PAUT54A1: A Convex Approach to Systems and Controls Theory

Syllabus

Instructor: M. Peet

Tuesday Meeting Time: 8:00-11:15 (break at 9:30); 13:30-16:45 (break at 15:00)
Wednesday Meeting Time: 8:00-11:15 (break at 9:30)
Thursday Meeting Time: 8:00-11:15 (break at 9:30); 13:30-16:45 (break at 15:00)
Office: B216

Goal Use and understand LMI and SOS approaches to optimization in systems and controls theory.

Content In this course, we study the role of LMI in systems and controls theory. The content is based on material from "A Course in Robust Control Theory: A Convex Approach" by G. Dullerud and F. Paganini, from lectures given by S. Lall and P. Parrilo, among other sources. The course is divided into four sections.

1. Optimal Control of Linear Systems via LMIs
   - Basic Linear Systems Theory; The optimal control framework; Introduction to LMIs and convex optimization; An LMI solution to the H_∞ optimal control problem; An LMI solution to the H_2 optimal control problem; Some LMIs in robust analysis.
2. Nonlinear Systems Theory
   - Existence and Uniqueness of Solutions; Lyapunov Theory; Converse Lyapunov Theory.
3. Sum-of-Squares and application to robust control and nonlinear analysis.
   - Optimization of polynomials; Sum-of-Squares; Cones and Inference; Positivstellensatz; Nullstellensatz; Applications; Nonlinear Stability Analysis.
4. Advanced topics and applications of SOS
   - Application to delayed systems; Application to control of PDE systems.

Prerequisites It is assumed that students are comfortable with basic results in finite-dimensional linear systems theory. Additionally, some background in analysis is recommended.

Format Lectures will utilize an evolving set of LaTeX slides. The slides are available from the instructor and will be posted online. Handouts will be distributed during class.

Evaluation There will be a single examination at the end of the class.

References Aside from Dullerud and Paganini, there are several excellent sources which may need to be consulted. Although not directly required for the course, students are encouraged to browse the following references.

The following are references for LMI methods in control.

- Zhou, Doyle and Glover. "Robust and Optimal Control", Prentice Hall, 1996.
- Boyd, El Ghaoui, Feron and Balakrishnan. "Linear Matrix Inequalities in Systems and Control Theory", SIAM, 1994.

The following is a thorough reference on matrix analysis.

- Horn and Johnson. "Matrix Analysis", Cambridge University Press, 1985.

The following is a clearly written text on mathematical analysis.

- Marsden and Hoffman. "Elementary Classical Analysis", Freeman 1993.