ECH 4323 Process Control Theory
Spring 2020

Instructor: Spyros A. Svoronos

Office Phone: 352-392-9101 (preferred over e-mail)
Home Phone: 352-378-1342 (only way to reach me during weekends)
E-mail: svoronos@ufl.edu (checked M-F)
E-mails must include a call-back phone number.
Without it, they may not receive a response.
Office: 264 Chemical Engineering Student Center
Office Hours: M 5:15 - 6:30 PM, W 2:00 - 3:00 PM, F 3:00- 4:00 PM
- In addition, I have an open door policy, but I am not available 45 minutes before class time or mornings

Specific course information

The analysis and automatic control of process systems in chemical engineering.

Corequisites: ECH 4323L

Required

Specific goals for the course:

Specific outcomes of instruction

1. The student will be able to draw feedback and feedforward control loops.
2. The student will be able to formulate dynamic models for chemical engineering systems and to perform model-linearization procedures
3. The student will be able to obtain approximate process models from experimental data
4. The student will be able to use and tune proportional-integral-derivative controllers
5. The student will be able to analyze the performance and stability of linear control systems, both open loop and closed loop

Student outcomes (ABET) addressed by the course

Outcome (1): An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

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.

Course Topics:

- Introduction to feedback and feedforward control
- Nonlinear state space models and their linearization
- Laplace transforms, transfer functions, and open-loop stability
- First-order plus time delay systems and approximate transfer functions from experimental data
- The PID control law and low-pass filtering
- Velocity and position forms of the discrete PID control law
- Frequency response analysis
- Closed-loop stability analysis
- Controller tuning methods

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

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 (Integrated with ECH 4323L):

- Exam 1, Monday February 24, 7:00 or 8:00 PM — 35%
  A review will be held Friday February 21 starting at 5:10 PM
- Exam 2, Monday April 27, 10:00 AM — 35%
  A review will be held Thursday April 23 starting at 2:00 PM
- Classwork and Homework — 25%
  Each homework/classwork problem (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.
- Class attendance & participation — 5%.

Detailed Explanation of Grading:

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

Overall Points = 0.35 * Exam1 Grade + 0.35 * Exam2 Grade + 0.25 * Homework/Classwork Grade + 0.05 * Class Participation Grade

where

- Exam grades are 0-100
- Homework/Classwork Grade = (Total homework points earned)/(maximum possible points) *100
- Class participation grade:
  88 if student never misses class (without excuse) and never speaks. This number is multiplied by my estimate of 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. However, if a student is engaged in obvious non-class activity (reading paper, having laptops on when lecture is not involving computer, etc), that student is considered absent. If you are using your laptops for taking class notes, you are encouraged to notify me of that (I may sometimes ask you to see your notes after a class).

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

Students Requiring Accommodations

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Course Evaluation

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University Honesty Policy

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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:

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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.

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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.

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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

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

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