

Syllabus for MAE281b

Nonlinear Control - Spring 2017

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

Teaching Assistant

Evan Gravelle, `evangravelle at gmail.com`. Office at Engineering Building I, room #2113

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/s17/>

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 Thursday, May 4, 2017, in class.

The final will be on Tuesday, June 13, 2017, 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. Collaboration is allowed, but your homework should reflect your own original work and be the result of your understanding of the material.

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.

TritonEd

Your grades will be available via TritonEd. Check out <http://tritoned.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 2016-2017 at <http://ucsd.edu/catalog/front/graduate-education.html>

Room location and hours

Lectures take place at EBU2 (Map Building # 610), room 584, 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).

Teaching Assistant: Wednesdays, 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. We will try to respond as quickly as possible.