The University of Texas at Austin
Department of Aerospace Engineering and Engineering Mechanics

ASE 381P 2: Multivariable Control Systems
Fall 2024 Syllabus

Unique number: 14405
Instructor:
Dr. Takashi Tanaka (ASE 4.230).
Email: ttanaka@utexas.edu
Office hours: Thursdays 10:00 am – Noon.

Time: T/Th 8:00 a.m. – 9:30 a.m.
Class format: Face-to-face
Location: ASE 2.134
Course webpage:
Canvas – http://canvas.utexas.edu
Main Textbook:

- Geir E. Dullerud and Fernando Paganini. *A Course in Robust Control Theory: A Convex Approach*. Springer Science & Business Media, (2000) ISBN: 9781441931894.

Additional References:

- Kemin Zhou, John C. Doyle, and Keith Glover. *Robust and optimal control*. Prentice hall, 1996.
- Jan M. Maciejowski, *Multivariable Feedback Design*, Addison-Wesley, 1989
- Stephen Boyd, Laurent El Ghaoui, Eric Feron, and Venkataramanan Balakrishnan. *Linear matrix inequalities in system and control theory*. Society for industrial and applied mathematics, 1994.

Course Objectives:

This course establishes mathematical foundations for multivariable control systems analysis through the development of robust control theory. Control design methods based on convex optimization are introduced. Topics to be covered include: finite dimensional vector spaces, convexity, state space systems theory, Linear Matrix Inequalities (LMIs), functional analysis and operator theory, Youla parametrization, H_2 (LQG) and H_∞ control, uncertain systems, μ-analysis, and Integral Quadratic Constraints (IQCs).

Prerequisites:

Undergraduate level linear algebra, matrix theory and complex analysis. Fundamentals of linear systems theory (ASE 330 or equivalent) and feedback control theory (ASE 370 or equivalent) will also be essential.

Grading:

The final grade will be calculated based on homework assignments (60 points), final project (40 points), attendance (5 points), and the final exam (5 points). Grades will be based on the following rules: A (93-110), A- (90-92), B+ (87-89), B (83-86), B- (80-82), C+ (77-79), C (73-76), and C- (70-72). An extra 10% is granted to all students to accommodate unexpected events such as medical emergencies.

Homework:

There will be biweekly homework assignments during the semester. Each assignment and its due date will be posted on Canvas. No late homework will be accepted unless prior permission in exceptional circumstances has been granted. Collaboration is allowed. In case of collaboration, each student should return her/his work along with a statement that indicates her/his collaborators and her/his role in the resulting work.

Attendance:

Regular attendance is expected and strongly recommended. Throughout the semester, the students are expected to engage in discussions. Absence must be notified in advance.

Final project:

Students are expected to either (1) read research papers on relevant topics in detail, or (2) develop original mini-research projects relevant to topics covered in class. Further details will be provided in the first lecture.

Final exam:

The final exam will be individual "exit interviews" in December.

Schedule:

Week	**Date**	**Topic**
1	8/27, 8/29	Introduction
2	9/3, 9/5	Generalized plant, finite-dimensional spaces, convexity,
3	9/10, 9/12	LMIs, controllability/observability, minimal realization
4	9/17, 9/19	Functional analysis and operator theory: L_2 norms, H_2 spaces
5	9/24, 9/26	H_∞ spaces, model realization
6	10/1, 10/3	LMI-based control design, Youla parametrization
7	10/8, 10/10	LQG control, Riccati equations
8	10/15, 10/17	H_2 optimal control
9	10/22, 10/24	H-infinity control
10	10/29, 10/31	Uncertain systems, **mid-semester project presentation**
11	11/5, 11/7	Small gain theorem, structured singular values
12	11/12, 11/14	Control of uncertain systems
13	11/19, 11/21	Robust control and IQCs
14	12/3, 12/5	Robust control and IQCs, **final project presentations**

Computer usage:

Students are assumed to have access to MATLAB and semidefinite programming solvers to complete homework assignments. Details will be discussed in the class.

Prepared by: Takashi Tanaka Date: 8/23/2024