

Syllabus for MAE281b

Nonlinear Control - Spring 2009

Jorge Cortés

June 7, 2009

This is the Syllabus for MAE281b - Nonlinear Control, Spring 2009. 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 1 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

Calendar (this version: June 7, 2009)

The following calendar is tentative.

Date	Topics	Reading	Tests & Deadlines
(1st wk) Mar 31 Apr 2	Syllabus and intro Feedback control	Khalil-Ch. 12	
(2nd wk) Apr 7 Apr 9	Feedback linearization (SISO)	Khalil-Ch. 13	
(3rd wk) Apr 14 Apr 16	No class		<i>Hmwk #1 due on 4/16</i>
(4th wk) Apr 21 Apr 23	Feedback linearization (MIMO)		
(5th wk) Apr 28	Nonlinear controllability		<i>Hmwk #2 due on 4/30</i>

End Part I

Midterm			<i>Thursday, Apr 30 (in class)</i>
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(6th wk) May 5 May 7	Control Lyapunov funcs		
(7th wk) May 12 May 14	Input-output stability	Khalil-Ch. 5	
(8th wk) May 19 May 21	Passivity	Khalil-Ch. 6	<i>Hmwk #3 due on 5/21</i>
(9th wk) May 26 May 28	Frequency domain		
(10th wk) Jun 2 Jun 4			<i>Hmwk #4 due on 6/4</i>

End Part II

Final			<i>Monday, June 8 in class: 11:30am-2:30pm</i>
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Homework

There will be a set of homework problems every other week. Due dates for the assignments are listed in the calendar of this syllabus. No late homework will be accepted.

Grading policy

Homework: 40%
Midterm: 20%
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.

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 2008-2009 at <http://infopath-1.ucsd.edu/catalog/front/content.html>

Room location and hours

Lectures take place at University Center, Building 413A, room 4, Tuesdays and Thursdays, from 12:30pm to 1:50pm.

Office hours

Instructor: Wednesdays, from 4:00pm to 5:00pm, 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.

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.