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:

   \[
   \text{Overall Points} = 0.35 \times \text{Exam1 Grade} + 0.35 \times \text{Exam2 Grade} + 0.25 \times \text{Homework/Classwork Grade} + 0.05 \times \text{Class Participation Grade}
   \]

   where

   - Exam grades are 0-100
   - Homework/Classwork Grade = \((\text{Total homework points earned})/\text{(maximum possible points)}\) *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 \(90 \geq \text{overall points} > 85\)
   Division between A- and B+: Largest gap between two students with \(85 \geq \text{overall points} > 80\)
   Division between B+ and B: Largest gap between two students with \(80 \geq \text{overall points} > 75\)
   Division between B and B-: Largest gap between two students with \(70 \geq \text{overall points} > 65\)
   Division between B- and C+: Largest gap between two students with \(65 \geq \text{overall points} > 60\)
   Division between C+ and C: Largest gap between two students with \(60 \geq \text{overall points} > 55\)
   **Division between C and C-:** overall points \(\geq 50\) (no gap here, 50 is C, 49.9 C-)
   Division between C- and D+: Largest gap between two students with \(40 \geq \text{overall points} > 35\)
   Division between D+ and D: Largest gap between two students with \(30 \geq \text{overall points} > 25\)
   Division between D and D-: Largest gap between two students with \(5 \geq \text{overall points} \geq 0\) (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

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

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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.

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Academic Resources

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


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/.


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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

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