskii, L.A. Slobozhanin, A.D. Tyuptsov, Low-Gravity Fluid Mechanics, Mathematical Theory of Capillary Phenomena
- Key journals: npj Microgravity, Microgravity Science and Technology, Acta Astronautica
- Specific materials will be recommended at the end of every technical lecture

Course Website and Other Classroom Management Tools

Course materials will be posted online to Canvas (<https://canvas.gatech.edu/>). Course materials (e.g. recorded videos) will be available to both in-person and distance learning sections. 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.

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 as far as it is appropriately cited following the proposal writing guidelines discussed in class.

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

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. If you choose to join the lectures, active participation is expected. Attendance may also be considered by the instructor in assigning final grades close to a letter grade boundary. Any material covered in class is susceptible to being evaluated.

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. In the event of a medical emergency or an illness that is severe enough to require medical attention, students are responsible for contacting [the Dean of Students](#).

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 assignments may be turned in during the advertised grace period (24 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.

Student-Faculty Expectations Agreement

At Georgia Tech we believe that it is important to strive for an atmosphere of mutual respect, acknowledgment, 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 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_1: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 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 / Project	Book	Week
T	8/20	Course Introduction	Concept Presentation Assigned		1
TR	8/22	Overview of gravity-related research			
T	8/27	Gravity machines	HW1 Assigned		2
TR	8/29	Surface tension & contact angle			
T	9/3	Equilibrium of liquid interfaces			
TR	9/5	Surface Evolver (guest lecture)	HW1 Due HW 2 Assigned		3
T	9/10	Dynamics of liquid interfaces I			
TR	9/12	Dynamics of liquid interfaces II			4
T	9/17	Stability of liquid interfaces			
TR	9/19	Bubble dynamics & Phase Separation	HW2 Due HW3 Assigned		5
T	9/24	Propellant Management Devices			
TR	9/26	Plant watering systems			6
T	10/1	Concept Design Review	Concept Presentation Due PDR Assigned		7
TR	10/3	Non-traditional actuation mechanisms	HW3 Due		

			HW4 Assigned		
T	10/8	Heat transfer in microgravity			8
TR	10/10	Overview of multiphase CFD methods			
T	10/15	Fall Break!			9
TR	10/17	Payload Electronics I	HW4 Due		
T	10/22	Payload Electronics II			10
TR	10/24	Preliminary Design Review	PDR Due CDR Assigned		
T	10/29	Work on project / guest lecture			11
TR	10/31	Work on project / guest lecture			
T	11/5	Work on project / guest lecture			12
TR	11/7	Concurrent Design Review	CDR Due		
T	11/12	Work on project / guest lecture			13
TR	11/14	Work on project / guest lecture			
T	11/19	Work on project / guest lecture			14
TR	11/21	Work on project / guest lecture			
T	11/26	Flight Readiness Review			15
TR	11/28	Thanksgiving Break			
T	12/3	Final report due			16

* Final Presentations may extend beyond regular class/lab time to accommodate all teams.