CHEG 401 Chemical Process Dynamics and Control
Fall 2020

Locations

Class	ON-LINE (205 Gore)	MW 3:35 pm – 4:50 pm
Lab	ON-LINE (046 Colburn)	W 10:10 am-12:00 pm; W 1:15-3:05 pm

Instructors

Babatunde A. Ogunnaike 205 Colburn ogunnaike@udel.edu
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Teaching Assistants

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Textbook

Process Dynamics, Modeling, and Control
Babatunde A. Ogunnaike and W. Harmon Ray
Oxford University Press, New York, 1994
(Supplemented with draft chapters from the 2nd Edition currently in preparation)

Course Description and Policies

Objectives

This course covers the analysis of process dynamics and its use in designing automatic control systems. These two topics are covered sequentially, with the emphasis on feedback control of linear systems. However, more advanced topics, including multivariable control, digital control and model predictive control, are also introduced.

Information

The course will make use of CANVAS for posting of course handouts, homework solutions, grades, etc. However, please do not use e-mail or comments within CANVAS

for communicating with the instructors or the TAs; the e-mail addresses given above should be used for that purpose instead.

Homework

Problem sets should be handed in *before the start of class* on the due date; late hand-ins will not be accepted. A minimum of 50% of the maximum homework points is required to receive a passing grade in the course.

Answers handed in should have each problem starting on a new page, the problems arranged in the proper numerical sequence, and all pages stapled together. Your name should be printed neatly in the upper right-hand corner of each page of your assignment.

You may choose to work on homework assignments individually or in groups. The impact of homework assignments on your grade is determined much more by the influence the experience has on your exam performance than by the numerical grade given to the homework problems. Make sure that you maximize your learning experience by balancing the extent to which you rely on group input versus your individual effort. If you work in a group, each member must prepare his/her own written answers based on the group discussion, and list all the members at the beginning of the problem.

Computer Lab

The lab portion of the course is a computer lab in which Matlab and Simulink will be used to simulate the dynamics of open- and closed-loop systems; such simulations are especially critical in optimizing the design and tuning of controllers. The lab is an integral part of the course, and the knowledge and abilities developed in the lab will be required to work homework problems and the second midterm exam. Although lab reports may be prepared by students working in pairs, all students are expected to develop the expertise covered in the lab and should be able to use the simulation methods independently.

Make-up exams

No make-up exams will be given, because they constitute a different exam taken at a different time by only a few students. If you have a valid excuse (according to University rules) to miss a midterm exam, the grade for the missed exam will be prorated such that the other exams will carry an appropriately increased percentage of your overall course grade. If you miss the final or any other exam without acceptable justification you will be assigned a zero. If you do have acceptable justification to miss the final exam you must make arrangements to take it at another date. A note from the attending physician is required in case of medical excuses.

Academic honesty

The University has explicit rules on academic honesty (https://www1.udel.edu/stuguide/18-19/code.html) that will be strictly enforced.

Syllabus and Provisional Schedule

1. Introduction to Process Control **Wed Sept 2**
Reading: Ogunnaike and Ray, Chapters 1 & 2

Computer Lab 0: Introduction to MATLAB/SIMULINK *Wed Sept 2*

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2. Process Modeling and Review of Math Tools **Mon Sept 7**
Reading: Ogunnaike and Ray, Chapter 4, 10

3. Basic Elements of Dynamic Analysis **Wed Sept 9**
Reading: Ogunnaike and Ray, Chapter 3

Computer Supplement: MATLAB Exercises *Wed Sept 9*

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4. Low Order Systems **Mon Sept 14**
Reading: Ogunnaike and Ray, Chapter 5

5. Higher Order Systems **Wed Sept 16**
Reading: Ogunnaike and Ray, Chapter 6

Computer Lab 1: Implementing Process model Equations in SIMULINK *Wed Sept 16*

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6. Inverse Response and Time Delay Systems **Mon Sept 21**
Reading: Ogunnaike and Ray, Chapters 7 & 8

7. Nonlinear Systems **Wed Sept 23**
Reading: Ogunnaike and Ray, Chapter 10

Computer Lab 2: Open-loop process dynamics *Wed Sept 23*

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8. Stability **Mon Sept 28**
Reading: Ogunnaike and Ray, Chapter 11

Computer Lab: No lab *Wed Sept 26*

9. Process Identification **Wed Sep 30**
Reading: Ogunnaike and Ray, Chapter 13

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10. Midterm Exam I **Mon Oct 5**

Computer Lab 3: Process identification *Wed Oct 7*

11. Intro to Feedback Control Systems **Wed Oct 7**
Reading: Ogunnaike and Ray, Chapter 14

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12. Conventional Design Methods **Mon Oct 12**
Reading: Ogunnaike and Ray, Chapter 15

Computer Lab 4: Feedback control *Wed Oct 14*

13. More Complex Control Structures **Wed Oct 14**
Reading: Ogunnaike and Ray, Chapter 16

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14. Inverse Response and Time Delay **Mon Oct 19**
Reading: Ogunnaike and Ray, Chapter 17

Computer Lab 5: Cascade control *Wed Oct 21*

15. Model-based Control **Wed Oct 21**
Reading: Ogunnaike and Ray, Chapter 19

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16. Midterm Exam II (Take Home) **Mon Oct 26**

Computer Lab 6: Feedforward control *Wed Oct 28*

17. Introduction to Multivariable Processes **Wed Oct 28**
Reading: Ogunnaike and Ray, Chapter 20

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18. RGA and Multiple Single Loop Designs **Mon Nov 2**
Reading: Ogunnaike and Ray, Chapter 21

Computer Lab: No Lab *Wed Nov 4*

19. Multivariable Controller Design **Wed Nov 4**
Reading: Ogunnaike and Ray, Chapter 22

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20. Introduction to Digital Control **Mon Nov 9**
Reading: Ogunnaike and Ray, Chapters 23 & 24

Computer Lab 7: Model-based Control-IMC/Discrete Control *Wed Nov 7*

21. Introduction to Digital Control **Thurs Nov 8**
Reading: Ogunnaike and Ray, Chapters 23 & 24

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22. Statistical Process Control **Mon Nov 16**
Reading: Ogunnaike and Ray, Chapter 28

Computer Lab 8: Multivariable Control *Wed Nov 18*

23. Model Predictive Control **Wed Nov 18**
Reading: Ogunnaike and Ray, Chapter 27

Thanksgiving Break **Mon Nov 23**

Computer Lab: No Lab *Wed Nov 25*

Thanksgiving Break **Wed Nov 25**

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24. Control Case Studies **Mon Nov 30**
Reading: Ogunnaike and Ray, Chapter 30

Computer Lab: No lab *Wed Dec 2*

25. Introduction to Biological Control Systems **Wed Dec 2**
Reading: *Ogunnaike and Ray, 2nd Ed. Chapter 14*

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26. Guest Lecture: Industrial Practice of Process Control **Mon Dec 7**

Computer Lab: No lab *Wed Dec 9*

27. Review and Summary **Wed Dec 9**

Final Exam **Date and location TBD**

Grading Summary

Homework:	100
Lab modules: 8	80
Exams: 2 (1 x 100, 1 x 120)	220
Final	200
Total	**600**

Homework Schedule

HW #	Topic	Assigned Date	Due Date
1	Review of Math Tools Dynamics	Sep 7	**Sep 14**
2	Low Order Systems	Sep 14	**Sep 21**
3	Higher Order, Inverse response, time delay	Sep 21	**Sep 28**
4	Stability/Process Identification	Oct 5	**Oct 12**
5	Feedback Control	Oct 12	**Oct 19**
6	Feedforward/Cascade Control	Oct 19	**Oct 26**
7	Multivariable Control	Nov 9	**Nov 16**
8	Model-Based/ Discrete Control	Nov 16	**Nov 30**
9	Review	Nov 30	**Dec** 7