# Syllabus for MAE281b
# Nonlinear Control - Spring 2015

Jorge Cortés

April 13, 2015

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

**Teaching Assistant**

Ashish Cherukuri, `acheruku at ucsd.edu`. Office at Engineering Building I, room #1605

**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

**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://carmenere.ucsd.edu/jorge/teaching/mae281b/s15/

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. To access them off campus, you will need the username and password provided in class.

**Part I**

- Introduction (Sa, Ch 1)
- Feedback control (Sa, Ch 6; 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 5, 2015, in class.

The final will be on Monday, June 9, 2015, in class, from 8:00am to 11:00am.

**Homework**

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

**Grading policy**

Homework: 30%
Midterm: 30%
Final exam: 40%

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.

**ted**

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

**Room location and hours**

*Lectures* take place at Center Hall (Map Building # 984), room 223, Tuesdays and Thursdays, from 9:30am to 10:50am.

**Office hours**

Instructor: Mondays, from 3:30pm to 4:30pm, at EBU I, room 1603 (conference room). Please, send me an email describing the problem before coming to office hours. I will try to respond as quickly as possible.