ME 559/EE 587 – NONLINEAR CONTROL AND STABILITY – FALL 08

COURSE: ME 559/EE 587, Section 1: Nonlinear Control and Stability
Lecture: M W 4:40 – 5:55, 151 Willard
Lab: 243 Reber

DESCRIPTION: **NONLINEAR CONTROL AND STABILITY** (3) Design of nonlinear automatic control systems; phase-plane methods; describing functions; optimum switched systems; Liapunov stability; special topics in stability. Prerequisite: EE 380 OR ME 455.

INSTRUCTOR: Professor C. D. Rahn
150A Hammond, 865-6237, cdrahn@psu.edu
Office Hours: 3:30 – 4:30 MWF or by appointment

WEB PAGE: See ANGEL

TEXT: Slotine and Li, Applied Nonlinear Control, Prentice-Hall, 1991.

REFERENCES:

- Haddad and Chellaboina, Nonlinear Dynamical Systems and Control, Princeton, 2008.
- Freeman and Kokotovic, Robust Nonlinear Control Design, Birkhauser, 1996.
- H. Khalil, Nonlinear Systems, Prentice-Hall, Inc., 3rd edition, 2002.
- Astrom and Wittenmark, Adaptive Control, Addison-Wesley, 2nd edition, 1995
- Isidori, Nonlinear Control Systems, Springer-Verlag, 3rd edition, 1995
- Sastry, Nonlinear System: Analysis, Stability, and Control, Springer, 1999
- Vidyasagar, Nonlinear Systems Analysis, Prentice-Hall, 2nd edition, 1993
- Rahn, C., Mechatronic Control of Distributed Vibration and Noise, Springer, 2001.
- Spooner et al., Stable Adaptive Control and Estimation for Nonlinear Systems, Wiley, 2002.
- Lewis et al., Neuro-Fuzzy Control of Industrial Systems with Actuator Nonlinearities, SIAM, 2002.
- Fantoni and Lozano, Non-linear Control for Underactuated Mechanical Systems, Springer, 2002.
- Dixon et al., Nonlinear Control of Engineering Systems, Birkhauser, 2003.
- Krstic et al., Nonlinear and Adaptive Control Design, Wiley, 1995

GRADING: Subject to later revision, the five homeworks, midterm, project, and final exam will contribute to the final grade in the following percentages:

Homework (5)	**25%**
Midterm	**20%**
Project	**25%**
Final	**30%**

Homework and projects are due at the beginning of class on the date specified in the attached schedule. Late homework and projects will be accepted only under extenuating circumstances (*e.g.* illness or death in the family). Please see me **within one week** if you feel you have been graded unfairly. There will be no makeup midterms. If you are unable to attend the midterm due to extenuating circumstances and notify me in advance, I will release you from having to take the midterm and increase the final exam percentage to 50%.

ACADEMIC HONESTY: Students are expected to conform to the highest standards of honesty and integrity. Cheating of any kind will not be tolerated and any infraction will be rigorously prosecuted through the appropriate university channels. Students may work together in the preliminary stages of individual homework assignments but the final work must reflect individual efforts. The project requires group effort and is assigned a group grade. The College of Engineering academic integrity policy includes a statement of behaviors that are in violation of academic integrity and the review process for violations. (http://www.engr.psu.edu/www/ug/acad_int/students/default.htm).

CLASS ATTENDANCE: Class attendance is expected but not required. You are responsible, however, for all material discussed and presented in class. A significant portion of the lecture material will not directly follow the text. My notes will be posted on ANGEL.

COMPUTER USAGE: Some of the homework requires the use of the software package MATLAB and/or SIMULINK.

LABORATORY WORK: The course includes one project that you may use the equipment in the Controls laboratory (243 Reber). The lab is available (Combination =) whenever the Reber building is open. Eight experimental systems are currently available in the lab for use in ME 559.

PROJECT: The project will be performed in groups. Each lab group will be required to propose and complete a semester project. Each group member is expected to understand all project activities. The breakdown of responsibilities is up to the partners. A group report must be submitted for the project that is concise with a brief introduction/background/approach and experimental results with discussion. Projects should apply some of the advanced techniques introduced in the class and include analysis, design, simulation, and, if possible, experiments to verify performance. A project report and oral presentation are required.

LAB POLICIES:

- NO smoking, eating, or drinking in the lab.
- Only students registered for authorized courses (*e.g.* ME 559) are permitted to use the lab equipment.
- No removal of manuals, hardware, or software from the lab without explicit permission of the TA.
- Use floppy disks to backup all your work. We assume no responsibility for hard disk failures or viruses.

SCHEDULE:

Date		Lecture	Topic	Reading	Assignment	Assignment Due
25-Aug	M	1	Introduction	1		
27-Aug	W		"			
1-Sep	M	**LABOR DAY - NO CLASS**				
3-Sep	W	2	Phase Plane Analysis	2		
8-Sep	M		"		HW #1	
10-Sep	W	3	Fundamentals of Lyapunov Theory	3		
15-Sep	M	4	Autonomous Systems Stability			
17-Sep	W	5	"			
22-Sep	M	6	Non-Auto Stability	4	HW #2	HW #1
24-Sep	W		"			
29-Sep	M	7	Passivity			
1-Oct	W	8	Absolute Stability			
6-Oct	M		"		HW #3	HW #2
8-Oct	W	9	Describing Function Analysis	5		
13-Oct	M	10	Feedback Linearization	6		
15-Oct	W		"			
20-Oct	M	11	Input-State Fdbck Linearization		HW #4	HW #3
22-Oct	W	12	Sliding Control	7		
27-Oct	M		"			
29-Oct	W	**MIDTERM**				
3-Nov	M	13	Robust Control			
5-Nov	W		"		HW #5	HW #4 & Proposal
10-Nov	M	14	Adaptive Control	8		
12-Nov	W		"			
17-Nov	M		"			
19-Nov	W	15	Lyapunov-Based Fun			HW #5
24-Nov	M	**THANKSGIVING - NO CLASS**				
26-Nov	W					
1-Dec	M	16	Advanced Topics			
3-Dec	W		"			
8-Dec	M	17	Review			
10-Dec	W		Project Presentations			Project Report
FINALS WEEK - 12/15 - 12/19						