

AE4610: DYNAMICS AND CONTROL LABORATORY Spring 2022

Catalog Description: Experiments in dynamics and control related to Aerospace Engineering topics. Pre-requisites: AE2610, AE3531

Purpose of Course: This laboratory course is designed to give students in Aerospace Engineering a hands-on experience with system modeling and simulation, control system design, analysis, and evaluation.

Lectures: All lectures will take place in Boggs B9 on Mondays from 11:00-11:50am. Occasionally, lectures will be delivered remotely-only using BlueJeans. In that case, an email will be sent to the whole class in advance.

Tentative Schedule

Week 1: (Jan 10 – 14) (No Lab)

Lecture: Overview of the course

Lab 1: Example problems in the use of MATLAB and SIMULINK (Individual)

Week 2: (Jan 17 – Jan 21) (No Lab)

Lecture: (No Lecture or Labs – MLK day)

Week 3: (Jan 24 – Jan 28) (AE Controls Lab, ESM G1)

Lecture: DC motor system modeling, PID controller design

Lab 2: DC Servomotor - Modeling (Group)

Due: Lab 1 report (Individual), due Monday 11AM, Jan 24

Week 4: (Jan 31 – Feb 4) (AE Computer Lab, Knight-318)

Lecture: No lecture

Lab 2: DC Servomotor - Controller Design (Individual)

Due: Lab 2 Pre-lab DC gain & time constant (Individual)

Week 5: (Feb 7 – Feb 11) (AE Controls Lab, ESM G1)

Lecture: Review of phase and gain margins, robustness, discretization

Lab 2: DC Servomotor - Controller implementation and evaluation (Group)

Due: Lab 2 DC motor controller design (Individual)

Week 6: (Feb 14 – Feb 18) (AE Computer Lab, Knight 318)

Lecture: 3D Helicopter controller

Lab 3: 3D Helicopter - Controller Design (Individual)

Due: Lab 2 (DC motor) report (Group)

Week 7: (Feb 21 – Feb 25) (AE Controls Lab, ESM G1)

Lecture: None

Lab 3: 3D Helicopter – Controller Implementation and Evaluation (Group)

Due: Lab 3 Controller gains (Individual)

Week 8: (Feb 28 – Mar 4) (AE Controls Lab, ESM G1)

Lecture: Flex Beam

Lab 4: Flex Beam – Controller Implementation and Evaluation Part 1 (Group)

Due: Lab 3 (3D helicopter) report (Group)

Week 9: (Mar 7 – Mar 11) (AE Controls Lab, ESM G1)

Lecture: Flex Beam controller evaluation

Lab 4: Flex Beam – Controller Implementation and Evaluation Part 2 & 3 (Group)

Due: Lab 4 Pre-lab calculation (Individual)

Week 10: (Mar 14 – Mar 18) (AE Computer Lab, Knight 318)

Lecture: LQR controller design

Lab 5: Inverted Pendulum Controller Implementation and Evaluation (Group)

Due: Lab 4 (Flex Beam) report (Group) & Lab 5 Feedback Gains (Individual)

Week 11: (Mar 21 – Mar 25) Break (No labs or lectures)

Week 12: (Mar 28 – Apr 1)

Due: Lab 5 (Inverted Pendulum) report (Group)

Weeks 13-15: (Apr 4 – Apr 22)

Take Home Project and Revision

Final Exam on April 29 (Friday) at 11:20 AM for two hours

Week	Date	Lecture	Lab	Lab Location	Due
1	01/10-01/14	Overview of the course	Lab 1: Example problems in the use of MATLAB and SIMULINK (Individual)		
2	01/17-01/21	MLK (01/17)			
3	01/24-01/28	DC motor system modeling, PID controller design	Lab 2: DC Servomotor - Modeling (Group)	ESM G1	Lab 1 report (Individual) by Monday 11AM, Jan 24
4	01/31-02/04		Lab 2: DC Servomotor - Controller Design (Individual)	Knight-318	Lab 2 Prelab Calculations DC gain & time constant (individual)
5	02/07-02/11	Review of phase and gain margins, robustness, discretization	Lab 2: DC Servomotor - Controller implementation and evaluation (Group)	ESM G1	Lab 2 DC motor controller design (Individual)
6	02/14-02/18	3D Helicopter controller	Lab 3: 3D Helicopter - Controller Design (Individual)	Knight-318	Lab 2 DC motor report (Group)
7	02/21-02/25		Lab 3: 3D Helicopter - Controller Implementation and Evaluation (Group)	ESM G1	Lab 3 Controller gains (Individual)
8	02/28-03/04	Flex Beam	Lab 4: Flex Beam Part 1 (Group)	ESM G1	Lab 3 3D helicopter report (Group)
9	03/07-03/11	Flex Beam controller evaluation	Lab 4: Flex Beam Part 2 & 3 (Group)	ESM G1	Lab 4 Prelab Calculations (Individual)
10	03/14-03/18	LQR controller design	Lab 5: Inverted pendulum Controller Implementation and Evaluation (Group)	ESM G1	Lab 5 Feedback gains (Individual) Lab 4 Flex Beam report (Group)
11	03/21-03/25	Spring Break			
12	03/28-04/01				Lab 5 Inverted Pendulum report (Group)
13	04/04-04/08				
14	04/11-04/15				
15	04/18-04/22				
16	04/25-04/29	Final Exam 04/29			

Important Note on Georgia Tech Honor Code: 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. Georgia Tech Honor Code applies to all the work carried out in this course. All violations will be promptly reported for appropriate disciplinary action, in addition to receiving a zero grade. For more information about the Georgia Tech Honor Code, please visit <http://policylibrary.gatech.edu/student-affairs/academic-honor-code>

<http://www.catalog.gatech.edu/rules/18/> .

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.

Grading:

Lab 1 5%

Lab 2 15%

Lab 3 15%

Lab 4 15%

Lab 5 15%

Take Home Lab 20%

Final 15%

Students will be evaluated by their team members, once at mid-semester and once at the end of the semester. These evaluations will be taken into consideration in assigning the final grades.

Grading Policy:

A 90 & above

B 80 – 89

C 65 – 79

D 50 – 64

F 49 & below

Instructor: Dr. Kyriakos G. Vamvoudakis (kyriakos@gatech.edu) Knight 415-B 404-385-3342

TAs:

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Lab Reports

Controller design parts of the experiments (where indicated) must be carried out individually. Also, summaries of individual controller designs from all group members must be included in the lab reports. Lab reports are due at the beginning of the next experiment as indicated by the syllabus. Late submissions without a valid explanation or prior approval will be penalized according to the following:

1 day late 25% off

2 days late 50% off

3 days late 75% off

4 days late 100% off

A lab report must include the following as a minimum:

1. Objective
2. Review of design steps, if any (be very concise and do not repeat material from the lab manuals)
3. Summary of individual controller designs clearly marked with student's name
4. Tabulated experimental data, charts, plots, etc.
5. Analysis, calculations, results, discussion, and evaluation, etc.
6. Answers to questions in the lab manual

Lab reports must be professionally done, preferably using a word processor. Lab reports must be written in a manner that is easy to follow while reading. That is, the order in which it is laid out should be in the order that the controller design is done, and in the order that the questions are asked. Also, figures and tables should be merged with the appropriate text, and not appended at the end of the report. There is no need to directly copy anything that is already in the lab manual, just for the sake of having a “formal” report. Points will be taken off if a lab report is hard to follow and grade. Controller gains from the design must clearly be stated in the report as this is a crucial result of design. Refer to the “Lab Report Rubric” document in the corresponding lab folder as a guide for what to include in each report.

Lab reports will be worth 60% of your grade for that lab unless otherwise noted by the TAs. Individual controller designs will be worth 30% and will be based on the summary of individual controller design in the lab report. An additional 10% will be based on peer-review.

All lab reports will be uploaded as a single pdf document on Canvas.

Important Notes on Lab Participation

1. You must perform all controller designs individually.
2. You must include a summary of your controller design results clearly marked by the student’s name as part of the lab report. (Note: Individual controller design is worth 30% of the grade for each experiment.)
3. You are reminded of the Georgia Tech Honor Code and any violations will be promptly reported to the proper Georgia Tech authorities.

Notes about the Lab

When you require help with the lab, please e-mail a TA to set up a time. Do not do any of the following:

1. Ask to see a TA during lab periods
2. Ask questions about anything but what you are supposed to be working on in lab

These are very important. The TAs will not answer any questions during the lab hours except to people who are supposed to be in there, and only about what they are supposed to be working on. If you need to see a TA and the controls lab is closed, please send the TA an e-mail.

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.

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: Vaccinate, Mask, Test

GT Safety Guidelines: <https://health.gatech.edu/tech-moving-forward>

Current guidance is summarized below, but continue to follow the site above and other Institute communications in case changes occur:

- If there is one thing each one of us can do to protect ourselves and keep others safe, it is to get vaccinated. The new vaccines have proven to be extraordinarily effective at preventing severe illness. [Getting vaccinated at Georgia Tech](#) easy and free.
- At Georgia Tech, everyone is encouraged to wear a mask or face covering while inside campus facilities.
- The free asymptomatic surveillance testing program remains available to all students and employees. You may participate in regular testing even if you have been fully vaccinated. We especially encourage those who have not been vaccinated to [get tested weekly](#).

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>