Syllabus for MAE281b
Nonlinear Control - Spring 2026

Jorge Cortés

April 3, 2026

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

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Teaching Assistants

Ben Hwang, `bdhwang at ucsd.edu`

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. honed in your qualitative and quantitative analytical skills to explain the behavior of dynamical systems
4. known and played around with a variety of interesting, inherently nonlinear examples
5. got a taste for how geometric and topological thinking and techniques can be helpful

Prerequisites

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

Text

Our main reference will be a set of notes available in the website in pdf format. To access them, you will need the username and password provided on Canvas (see announcement "Course Website and Password"). These notes are the result of distilling material from different sources listed below.

Additional recommended texts and readings

You will also find great insight in

- H. K. Khalil. *Nonlinear Systems*. Prentice Hall, 3 edition, 2002
- 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://terrano.ucsd.edu/jorge/teaching/mae281b/s26

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

Calendar

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)

Part II

- Nonlinear controllability and observability (So, Ch 4; Is, Ch 2)
- Control Lyapunov functions (So, Ch 5)
- Input-output stability (Kh, Ch 5)
- Passivity (Kh, Ch 6)

Exams

The midterm will be on Thursday, April 30, 2026, in class

The final will be on Tuesday, June 9, 2026, 8:00am-11:00am

Homework

There will be a set of homework problems per week. Homework assignments are due weekly, on Fridays at midnight (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.

We use an all electronic homework submission and grading process through Canvas. Homework and instructions will be posted there. You can handwrite legibly or type, then scan your homework as a PDF file for submission. Please check the quality of your PDF file before submission. If we cannot read it, we cannot grade it! Please turn in a readable and organized homework. Here is a suggestion: include your name and your ID # on top of each and every page, answer questions in logical order, and start answering a question always on the top of the page.

To efficiently address questions related to homework, we use Piazza at https://piazza.com/ucsd/spring2026/mae281b_sp26_a00. Answers to questions will be posted regularly, but do not expect immediate turnarounds!

Grading policy

Homework: 20% Midterm: 35% Final exam: 45%

Canvas

Your grades will be available via Canvas on https://canvas.ucsd.edu/courses/75557. Please **check it regularly** to make sure your homework scores are being transcribed correctly.

Academic honesty

No form of academic dishonesty will be tolerated. We take this very seriously. For the definition of academic dishonesty and its (ominous) consequences, refer to the UCSD General Catalog 2025-2026 at http://www.ucsd.edu/catalog/

All participants in the course are bound by the UCSD Code of Conduct and Academic Integrity. In this course, the use of GenAI tools to solve homework problems on your behalf is not allowed and constitutes cheating. Misrepresenting your own solutions in a homework (or using AI to do the work for you) is also considered cheating. More information can be found at https://academicintegrity.ucsd.edu

Prior to starting the course, you should visit https://academicintegrity.ucsd.edu/forms/form-pledge.html and take the UCSD Academic Integrity Pledge.

Lectures and hours

Lectures take place at Center Hall, room 217A, Tuesdays and Thursdays, from 9:30am to 10:50am.

Office hours

Specific access information is provided on Canvas in the announcement "Office Hours"

Jorge: Tuesdays, from 3:30pm to 4:30pm, at EBUI, room 1603.

Ben: Thursdays, from 2:00pm to 3:00pm, at EBUI, room 1603.