ECE 3510

Introduction to Feedback Systems

Fall 2022 Class Syllabus

Instructor: Arn Stolp
Office: MEB 2262
Phone: U of U: 581-4205
Cell: **(801) 657-7766 Always text first & start text with "ECE 3510"**. This is the best way to contact me. I may call back from (385) 429-3439 (a google voice number). Do not initiate contact on the 385 number.
E-mail: arnstolp@ece.utah.edu. I don't check my e-mail as often as I should, so text me if you send me email that I need to read. DO NOT use other email addresses.
Office hours: My "office hours" are the problem sessions at the end of class. Otherwise it's catch me if you can. To increase your chances, talk to me after class. I'm usually around between 12:20 a.m. & 2 p.m. T & Th. If I'm not in my office, check the lab.
DO NOT send messages via Canvas. I don't have the time to monitor them.

Web Site: http://www.ece.utah.edu/~ece3510/

Required books and lab supplies:
Textbooks: Introduction to Feedback Systems, by Marc Bodson, available free at http://www.ece.utah.edu/~bodson/ifs/
Control Systems Engineering, 3rd , 4th or 5th ed. by Norman S. Nise
Ring binder for the Bodson text and additional materials to be handed out in class.
Lab notebook (bound or spiral)
Super-strip (bread-board) and some money on your U-card to buy parts

Prerequisites: C- or better in ECE 2260

Introduction:

When you're walking down the sidewalk, how do you actually stay on the sidewalk? "Duh, I watch where I'm going", you say. Well, that's feedback. You use your vision to detect which way the sidewalk leads as well as which way you are moving and adjust your direction to minimize the difference between the two. The sidewalk direction is the input, you are the system, and your movement direction is the output. Detecting your direction and using that information to adjust your direction is feedback.

Your body uses feedback control systems to automatically regulate your internal temperature, heart-rate, blood sugar, etc. etc.. Without feedback systems you'd be dead by this afternoon! Feedback is important stuff! Any system that uses a sensor to regulate or control what the sensor is measuring is a feedback system. Engineers use this concept extensively.

This class will introduce you to some of the basics of feedback and control systems and the math used to analyze, design, and stabilize these systems.

I teach concepts and the use of those concepts to solve problems, not formulas and memorization. The hands-down easiest way get a good grade in this class is to *learn* those concepts.

This class consists of:

Lectures: M, W & F 10:45 -12:08 am. WEB L208

Lectures set the direction and tone of the class and cover more than the written material. You will be held accountable for everything discussed in the lectures, so your attendance is important.

Supplemental Example / Problem Sessions: on Zoom

We cover a lot of material in this class and there is rarely enough lecture time to cover everything in the reading assignments, to work as many examples as most students would like, or to answer your questions in detail. These supplemental sessions will make the class much easier to follow with less outside reading and study time.

Textbook:

The main textbook was written by Dr. Marc Bodson, who taught this class for many years. The secondary textbook is an older edition of a popular control-systems textbook which you will have to buy on-line.

Handouts:

There will be a number of handouts for, homework, labs, notes, etc.. I may hand these out before class or may have to download them from the class web site; http://www.ece.utah.edu/~ece3510/.

Homework, homework, and more homework: 14%

I will assign a lot of homework, it will be your main study tool. As such, I'll give you all the numeric answers so that you can check your work immediately. In fact, you'll have to self-correct your homework. If you can't get the answer, check the web site for corrections, study some more, come to the problem session, or ask for help.

Your homework should be neat and clear and show all your work. For most problems the grader will simply check to see that you've done it and that your paper shows the necessary work to get the answer. Only a few problems will be checked in greater detail. You may collaborate with others to learn how to do the homework, but will need to hand in your own work. Copying or allowing another student to copy your work is considered cheating.

You will probably learn more from doing the homework than any other part of this class. If you thoroughly understand the homework, you will know what the class is about, and the exams should give you no trouble.

You will need to scan your homework, create a .pdf file, and turn that in on canvas by 11:59 pm of the due date. Solutions will be posted in my office window. Most graded material will be returned on Canvas.

Midterms: (300 exam pts) 43.75%

You will take three 50-minute midterms throughout the semester. They will cover material up to the time of the test. All exams are closed book, closed notes, no phones, tablets or computers allowed. These exams will be in two parts, a no calculator, no reference material part where I ask for items that you should have committed to memory, and a part with *some* reference material where I will ask you to solve problems that may require your calculator. This part is designed to see if you learned concepts and problem solving strategies and whether you can work with them, sometimes in new and different ways. I want to find out how much you *know*, not how quickly you can find a similar example. Don't try to memorize specific problems. Exams also cover what you learn in the labs. Exams will be returned in class or to a file cabinet in MEB 2365. They will be an unlocked drawer and will **not be secure**. If you want your material returned to a locked location, simply remove your file and slip it under my office door.

Final: Monday, 12/12/22 10:30 - 12:30 pm (180 exam pts) 26.25%

The final will be comprehensive with greater emphasis on the most recent material. It may also be in two parts. There will be a zoom review session. Listen for details in class.

Labs: MEB 2365 16%

Lab will be held every week, beginning the second week and including the last week of class. Many of the subjects covered in lab aren't covered anywhere else in class, so make sure you pay attention and read the lab instructions. You will have to keep a laboratory notebook as a requirement of the lab. Your lab TA will collect and grade these notebooks.

Labs are **not optional.** For each lab that you miss or fail (< 60% score), your final grade will suffer a **half letter drop** (5% of possible points). Be sure to make-up any labs you miss or fail.

Grades:

Homework:	14%
Labs:	16%
Exams:	70%
Total:	100%
Failed lab:	-5%
Cheating:	-100%

% of total	Grade
> 93	A
90-93	A-
87-90	B+
83-87	B
80-83	B-
77-80	C+
73-77	C
70-73	C-
67-70	D+
63-67	D
60-63	D-
< 60	E

If you want any deviations from the normal requirements, you will need to see me before the work would normally be due and get an agreement *in writing*. You'll need to turn in your copy of the agreement with your final, so I'll remember to grade you properly.

Disclaimer:

All information provided here is subject to change due to external factors or unintended typos or errors.

ECE 3510 Fall Semester, 2022

A. Stolp 8/26/22

Month	Week	Mon	Tue	Wed	Thur	Fri
Aug	1	22	23	24	25	26 Last day to add or drop simply
	2	29	30	31	1	2 Last day to reverse CR/NC
Sept	3	5 Labor Day	6	7	8	9
	4	12	13	14	15	16
	5	19	20 Exam 1	21	22	23
	6	26	27	28	29	30
Oct	7	3	4	5	6	7
		10 Fall break	11	12	13	14
	8	17	18	19	20 Exam 2	21 Last day to withdraw
	9	24	27	26	27	28
Nov (tue)	10	31	3	2	3	4
	11	7	10	9	10	11
	12	14	15 Exam 3	16	17	18
	13	21	22	23	24 Thanksgiving	25
	14	28	29	30	1	2 Last day to add or drop or elect CR/NC
Dec	15	5	6 ME Design Day in Union bldg (maybe)	7	8 Last Day of Classes	9 Reading Day
	16	12 Finals ECE 3510, 10:30	13	14	15	16

ECE 3510 Fall Semester, 2022

ECE 3510

A. Stolp

Tentative

01/09/22

Fall 2022 COURSE SCHEDULE

Week		Date	lect	Topics	Books Bodson	Nise
1	T	08/23	1	Introduction to Feedback Systems, Block diagrams	1.1	1.1 - 6
				Transfer functions and signals, The Laplace transform of signals	2.1	2.1
				The Laplace transform, Relationship between pole locations and signal shapes	2.1	2.2
	T	08/30	3	Inverse of Laplace transforms using partial fraction expansions	2.2 - 3	2.2
	Th	09/01	4	Inverse of Laplace transforms, Properties of signals	3.1	2.2
3	M	09/06		Labor Day		
3	T	09/06	5	Transfer functions, Interconnected systems, Feedback system	3.1	2.3, 5.1,2
				Systems, Circuits, BIBO stability	3.2	2.4
				Responses to step inputs, % overshoot, effect of zeros	3.3	4.1 - 4.5
4	T	09/13	7	Responses to sinusoidal inputs, sinusoidal steady-state	3.4	4.6 - 8
				Effect of initial conditions, State-space advantages	3.5 - 6	3.5
				Electrical analogies of mechanical systems	notes	3.1 - 3
5	T	09/20		Exam 1		
	Th	09/20	9	Electrical analogies of mechanical systems	notes	2.5 - 9
6	T	09/27	10	Stability and Performance of Control Systems	4.1	6.1
				Control system characteristics	4.1	7.1
				Steady-state error and integral control	4.2	7.2 - 5
				Routh-Hurwitz stability test	4.3	6.2 - 5
7	T	10/04	12	Root-locus introduction, main rules RL1	4.4	8.1 - 5
				Root-locus main rules, examples fill in from screen	4.4	8.5 - 7
	S	10/08		Fall Break		
	Su	10/16				

					Books	
					Bodson	Nise
8	T	10/18	14	Root-locus additional rules, examples fill in from screen	4.4	9.1 - 3
				Root-locus design, PI, Lag, PD, Lead	4.4	9.4 - 5
				PID, Lag - lead, Catchup and Review		
	Th	10/20		Exam 2		
9	T	10/25	15	Root-locus design, PI, Lag, PD, Lead	4.4	9.4 - 5
				Pole dominance, Physical realization,	notes	9.6
				PID tuning and Relay logic	notes	
				Ladder Logic & Programmable Logic Controllers (PLCs)	notes	
10	T	11/01	17	Ladder Logic & Programmable Logic Controllers (PLCs)	notes	
				Frequency-Domain Analysis of Control Systems, Bode plots	5.1	10.1 - 2
				Bode Plots complex poles & zeros, ζ, ω_n	5.1	10.2
11	T	11/08	19	Bode Plots to Transfer functions	5.1	10.13
				Gain, phase and delay margins	5.1, 3	10.6-7, 12
				Amplifier Feedback, Frequency Response and Op-Amp Compensation	notes	
12	T	11/15		Exam 3		
	Th	11/17	21	Amplifier Feedback, Input and Output Impedance	notes	
13	T	11/22	22	Relation to transient response, Frequency-Domain Design	5.3	10.8, 11
	Th	11/24		Thanksgiving		
					notes	
14	T	11/29	23	Discrete-time Signals and Systems	6.1	13.1 - 2
	T	11/29		Mechanical Engineering Design Day in the Union Ballroom, attendance require		
				The z-transform	6.1	13.3
15	T	12/06	25	Properties of the z-transform	6.2	13.3
	Th	12/08	26	Inversion of z-transforms	6.3	13.4
				Nyquist Criterion of stability, introduction	5.2	
	Su	12/11		Zoom Review		
	M	12/12		Final Exam, 10:30 -12:30		

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