

THE UNIVERSITY OF TEXAS AT SAN ANTONIO — ECE DEPARTMENT

EE 5143 — LINEAR SYSTEMS AND CONTROL

Fall 2017

Instructor: Ahmad F. Taha	Time: T-Th, 14:30 – 15:45
Email: ahmad.taha@utsa.edu	Place: EB 2.04.02

Course Pages:

- UTSA Blackboard: <http://utsa.blackboard.com>
- My Webpage: <http://engineering.utsa.edu/~taha>

Office Hours:

- Tuesdays, 16:00–17:00
- Thursdays, 16:00–17:00
- Or by appointment

Catalog Course Description: Advanced methods of analysis and synthesis of linear systems, continuous and discrete-time systems, analytical approach to linear control theory. Prerequisite: Graduate standing or consent of instructor.

Main References: No textbook is required for the class. Lecture notes will be provided as handouts or presentation slides (all posted on Blackboard). However, you may need to refer to books on linear algebra and linear systems theory (most are freely available online as ebooks). This book might prove to be useful.

- C. T. Chen, *Linear System Theory and Design*, Oxford University Press.

Course Objectives & Expected Outcomes:

This course is designed for graduate students who are interested in learning the basics of control theory for linear, lumped dynamical systems. Control theory is a rich field with various sub-disciplines. The objective of this course is to introduce students to basic analysis and design techniques for linear systems. Specifically, given a linear dynamical system that evolves in time, the aim is to develop a control law that would stabilize the operation of such a system or achieve a certain desired performance.

Prerequisites:

An undergraduate-level understanding of multi-variable calculus, Laplace transforms, transfer functions, feedback systems, and basic linear algebra is assumed. Nonetheless, basics related to the aforementioned topics will be covered in the first few weeks of classes.

Grading Policy

- Homework assignments and unannounced, in-class quizzes (25%)
- Exam 1 (20%)
- Exam 2 (20%)

- Final Exam (30%)
- Attendance and instructor evaluation (5%)

Course Grade Cutoffs:

- A-, A, A+: 85–100
- B-, B, B+: 70–84
- C-, C, C+: 55–69
- D-, D, D+: 40–54
- F: ≤ 39

Important Dates:

Exam 1	Thursday, September 28, 2017, In Class
Exam 2	Thursday, November 9, 2017, In Class
Final Exam	TBA

Programming Tools:

MATLAB will be required for homework assignments. Students can obtain the discounted student version of MATLAB online or through the university bookstore. Also, students are encouraged to use L^AT_EX for their homework assignments.

Class Policy:

- **Regular attendance** is essential and expected. The course instructor will occasionally take attendance and this will be counted towards the overall course grade. Students are allowed to miss one class when the attendance is recorded.
- **Emailing the instructor:** we all receive tons of emails every day. Students are required to write exactly the following in the subject line of the email: [EE 5143] – ABC, where ABC is the usual subject of the email. Your email might be ignored if you do not include that in the subject line of your email.
- **Students are expected to show few minutes before the start of the class.** It is the student's responsibility to plan ahead of time and inform the course instructor of any emergencies. In case the student anticipates that they will be late for class, he/she should email the instructor before the class starts.
- **Late submission policy:** besides medical and family emergencies (a written verification is required), there will be no extensions granted for homework submissions, unless the instructor feels the need to do so. Late submissions will be scaled according to lateness, removing 10% from your assignment grade per day late, up to a maximum of 50%. Submissions more than 5 days late will be assigned a score of 0.
- **Changes to the syllabus:** students will be regularly informed about any changes for the course syllabus.

Tentative Course Outline:

Part I — Control Systems Introduction & Background	≈ 1–2 classes
■ Course introduction & syllabus, prerequisites, major applications, assessment exam	
Part II — Transfer Functions, Linear Algebra Review, State Space	≈ 3–4 classes
■ A review of transfer functions of linear systems, intro to state space representation	
Part III — State Space Solutions, Exponential of a Matrix	≈ 3–4 classes
■ Analytical computations of state and output solutions, exponential of a matrix	
Part IV — Discrete Time Systems	≈ 1–2 classes
■ Introduction to discrete time systems and their analytical solutions	
Part V — Stability of Continuous and Discrete-Time Systems	≈ 3–4 classes
■ Input-output stability, internal stability, Lyapunov theorem	
Part VI — Controllability and Observability	≈ 2–3 classes
■ Metrics for controllability and observability of linear systems	
Part VII — State Feedback Control	≈ 2–3 classes
■ Design of feedback controllers to stabilize linear systems	
Part VIII — State Observation & Estimation of Control Systems	≈ 3–4 classes
■ Introduction to dynamic estimators (observers) of control systems	
Part IX — Model-Free Control Systems	≈ 1–2 classes
■ System Identification, Special Topics	
Part X — Advanced Topics in Control Theory	≈ 1–2 classes
■ Optimal control, estimation of uncertain dynamical systems, perturbation theory	

Collaboration Policy and Academic Honor Code:

You are responsible for your own work in this course. You may consult with classmates but copying from another student's work is considered CHEATING and will have severe consequences. Ask yourself whether you are compromising your integrity. If in doubt, ask first. That being said, the instructor highly values collaboration and teamwork. Some of the homework problems might require group brainstorming. That's perfectly fine. Even thinking of one solution is okay, but you are required to write, and submit your own solution.

A. Preamble

The University of Texas at San Antonio community of past, present and future students, faculty, staff, and administrators share a commitment to integrity and the ethical pursuit of knowledge. We honor the traditions of our university by conducting ourselves with a steadfast duty to honor, courage, and virtue in all matters both public and private. By choosing integrity and responsibility we promote personal growth, success, and lifelong learning for the advancement of ourselves, our university, and our community.

B. Honor Pledge

In support of the ideals of integrity, the students of The University of Texas at San Antonio pledge: *As a UTSA Roadrunner, I live with honor and integrity.*

C. Shared responsibility

The University of Texas at San Antonio community shares a commitment to integrity, the ethical pursuit of knowledge, and adheres to the UTSA Honor Code. <http://utsa.edu/about/honorcode/>

D. Academic Dishonesty:

As an entity of The University of Texas at San Antonio, ECE Department is committed to the development of its students and to the promotion of personal integrity and self responsibility.

The assumption that a student's work is a fair representation of the student's ability to perform forms the basis for departmental and institutional quality. All students within the Department are expected to observe appropriate standards of conduct. Acts of scholastic dishonesty such as cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designated to give unfair advantage to a student, or the attempt to commit such acts will not be tolerated. Any case involving academic dishonesty will be referred to the Office of Student Judicial Affairs who will investigate the charge and set a preliminary meeting with the student to discuss disposition. Consequences of academic dishonesty may be as severe as dismissal from the University.

E. Road Runner Creed

The University of Texas at San Antonio is a community of scholars where integrity, excellence, inclusiveness, respect, collaboration, and innovation are fostered. As a Roadrunner, I will:

- Uphold the highest standards of academic and personal integrity by practicing and expecting fair and ethical conduct;
- Respect and accept individual differences, recognizing the inherent dignity of each person;
- Contribute to campus life and the larger community through my active engagement; and
- Support the fearless exploration of dreams and ideas in the advancement of ingenuity, creativity, and discovery.

Guided by these principles now and forever, *I am a Roadrunner!*

F. UTSA policies

Students are expected to follow the student code of conduct as explained in <http://catalog.utsa.edu/informationbulletin/appendices/studentcodeofconduct/> and scholastic dishonesty under Section 203.

G. Campus Carry and My Office Space

Pursuant to HOP 9.48, Carrying of Concealed Handguns on Campus, my private office (BSE 1.514) is a designated exclusion zone. As set out in Section 30.06, Penal Code (trespass by license holder with a concealed handgun), a person licensed to carry a Concealed Handgun under Subchapter H, Chapter 411 Government Code (handgun licensing law), may not enter this property/office with a concealed handgun.

De conformidad con HOP 9.48, Llevar Armas de Fuego Encubiertas en el Campus, mi oficina privada (BSE 1.514) es una zona designada de exclusin. Conforme a la seccion 30.06 del cdigo penal (trespasar portando armas de fuego) personas con licencia bajo del sub-capitulo H, capitulo 411, codigo de gobierno (ley de portar armas), no deben entrar a esta propiedad portando un arma de fuego.