ECSE-6420: Nonlinear Control Systems
FALL 2010

Instructor: Dr. Agung Julius (JEC 6044, Email: agung@ecse.rpi.edu, Phone: x6993)
Office hours: Tuesday, Wednesday; 14.00 – 15.00

Classroom: JEC 4304/ Monday,Thursday; 12:30 – 13:50
Textbook: Khalil, *Nonlinear Systems*, Prentice Hall, 3rd Edition

Grading:	Homework (6 sets)	40%
	Midterm Exam 1+2	20% + 20%
	Class Project Report	10%
	Class Project Presentation	10%

- Homework sets are due one week after hand-out at the end of the class. For each day late (**3 days max**), there is a 20pt penalty.
- There will be two (2) midterm exams in class.
- Class project consists of a report and presentation of a self-chosen topic (consult with instructor to avoid conflicts). Presentations will be graded by students.

Prerequisites: ECSE 6400 (System Analysis Techniques).

Summary:
This course discusses continuous time nonlinear dynamical systems. It consists of two main topics, nonlinear system analysis and nonlinear control techniques. The topics discussed in nonlinear system analysis include planar dynamical systems, existence and uniqueness of the solution of nonlinear differential equations, Lyapunov stability theory, frequency domain techniques, and singular perturbation. The control part discusses some controller design techniques for nonlinear systems, including design through linearization and Control Lyapunov Functions. This course also discusses some nontraditional application of nonlinear system theory in hybrid systems and systems biology. As a part of the course, each student undertakes a class project that explores the application of the theory and other topics of interest related to the course.

Learning Objectives:
The students are expected to:
- understand the fundamental differences between linear and nonlinear systems.
- understand the concept behind small gain theory and its applications.
- understand the different notions of system stability and their Lyapunov function characterization.
- understand the characterization of passive systems and its consequences,
- be able to design controllers for nonlinear systems using tools learned in this course.

Statement of academic integrity:
The Rensselaer Handbook of Student Rights and Responsibilities defines various forms of Academic Dishonesty and the students should make themselves familiar with these. All homework, quizzes and exam are expected to be individual work. You are allowed to work together for the homework. However, the writing must be your own (copying is not acceptable). One instance of unacceptable collaboration or plagiarism will result in 0 point for the work. A second instance of academic dishonesty will result in failure of the course.

Tentative Course Outline:

Date	Day	Topic	Remark
8/30	Mon	Intro, course structure, course overview.	
9/2	Thu	Nonlinear models and phenomena (Ch 1)	
9/9	Thu	Planar/Second order dynamical systems (Ch 2)	
9/13	Mon	Planar/Second order dynamical systems (Ch 2)	HW 1
9/16	Thu	Fundamental properties (Ch 3)	
9/20	Mon	Fundamental properties (Ch 3)	HW 1 due
9/23	Thu	Fundamental properties (Ch 3)	HW 2
9/27	Mon	Lyapunov stability (Ch 4)	
9/30	Thu	Lyapunov stability (Ch 4)	HW 2 due
10/4	Mon	Lyapunov stability (Ch 4)	HW 3
10/7	Thu	Lyapunov stability (Ch 4)	
10/12	Tue	Lyapunov stability (Ch 4)	HW 3 due
10/14	Thu	Input - Output Stability (Ch 5)	
10/18	Mon	Input - Output Stability (Ch 5)	
10/21	Thu	**EXAM 1 in class**	
10/25	Mon	Passivity (Ch 6)	
10/28	Thu	Passivity (Ch 6)	HW 4
11/1	Mon	Frequency domain analysis (Ch 7)	
11/4	Thu	Frequency domain analysis (Ch 7)	HW 4 due

11/8	Mon	Perturbed systems (Ch 9)	
11/11	Thu	Singular perturbation (Ch 11)	HW 5
11/15	Mon	Feedback control and linearization (Ch 12 - 13)	
11/18	Thu	Feedback control and linearization (Ch 12 - 13)	HW 5 due
11/22	Mon	Feedback control and linearization (Ch 12 - 13)	
11/29	Mon	**EXAM 2 in class**	
12/2	Thu	Project Presentation	HW 6
12/6	Mon	Project Presentation	
12/9	Thu	Project Presentation	HW 6 due