

AME 541 Syllabus - Fall 2014

Instructor: Prof. Néstor O. Pérez-Arancibia (perezara@usc.edu)

Class Formal Name: Linear Control Systems II

Class “True” Name: Linear Systems Theory & Design

Phone Number: 310-384-0123 (for emergencies and during take-home exams)

Time: Thursdays 6:40-9:20 PM

Location: OHE 132

Instructor Office Hours: Mondays 2:00-4:00 PM (OHE 430-I). DEN students can connect via Skype (2:00-4:00PM CA time).

Teaching Assistant: Edward Wagner (evwagner@usc.edu)

TA Office Hours: Mondays 2:30-5:30 PM and Tuesdays 2:30-5:30 PM (PED Building, Room B9). DEN students can connect via Skype (2:30-5:30 PM and Tuesdays 2:30-5:30 PM CA time).

Formal Prerequisite: AME 451 (Linear Control Systems I)

Recommended Prerequisites: Linear Algebra; Differential Equations; Basic Probability Theory; Signals & Systems; Basic Programming using MATLAB[®] and SIMULINK[®].

Textbook: [1] Chi-Tsong Chen, *Linear System Theory and Design*, New York, NY and Oxford, UK: Oxford University Press, 2013 (4th Edition).

Other References (Not Officially Required):

- [2] João P. Hespanha, *Linear Systems Theory*, Princeton, NJ and Oxford, UK: Princeton University Press, 2009.
- [3] Geir E. Dullerud and Fernando Paganini, *A Course in Robust Control Theory*, New York, NY: Springer, 2000.
- [4] Thomas Kailath, *Linear Systems*, Englewood, NJ: Prentice-Hall, 1980.
- [5] Kemin Zhou and John C. Doyle, *Essentials of Robust Control*, Upper Saddle River, NJ: Prentice-Hall, 1998.
- [6] Gilbert Strang, *Introduction to Linear Algebra*, Wellesley, MA: Wellesley-Cambridge Press, 2009 (4th Edition).
- [7] Gilbert Strang, *Linear Algebra and Its Applications*, Brooks/Cole, 2006.
- [8] T. S. Blyth and E. F. Robertson, *Basic Linear Algebra*, London, UK: Springer, 1998.
- [9] T. S. Blyth and E. F. Robertson, *Further Linear Algebra*, London, UK: Springer, 2002.
- [10] Alan V. Oppenheim and Alan S. Willsky, *Signals and Systems*, Upper Saddle River, NJ: Prentice-Hall, 1997.
- [11] Alberto Leon-Garcia, *Probability and Random Processes for Electrical Engineering*, Reading, MA: Addison-Wesley, 1994.
- [12] Thomas Kailath, Ali H. Sayed and Babak Hassibi, *Linear Estimation*, Upper Saddle River, NJ: Prentice-Hall, 2000

Course Objectives:

This course discusses the fundamental topics in *linear systems theory* upon which *modern control theory*, *linear estimation (Kalman filtering)* and *linear robust control theory* have been developed. At the end of the semester, the students will be proficient in the most important topics in linear systems theory, including *system representation*, *stability*, *controllability*, *observability*, *realization theory*, *state estimation*, *state feedback control*, *LQR control*, basic concepts in *Kalman filtering*, *LQG control*, and *LTI system-order reduction*.

Grading:

5% Quiz #1 (October 02, 2014 at 6:40PM in class)

5% Quiz #2 (December 04, 2014 at 6:40PM in class)

10% Homework

35% Midterm Exam (October 30, 2014 at 6:40PM in class)

45% Final Exam (December 11, 2014, 7:00-9:00PM)

Homework:

Homework is assigned weekly in class (Thursdays at 6:40 PM, CA time) and due on Fridays of the following week at 11:59 PM, CA time. **Please check the DEN blackboard regularly for homework updates addressing questions and comments from students in the class.** Late submissions will not be graded and will receive a score of 0. While working on your homework you are allowed to talk to the teaching assistant (TA) and your classmates. Also, it is allowed to look at material on-line such as Wikipedia. However, you **must** write down your own solutions, using your own words. Therefore, copy-and-pasted solutions from other sources (classmates, books, on-line material, etc.) will be considered an academic integrity violation.

During the semester, **12 (twelve)** weekly homework assignments will be given. Each weekly assignment will have **at least 120 points** so that at the end of the semester the aggregated amount of points will be **at least 1440 achievable points**. **A thousand (1000) points** are required for a 100% of the homework credit.

Midterm and Final Exams:

The Midterm and Final Exams will have an in-class, **open-book** part, and possibly, a take-home part. Talking on the phone, texting, emailing, communicating in any way with other people or similar activities are not allowed during the in-class part of the exam. You should bring your own exam book.

While working on the take-home part of the exams, you **are not** allowed to communicate, regarding the exam, with the teaching assistant, classmates or any other person except for the instructor, Prof. Pérez-Arancibia, in person, by email, or by phone.

Academic Integrity:

All cases of academic integrity violation will be referred by a written report to the Student Judicial Affairs and Community Standards (<http://www.usc.edu/student-affairs/SJACS/>). The typical penalty recommended by SJACS is a grade of F for the course.

Computer Software:

MATLAB[®] and SIMULINK[®], which can be downloaded from the USC IT website. These are computer tools required for solving some of the homework questions and take-home exam questions.

Programmed Lectures

Week	Date	Topics	References	Comments
1	Aug. 28	Modeling and mathematical description of linear systems	Slides; Ch2 in [1]; Ch1 in [2]; [10].	
2	Sep. 04	Linearity, time invariance, and causality; Review of mathematical concepts	Slides; Ch2 in [1]; Ch3 in [2]; [10]; Ch3 in [6]; Ch3 in [7]; Ch1 in [3].	HW #1 due next day (Friday)
3	Sep. 11	Review of fundamental mathematical concepts	Slides; Ch3 in [1]; Ch3 in [6]; Ch3 in [7]; Ch1 in [3]; CH5 in [8].	HW #2 due next day (Friday)
4	Sep. 18	Solutions to LTI systems – Part 1	Slides; Ch4 in [1]; Ch6 in [2].	HW #3 due next day (Friday)
5	Sep. 25	Solutions to LTI systems – Part 2 (Jordan Form)	Slides; Ch4 in [1]; Ch7 in [2].	HW #4 due next day (Friday)
6	Oct. 02	Quiz #1; Lyapunov stability	Slides; Ch5 in [1]; Ch8 in [2]	HW #5 due next day (Friday)
7	Oct. 09	Input-output stability	Slides; Ch5 in [1]; Ch9 in [2].	HW #6 due next day (Friday)
8	Oct. 16	Controllability	Slides; Ch6 in [1]; Ch11 & Ch12 in [2].	HW #7 due next day (Friday)
9	Oct. 23	Observability	Slides; Ch6 in [1]; Ch15 & Ch16 in [2].	HW #8 due next day (Friday)
10	Oct. 30	Midterm Exam		No Homework due
11	Nov. 06	Minimal Realizations and Coprime Fractions	Slides; Ch7 in [1].	HW #9 due next day (Friday)
12	Nov. 13	State feedback and LQR	Slides; Ch8 in [1].	HW #10 due next day (Friday)
13	Nov. 20	State estimators and LQG	Slides; Ch8 in [1].	HW #11 due next day (Friday)
14	Nov. 27	Thanksgiving		No Homework due
15	Dec. 04	Quiz #2; Advanced topics (system-order reduction)	Slides; Ch4 in [3].	HW #12 due next day (Friday)

Document first uploaded: June 1, 2014.

Document modified: July 11, 2014.

Document last updated: September 6, 2014.

The contents of this syllabus are subject to change. Weekly information will be updated without notice. Change in policies, important dates, and homework content will be announced in class.

Prof. Néstor O. Pérez-Arancibia