UNIVERSITY of HOUSTON | ECE

ECE 5335/6325 State-Space Control Systems

Course description: 3 credit hours. (3-0). Prerequisites: ECE 4375. State-space modeling, matrix algebra, system response, coordinate transformation, stability, controllability, observability, realization, state-feedback design and observers, nonlinear systems, Lyapunov functions, and optimal control.

Course topics: The course provides the mathematical basis for state-space methods for analysis and design of control systems. Mathematical tools will be developed to analyze and design systems expressed as coupled linear differential equations. State-space methods enable us to analyze and design multi-input/multi-output systems in time domain. The main focus will be on the properties of state-space equations, stability analysis, and state-feedback control design. The course will concentrate on linear systems, but an introduction to nonlinear control techniques will also be provided.

Learning objectives and expected course outcomes: Students who successfully complete this course are expected to develop the following skills:
(1) State-space Modeling,
(2) Analysis and Design in Modern Control Systems,
(3) Analysis and Design in Optimal Control Systems,
(4) Nonlinear Control Systems Analysis.

Textbook: The course will be based on the material covered in the lectures.
The topics that are listed can be found in most major textbooks such as:

Linear State-Space Control Systems by Robert L. Williams, II and Douglas A. Lawrence

Recommended Textbook: The following books are also valuable resources:

Feedback Systems: An Introduction for Scientists and Engineers by Karl J Astrom and Richard Murray
The textbook is available online for free on the author's website.
URL: http://www.cds.caltech.edu/~murray/amwiki/

Modern Control Engineering by Katsuhiko Ogata

Linear Control Theory by Frederick W. Fairman

Linear Systems Theory and Design by Chi-Tsong Chen

Tentative Topics (This is subject to change; how we adhere to this depends in part on the pace that we feel is reasonable for the class.)

Introduction to Feedback Control Systems
Introduction to System Modeling: Dynamical systems, interconnections, state-space models; equilibrium points, linearization; system modeling and linearization examples.
Analysis in Modern Control Systems: Time response, matrix exponential, modal form; eigenvector mechanics, stability of linear systems, dynamic interpretations, diagonalization; stability of linear systems, Jordan form.
Design in Modern Control Systems: Cayley-Hamilton Theorem, Controllability, full-state feedback,

eigenvalue placement with Ackerman's formula; observability; open-loop vs. closed-loop estimation; dynamic output feedback control systems; similarity transformations.
Analysis in Optimal Control Systems: Laplace transform and transfer functions for SISO systems; transfer matrices for MIMO systems; converting between state-space and transfer function models; poles and zeros of state space models; reference tracking, Gilbert realization; pole-zero cancelation; minimal realizations; modal tests.
Design in Optimal Control Systems: Linear Quadratic Regulator (LQR) control; LQR as an optimization problem, Ricatti equation.
Nonlinear State-Space Control Systems Analysis: Lyapunov's local stability theorems, Lyapunov's global stability theorems.

Disclaimer

Information contained in this document is subject to change without notice. Students are expected to read the course syllabus handed out on the first day of classes and to be aware of any additional course policies presented by the instructor during the course.