ME/ECE 859-Spring 2008
Nonlinear Systems and Control

- Instructor: Jongeun Choi; Room 2459 EB; Tel 517-432-3164; E-mail jchoi@egr.msu.edu; Class web http://www.egr.msu.edu/classes/me859/jchoi/
  Personal web http://www.egr.msu.edu/∼jchoi/
- Class schedule: M W F 9:10-10:00, Room 2320 EB.
- Office Hours: M 10:10-11:00 & 13:30-14:30, W 13:30-14:30, Room 2459 EB. Extra hours can be arranged by appointments.
- Textbook: H.K. Khalil, Nonlinear Systems, 3rd Ed., Prentice Hall 2002.
- Recommended Background: ECE/ME 851 Linear Systems and Control.
- Topics: Introduction to nonlinear phenomena (2 lectures). Second-order systems (4 lectures). Stability of equilibrium points and Lyapunov stability (7 lectures). Passivity (4 lectures). Input-state and Input-output stability (4 lectures). Special nonlinear forms (3 lectures). Stabilization (7 lectures). Robust stabilization (3 lectures). Tracking (2 lectures). Observers (4 lectures). Class project.
- Sample course outline and lectures by Prof. Khalil:
  http://www.egr.msu.edu/∼khalil/NonlinearSystems/Sample/
- Grading policy:

Homework	Project	Exam 1	Exam 2	Exam 3
25%	15%	20%	20%	20%

  - Homework: There are about 11 homework assignments, which will be posted at least a week before the due date. The lowest two homework grades are dropped.
  - Exams: All exams are open book and notes
  - Project: Each of students will choose a problem with some motivation. This will serve as a testbed problem throughout the class. Analysis and synthesis techniques from the class may be applied to the problem. The abstract, introduction, and results of the topic will be written in a technical paper format. The page limit of the final paper is 6. The IEEE conference paper format is strongly recommended:
    http://css.paperplaza.net/conferences/support/support.php. Each student will choose two papers to review based on the abstract. Reviewers will submit a one paged review report per each of assigned papers to the instructor. The presentation of the project at the end of the semester will facilitate the review process. The following paper review criteria will be used:

1. Is the paper suited as a nonlinear systems and control class project?
2. Evaluate the mathematical correctness of the paper (1-10).
3. Evaluate the contribution of the paper (1-5).
4. Is it easy to understand and concisely written? (1-5)
5. Support your scores for the previous items. Provide any comments, suggestions and feedback.

The total credit of the project (15%) will be based on the paper quality (7%), the presentation (3%), peer-reviews of the paper (3%) and the review reports on other papers (2%).

- Grading may be assigned using the following straight scale:

Percent	85-100	75-84	65-74	55-64
Grade	4	3.5	3	2.5

Table 1: A tentative lecture plan:

Lecture #	Date	General Topic	Lecture Topic	HW Due	Project Due
1	M 1/7	Introductions	Nonlinear models		
2	W 1/9		Examples		
3	F 1/11	2nd order sys.	Phase portraits		
4	M 1/14		Multiple equilibria		
5	W 1/16		Limit cycles		
6	F 1/18		Bifurcation	HW 1	
	M 1/21		No class MLK		
7	W 1/23	Stability of EPs	Basics & linearization		Abstract
8	F 1/25		Lyapunov's method		
9	M 1/28		Lyapunov's method		
10	W 1/30		Invariance principal	HW 2	
11	F 2/1		Exp stability & ROA		
12	M 2/4		Converse thm's & TVS		
13	W 2/6		Perturbed systems	HW 3	
14	F 2/8	Passivity	Memoryless & S models		
15	M 2/11		PRTF & Lyapunov	HW 4	
Exam 1	W 2/13				
16	F 2/15		Feedback systems		
17	M 2/18		Circle & Popov Criteria		
18	W 2/20	IS & IO stability	Ultimate bound & ISS		
19	F 2/22		Input-output stability		
20	M 2/25		L stability of S models	HW 5	
21	W 2/27		L_2 gain & small gain th		
22	F 2/29	Nonlinear forms	Normal form		
23	M 3/10		Controller form	HW 6	
24	W 3/12		Observer, output & SF		
25	F 3/14	Stabilization	Concepts & linearization		
26	M 3/17		Feedback linearization	HW 7	
27	W 3/19		Cascade systems		
28	F 3/21		Backstepping		
29	M 3/24		Passivity-based control	HW 8	
Exam 2	W 3/26				
30	F 3/28		Control Lypunov func		
31	M 3/31		Output feedback		
32	W 4/2	Robust stabilization	Sliding-mode control		
33	F 4/4		Sliding-mode control	HW 9	
34	M 4/7		Lyapunov redesign & BS		
35	W 4/9	Tracking	Feedback linearization & Sliding-mode control		
36	F 4/11		Eqlb. to eqlb. transition	HW 10	
37	M 4/14	Observers	Extended Kalman filter		
38	W 4/16		Exact observers		
39	F 4/18		Sliding-mode observers	HW 11	Final paper
Present.	M 4/21	Project presentation			
Present.	W 4/23	Project presentation			
40	F 4/25	Summary			Review reports
Exam 3					