ECH 4323L Process Control Laboratory – Campus Sections
Spring 2021

Instructor: Kyle Griffin

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Office Hour via Zoom: TBA

Schedule: Once a week, 4:05-7:05 PM
First class (Introduction & Equipment Checking): Week of January 18 (Jan 19)
Monday is a holiday, so Monday students can choose between the campus Wednesday January 20 section at 5:35 PM (at that time the Wednesday section should have finished) or the Saturday January 16 online section at 1:55 PM.
To avoid overloading work during midterm exams there will be no lab the week of March 1. To accommodate the March 24 recharge day, there will be no lab the week of March 22. As there is a small number of students for the other recharge day (Thursday February 25) and as all other lab dates are needed, the Thursday students have the option of joining the Monday 2/22 or the Tuesday 2/23 campus sections or the Saturday 2/20 online section.

Specific course information

Laboratory work associated with ECH 4323.
Corequisites: ECH 4323
Required

Specific goals for the course:

Specific outcomes of instruction

- The student will be able to obtain data from an experimental system and use the data to build approximate open-loop models useful for controller tuning
- The student will be able to tune a proportional-integral-derivative controller (PID) in a closed loop implemented by an Arduino microcontroller.
- The student will understand the advantages and disadvantages of low pass filtering and will be able to tune such a filter

Student outcomes (ABET) addressed by the course

Outcome (2): An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

Outcome (6): An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw appropriate conclusions.

Course Topics:

- Modeling a physical temperature-control system of a water-filled container heated by a beverage heater and cooled by computer fans
- Linearizing the model of the temperature-control system
- Directly obtaining a first order plus time delay (FOPTD) transfer function model by fitting parameters to experimental data from step changes
- Directly obtaining a higher order transfer function model by fitting parameters to experimental data from step changes
- Directly obtaining transfer function models by fitting parameters to experimental data from pulse changes
- Designing PI and PID controllers for a FOPTD model using the Cohen-Coon and the minimization of integral-time-absolute-error methods, and experimentally testing their performance.
- Designing PI and PID controllers for FOPTD and higher order transfer functions using the Ziegler-Nichols method and experimentally testing its performance
- Experimentally investigating the effect of the filtering time constant on the performance of PID controllers

Experiments:

1. (week of 1/25) Intro to Process Control: Student competition on controlling the can temperature manually
2. (week of 2/1) Experiments to validate the energy balance model for the heater effect on the can temperature
3. (week of 2/8) Experiments used to build a model of the effect of fan speed on the heat transfer coefficient
4. (week of 2/15) Introduction to feedback control and the benefits of integral action
5. (week of 2/22) Step change experiments used to build a first order plus time delay (FOPTD) transfer function model
6. (week of 3/8) Testing the performance of PI controllers tuned using the Cohen-Coon and ITAE minimization methods applied to the transfer function of Experiment 5.
7. (week of 3/15) Pulse input testing and use of the data to build a FOPTD transfer function model and a Second Order Plus Time Delay (SOPTD) transfer function model.
8. (week of 3/29) Testing the performance of PI controllers tuned using the Cohen-Coon and ITAE minimization methods applied to the transfer function of Experiment 7.
9. (week of 4/5) Experiments to investigate the effect of derivative action and low-pass filtering.
10. (week of 4/12) Testing the performance of PI and PID controllers tuned by the Zieger-Nichols method applied to the FOPTD and SOPTD transfer functions of Experiment 7.
11. (week of 4/19) Student competition on controlling the can temperature with their deigned PI or PID controllers.

Required Text: None. Instructor notes are posted in the CANVAS learning management site.

Computer: Laptop computer running **Windows** and Excel is **required**

Additional Requirement: Arduino-based equipment for conducting experiments (provided)

Attendance Policy:

Attendance is required. Excused absences must be consistent with university policies in the undergraduate catalog (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx) and require appropriate documentation. Unexcused absences will significantly impact the class participation grade (see below).

Course Assessment:

- Lab reports 75%
  Each report question (or part of it) will be graded in a scale from 0 to 3, with a 3 earned only for perfect answers. Some assignments involve performing experiments.
- Final Controller Design Contest 20%
- Class attendance & participation 5%.

Detailed Explanation of Grading:

1. For each student, Overall Points are calculated as follows:

Overall Points = 0.75 * Lab Report Grade + 0.20 * Final Controller Design Grade +
0.05 * Class Participation Grade

where

- Lab Report Grade = (Total report points earned)/(maximum possible points) *100
- Class participation grade:
  88 if student never misses class (without excuse) and never speaks or messages. This number is multiplied by the fraction of times the student was present in class. Then the grade is raised according to how frequently a student answers or asks questions. Corrections of my lecture errors are especially noted. Also, participation during breakout room problem solving sessions may have a positive impact

2. The students are sorted in the order of decreasing overall points. Grades are then decided as follows:

Division between A and A- : Largest gap between two students with 90 >= overall points > 85
Division between A- and B+ : Largest gap between two students with 85 >= overall points > 80
Division between B+ and B : Largest gap between two students with 80 >= overall points > 75
Division between B and B- : Largest gap between two students with 70 >= overall points > 65
Division between B- and C+ : Largest gap between two students with 65 >= overall points > 60
Division between C+ and C : Largest gap between two students with 60 >= overall points > 55
Division between C and C- : overall points > = 50 (no gap here, 50 is C, 49.9 C-)
Division between C- and D+ : Largest gap between two students with 40 >= overall points > 35
Division between D+ and D : Largest gap between two students with 30 >= overall points > 25
Division between D and D- : Largest gap between two students with 5 >= overall points >= 0
(never happens)
E: Given to students for honesty violations

The class participation grade is designed so that a student who attends class regularly will not have an A grade lowered even if s/he never speaks. It helps attending students with lower overall points.

Other: Do not hesitate to ask questions both in class and outside class.

ADDITIONAL INFORMATION

Class Recordings

Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, https://www.dso.ufl.edu/drc) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor of this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

• Your academic advisor (Me or Cynthia Sain)

• Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu

• Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu

• Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Campus Resources:

Health and Wellness

U Matter, We Care:
Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.ufl.edu/.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://care.dso.ufl.edu.

On-Line Students Complaints*:* http://www.distance.ufl.edu/student-complaint-process.