ECE682: Multivariable Control Systems
Fall 2022

Instructor: *Prof. Ravi R. Mazumdar*, , tel: X 37444, e-mail: mazum@uwaterloo.ca

Schedule: in [redacted]

There are additional lectures planned on the following Wednesdays
September 28, Oct. 5 and Nov 9 from [redacted]

Course Website: LEARN (Announcements, notes and problem sets will be posted)

Pre-requisite: ECE380 and basic linear algebra.

Aims: The principal aim of this course is to introduce the student to linear (primarily) multivariable systems and the associated frameworks and tools. In this course the student will be introduced to the notion of linear operators and their geometric properties. Following this the course will cover representation of linear multivariable systems.They will then study the important properties of controllability and observability of systems. A frequency based I/O theory will also be covered. The student will then be introduced to the notion of stability and stabilizability of systems with the introduction of the Lyapunov theory and the Lyapunov equation. Following this the course will cover Linear Quadratic Regulators (LQR) and discuss the steady state theory. We will then study robust stabilization theory. Then the Luenberger observer theory will be introduced showing the role and separation between observation and control in linear multivariable systems. The course will end with an introduction to optimal control and the Hamilton-Jacobi equation.

COURSE OUTLINE

1. Introduction to linear matrix theory. Bases and representations. Notions of range, null spaces. Introduction to Hilbert spaces.

2. Linear dynamical systems and their matrix representation. The notion of Input/Output maps and transfer functions.

3. Stability and pole placement.

4. The notions of controllability, reachability, observability and detectability of systems. Canonical forms.

5. Introduction to Lyapunov stability theory. The Lyapunov equation.

6. Linear quadratic control. Ricatti equations. Steady state theory. Applications to robust control.

7. Observer theory and the separation between control and observation.
8. Introduction to optimal control. Hamilton Jacobi equation.

TEXT AND REFERENCES

There is no required text for the course.

Course notes will be provided where my treatment will be different from the references. A suggested textbook is :

Linear System Theory and Design, 3rd edition, C.T. Chen.

The following references are excellent for selected topics.

References:

1. A Second Course in Linear Systems, C. Desoer.
2. Robust and Optimal Control, K. Zhou, J.C. Doyle and K. Glover.
3. Linear Systems, T. Kailath

Course Evaluation

- Weekly problem sets will be handed out. The onus is on you all to attempt them. Solutions will be posted.
- There will be a midterm that will count for 40% of the grade and a final exam that will count for 60%.
- The midterm will be in-class on October 20, 2002. The date for the final exam will be announced later.

Additional remarks

- All in term exams will be open notes.
- If you miss the midterm exam no make-up exam will be given. If you have a valid reason then your final grade will be based on your performance in the rest of the course.
- Dishonesty will be dealt with the rules of the university.