

# Course Syllabus

**Course Number/Name:** CHE 450: Process Dynamics and Control

**Credits:** 3

**Prerequisites:** CHE 210.

In addition, prerequisite understanding of:

- Laplace
- Partial fraction
- Working knowledge of numerical

**Delivery:** Online

**Course Overview:** The course is an introduction to process control theory. Two objectives will be pursued. The first part of the course will be devoted to the analysis of the dynamic behavior of processes described by linear models. The second part of the course will cover introductory control methods that allow modifying the dynamic behavior of these processes in a desirable way.

**Instructor Information:** Dr. Antonios Armaou | 230 Chemical and Biomedical Engineering Building | 814.865.5316 | armaou@psu.edu

## Course Materials

- **Required:** *Process Control: Designing Processes and Control Systems for Dynamic Performance Process Systems Analysis and Control*, T. Marlin, 2nd ed., available free on-line.
- **Optional References:**
  - - *Process Systems Analysis and Control*, D.R. Coughanowr & S. E. LeBlanc, McGraw-Hill, 3rd ed.,
    - *Introduction to Process Control*, J.A. Romagnoli & A. Palazoglu, CRC Taylor & Francis, 2nd ed.
    - *Process Control A first Course with MATLAB*, C. Chau, Cambridge University Press, 2002.
    - *Process Dynamics and Control*, D.E. Seborg, T.F. Edgar and D.A. Mellichamp, Wiley,
    - *Chemical and Bioprocess control*, J Riggs & M. Karim, Ferret Publishing, 2016.

- *Modern Control Engineering*, K. Ogata, Prentice Hall, 5th ed.,
- *Modern Control Systems An introduction*, S. M. Tripathi, Jones & Bartlett Learning, 2008

## Library Resources

Many of Penn State's library resources can be utilized from a distance. Through the University Libraries website, you can

- access magazine, journal, and newspaper articles online using library databases;
- borrow materials and have them delivered to your doorstep...or even your desktop;
- get research help via e-mail, chat, or phone using the [Ask a Librarian service \(Links to an external site.\)](#); and much more.

You must have an active Penn State Access Account to take full advantage of the University Libraries' resources and services. Once you have a Penn State account, you will automatically be registered with the library within 24–48 hours. If you would like to check that your registration has been completed, visit the [Libraries home page \(Links to an external site.\)](#), click on **Library Accounts**, and then click on **My Library Account**.

## Course Outline

The course will cover the following topics in the order presented.

- **Part A: Modeling and Dynamic Analysis**
  - Linear algebra concepts
  - mathematical modeling of chemical processes; linearization of dynamic
  - Analytical solution of linear ordinary differential equations (Laplace transforms & state-space).
  - Transfer functions; poles and
  - State-space models;
  - First-order & higher-order systems.
  - Stability of open-loop
- **Part B: Classical Control**
  - Classical feedback controllers; Proportional (P)
  - closed-loop process dynamics; closed-loop
  - Controller tuning; analysis of closed-loop
  - Proportional Integral (PI), Proportional-Integral-Derivative (PID) controller

- State-space controller synthesis
- **Part C: Modern Control**
  - Multiloop control: Feedforward/feedback control; cascade
  - When the output cannot be measured; observer

## Course Requirements & Grading

- **Homework:** Homework will be assigned weekly on Friday (starting 2nd week) and will be due the following week. All homework will be submitted in Canvas & PDFs are requested. If computational code is used, it will also be submitted in a ZIP file with the following naming convention for individual codes: **psuid HW# Q#.m (e.g. dwc179 HW3 Q2.m)**. The complete name will be included as a comment at the beginning of the computer code script. The homework solutions will be posted on CANVAS after the due date. Credit for late homework will be given only in special cases and only if submitted before the distribution of the solutions. The homework grade will reflect the correctness of the solution as well as clarity in the presentation and neatness in form. In the case of grading dispute, please submit the original with a cover page describing exactly what is disputed. The entire homework will be reviewed and returned to you with the final judgment
- **Exams:** There will be one midterm and one final exam. The exams will be testing all material covered in lectures and reading assignments, from the beginning of the course until the exam date, with special emphasis on the material that has not been covered by the previous exam. The exam format will be announced, pending new on-line examination resources available to the student body.

## Assignments

Assignment Group	Percentage
Homework	30%
Midterm Exam	30%
Final Exam	40%
<b>Total</b>	<b>100%</b>

## Grading Scale

<b>Percentage</b>	<b>Letter Grade</b>
100% - 93%	A
< 93% - 90%	A-
< 90% - 87%	B+
< 87% - 83%	B
<83% - 80%	B-
< 80% - 77%	C+
<77% - 70%	C
< 70% - 60%	D
< 60%	F

**Note:** You are encouraged to discuss the issues raised by the material of the course, however, you are expected to work on assigned problems independently. In the case of plagiarism or cheating, zero credit will be given for the work in question to all parties implicated.

## University Policies:

### Academic Integrity

This course adheres to University Senate Policy 49-20: “Academic integrity is the pursuit of scholarly activity in an open, honest, and responsible manner, serving as a basic guiding principle for all academic activity. Academic integrity includes a commitment not to engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty violate the fundamental ethical principles of the University community and compromise the worth of work completed by others.” Unless explicitly directed otherwise by the instructor, all assignments are expected to be the student’s own original work completed individually without collaboration. Violations of this code of conduct can result in reduced grades and can be reported to the College or University for further action.

## **Statement of Compliance with the Americans with Disabilities Act**

Penn State welcomes students with disabilities into the University's educational programs. If you have a disability-related need for reasonable academic adjustments, contact the Office for Disability Services (ODS) at 814-863-1807 (V/TTY). For further information regarding ODS, please visit the Office for Disability Services website at <http://equity.psu.edu/ods/>. In order to receive consideration for course accommodations, you must contact ODS and provide documentation (see the documentation guidelines at <http://equity.psu.edu/student-disability-resources/guidelines>). If the documentation supports the need for academic adjustments, ODS will provide a letter identifying appropriate academic adjustments. Please share this letter and discuss the adjustments with your instructor as early in the course as possible. You must contact ODS and request academic adjustment letters at the beginning of each semester.

## **Information about How to Contact Counseling and Student Health**

Students with academic concerns related to this course should contact the instructor in person or via email. Students also may occasionally have personal issues that arise in the course of pursuing higher education or that may interfere with their academic performance. If you find yourself facing problems affecting your coursework, you are encouraged to talk with an instructor and to seek confidential assistance at the Penn State Counseling and Psychological Services (CAPS) Center at (814) 863-0395. Visit their website for more information <http://studentaffairs.psu.edu/counseling/>. Also, crisis intervention is always available 24/7 from Centre County CAN HELP (1-800-643-5432), or contact University Police at (814) 863-1111.

## **Statement Regarding Discrimination**

As an institution of higher education, The Pennsylvania State University is committed to making post-high school education available to all who possess a high school diploma or its equivalent without regard to personal characteristics not related to ability, performance, or qualifications. The Pennsylvania State University does not discriminate against any person because of age, ancestry, color, disability or handicap, national origin, race, religious creed, sex, sexual orientation, or veteran status. Bias can be reported anonymously to the website “reporting bias on campus” <http://equity.psu.edu/reportbias>.