Syllabus for MAE281b
Nonlinear Control - Spring 2011

Jorge Cortés

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This course covers analysis and design of nonlinear control systems, and is the continuation of MAE281a. Topics include: small-gain theorem, passivity, nonlinear accessibility and controllability, feedback linearization, input-state and input-output linearization, zero dynamics, stabilization, Brockett's necessary conditions (local), control Lyapunov functions, Sontag's formula (global), describing functions. Prerequisite: MAE 281A.

Instructor

Jorge Cortés, `cortes at ucsd.edu`. Office at Engineering Building I, # 1608

Course Objectives

By the end of the course, you would/should have:

1. learned and used various tools for the analysis and control of nonlinear systems.
2. got a feeling and gained insight into the complexity of nonlinear systems.
3. known and played around with a wide variety of interesting, inherently nonlinear examples.

Prerequisites

MAE281a. Knowledge of calculus, linear algebra, and ordinary differential equations is assumed. Familiarity with simulation software of your choice (e.g., Matlab/Mathematica/Maple).

Text

Our main reference will be H. K. Khalil. *Nonlinear Systems*. Prentice Hall, 3 edition, 2002. For the topics not covered by Khalil, we will use the references below.

Additional recommended texts and readings

You will also find great insight in

- A. Isidori. *Nonlinear Control Systems*. Communications and Control Engineering Series. Springer, 3 edition, 1995
- S. S. Sastry. *Nonlinear Systems: Analysis, Stability and Control*. Number 10 in Interdisciplinary Applied Mathematics. Springer, 1999.
- H. Nijmeijer and A. J. van der Schaft. *Nonlinear Dynamical Control Systems*. Springer, 1990
- E. D. Sontag. *Mathematical Control Theory: Deterministic Finite Dimensional Systems*, volume 6 of *TAM*. Springer, 2 edition, 1998

Course webpage

http://tintoretto.ucsd.edu/jorge/teaching/mae281b/

The webpage contains this syllabus and the list of homework due. Please check it periodically for updates and other announcements related to the course.

Calendar

The website contains a list of downloadable PDFs for the lectures:

Part I

- Introduction (T & R, Chapters 1 & 2)
- Feedback control (Kh, Ch 12)
- Feedback linearization - SISO (Kh, Ch 13)
- Feedback linearization - MIMO (Is, Ch 5)
- Nonlinear controllability and observability (So, Ch 4; Is, Ch 2)

Part II

- Control Lyapunov functions (So, Ch 5)
- Input-output stability (Kh, Ch 5)
- Passivity (Kh, Ch 6)
- Frequency domain analysis (Kh, Ch 7)

Exams

The midterm will be on Tuesday, May 3, 2011, in class.

The final will be on Monday, June 6, 2011, in class, from 11:30am to 2:30pm.

Homework

There will be a set of homework problems per week (mostly from the main text). The homework will be collected on Thursdays. You need to complete all exercises, although only one, randomly selected, will be corrected each time. Homework assignments are due weekly (specific dates for your reference are included in the webpage). No late homework will be accepted.

Grading policy

Homework: 25%
Midterm: 25%
Final exam: 50%

In exceptional cases, I reserve the right to give extra points for excellent performance on the midterm and final. Please do not count on it as a way to avoid doing the other assignments.

WebCT

Your grades will be available via WebCT. Check out http://webct.ucsd.edu for instructions on how to register and log in.

Academic honesty

No form of academic dishonesty will be tolerated. For the definition of academic dishonesty and its (ominous) consequences, refer to the UCSD General Catalogue 2010-2011 at http://infopath-1.ucsd.edu/catalog/front/content.html

Room location and hours

Lectures take place at Center Hall (Map Building # 984), room 220, Tuesdays and Thursdays, from 12:30pm to 1:50pm.

Office hours

Instructor: Wednesdays, from 3:30pm to 4:30pm, at EBU I, room 1603 (conference room). Please, send me email describing the problem before coming to office hours. Be prepared to show attempts at solving the problem.

If you have any questions about the course, please send me email. I will try to respond as quickly as possible. Additionally, I will share questions that are particularly good (and their answers) with the rest of the class by broadcasting my answer to the entire class.