Instructor: Mark Minor, 145B KNNB, minor@mech.utah.edu, 587-7771.
Office Hours: M W F 2:30-3:30pm, or by appointment.
Lecture Time: T TH 09:10 AM-10:30 AM
Lecture Location: EMRL 241
Lab Location: 2360 MEB

Course Objectives: The modeling, analysis, and control of nonlinear systems will be discussed. Specific topics include phase portraits, Lyapunov functions, linearized controllers, gain scheduling, linearizing controllers, sliding mode control, Lyapunov redesign, and backstepping. Autonomous and nonautonomous systems will be discussed.

Prerequisites: ME EN 6210 or 5210 and graduate status.

Required Text: H. Khalil, Nonlinear Systems, 3rd edition, Prentice Hall, ISBN 0-13-067389-7

Alt Ref: S. Sastry, Nonlinear systems: analysis, stability, and control, Springer, ISBN 0-38-798513-1

Homework Policies:
1. Homework must be submitted in the 145 Kennecott by 4:30pm on the date due.
2. Late homework will be marked down 20% per business day unless prior arrangements exist.
3. Discussion of homework and teamwork is encouraged, but each student must complete each assignment individually. Figures and computer programs CANNOT be shared.
4. Grading: each homework problem will be evaluated on a 3-point scale: 3 = good effort, results, and technique; 2 = modest effort with some incorrect technique or results; 1 = poor effort or technique; and 0 = no attempt.
5. It is the students' responsibility to compare their results to homework solutions and find errors in their work.
6. Grader: Y. Kim, 145 KNNB, youngshik.kim@utah.edu, 587-9018.

Exam Policies:
1. Examinations must be taken at the scheduled time unless prior arrangements are made at least two weeks before the exam.
2. Accommodations will be arranged if a student has a special requirement due to a disability. It is the responsibility of the student to request these accommodations at least two weeks prior to the exam and provide documentation specifying the arrangements from the University of Utah Center for Disability Services (see statement below for contact information).
3. Any students cheating on an exam will receive a failing grade for the class.

Grade Weightings: Homework: 25%
                    Project: 15%
                    Midterm Exam: 25%
                    Final Exam: 35%

Disability Services:
The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the instructor and to the Center for Disability Services, 162 Olpin Union Building, 581-5020 (V/TDD) to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification.

College Announcements: See www.coe.utah.edu/guidelines.pdf for additional information about changes in policy regarding appeals and repeating, withdrawing, and adding classes.

SCHEDULE
(subject to change)

No	DATE	TOPIC	READING	HW Due*
1	1/7	Introduction	1.1-1.2	
2	1/9	Second-Order Systems	2.1-2.3	
3	1/14	Second-Order Systems	2.4-2.5	HW 1: 1.4, 1.15, 1.17, 2.1, 2.3
4	1/16	Second-Order Systems	2.6-2.7	
5	1/21	Fundamental Properties: Existence, Uniqueness, Continuity, and Differentiability	3.1-3.3	HW 2: 2.4, 2.9, 2.17, 2.20, 2.28
6	1/23	Fundamental Properties: Comparison Principle	3.4	
7	1/28	Lyapunov Stability: Autonomous Systems	4.1	HW 3: 3.1, 3.8, 3.16, 3.14
8	1/30	Lyapunov Stability: Invariance Principle & Linear Systems	4.2-4.3	
9	2/4	Lyapunov Stability: Comparison Functions & Nonautonomous Systems	4.4-4.6	HW 4: 4.1, 4.3, 4.6, 4.28, 4.29
10	2/6	Lyapunov Stability: Converse Theorems	4.7	
11	2/11	Lyapunov Stability: Boundedness, Input-to-state stability	4.8-4.9	HW 5: 4.37, 4.41, 4.44
12	2/13	Input-Output Stability: L stability, L2 gain	5.1-5.3	
13	2/18	Input-Output Stability: Small Gain Theorem	5.4	HW 6: 4.54, 4.55, 5.1, 5.10 (1)
14	2/20	Passivity	6.1-6.4	
15	2/25	Passivity & Frequency Domain	6.5, 7.1	HW 7: 5.15, 6.2
16	2/27	Frequency Domain: Describing Function	7.2	
17	3/ 4	Feedback Control: Intro and Linearization	12.1-12.2	HW 8: 6.11, 6.15, 7.10(1)-(3), 7.11(1)
18	3/6	Midterm (covers through and including HW 7)		
19	3/11	Feedback Control: Integral control	12.3-12.4	HW 9: 12.2
20	3/13	Feedback Control: Gain Scheduling	12.5	
	3/18	Spring Break		
	3/20	Spring Break		
21	3/25	Feedback Linearization	13.1-13.2, Supplemental	HW 10: 12.8 (skip parts e, h, i, and j)
22	3/27	Feedback Linearization	13.2-13.3	
23	4/1	Feedback Linearization	13.4	HW 11: 13.2, 13.4
24	4/3	Nonlinear Design Tools: Sliding Mode Control	14.1	
25	4/8	Nonlinear Design Tools: Sliding Mode Control	14.1	HW 12: 13.11, 13.17
26	4/10	Nonlinear Design Tools: Lyapunov Redesign	14.2	
27	4/15	Nonlinear Design Tools: Lyapunov Redesign	14.2	HW 13: 14.1, 14.5
28	4/17	Nonlinear Design Tools: Backstepping	14.3	
39	4/22	Nonlinear Design Tools: Backstepping	14.3	HW 14: 14.14, 14.30
30	5/1	*Final Exam, Thursday, May 1, 8:00 - 10:00 a.m.*		

Notes: * All homework is due by 4:30 pm in 145 Kennecott on the date that the problems are listed.