Umass Lowell
Electrical & Computer Engineering

Fall 2019
Tingshu Hu

# EECE5130 Control Systems

## COURSE OUTLINE

**Fall 2019 Catalog Data:**

3 credits.

Prerequisites: EECE4130, Linear Feedback Systems and working knowledge of Linear Algebra

Content: Modeling, analysis and design of linear systems. Linear algebra with emphasis on matrices, linear transformations, eigenvalues and eigenvectors. State space solutions and realizations. Stability, controllability and observability. Feedback design through pole assignment, LQR method and state estimation. Robust tracking and disturbance rejection. Analysis and design of systems using Simulink and Matlab.

**Instructor**:

Tingshu Hu

Office: Ball Hall 405
Office hours: MW: 9-11am; Thursday: 4 - 6pm
Phone: 934-4374, Fax: 934-3027,
Email: tingshu_hu@uml.edu, URL: http://faculty.uml.edu/thu/
Class website: http://faculty.uml.edu/thu/controlsys/controlsys.html

**Classes:** Thursday, 6:30-9:20pm , Classroom: Kitson 309

**Text:** Chi-Tsong Chen, *Linear System Theory and Design*, Third Edition, Oxford University Press, 1999.

**Goals:**

This course is designed to provide a thorough understanding about linear systems theory and multivariable system design. The students will learn how to model a physical system (including continuous-time systems and discrete-time systems), how to derive system response for a given input, and how to analyze system characteristics such as stability, controllability, observability and robustness. The students will then learn system design, including how to realize a system given its mathematical description, how to design a control law so that system response satisfies certain properties, and how to design an observer to estimate the state of the system. Fundamental tools from linear algebra will be used throughout the course. Robust stability theory will be introduced through linear differential inclusions. Matlab and Simulink will be used for homework and project.

**Tentative Outline (12 Lectures):**

1. Introduction and mathematical description of systems
2. Linear algebra review, Modeling of systems
3. Modeling of selected systems; Linear algebra, vector space and linear independence
4. Basis, representation and orthogonality; solutions to algebraic equations
5. Companion form, diagonal form, Jordan form; Functions of a square matrix
6. General matrix functions, solutions to state-space equation
7. Dealing with complex eigenvalues, state space realization of transfer functions; simulink, course project
8. Quadratic functions and positive definiteness; Controllability
9. Controllability and observability, Canonical decomposition
10. Canonical decomposition, minimal realization, pole assignment via state feedback

11. Robust tracking, disturbance rejection, full dimensional estimator
12. Feedback from estimated state; Deadbeat control; LQR optimal control
    Rejecting sinusoidal disturbances

**Grading:**

| | |
|---|---|
| Homework | 15% |
| Mid Term | 30% |
| Project | 25% |
| Final Examination | 30% |

All exams are open book, open notes

**Homework Rules:**

- Homework should be clear, concise, and complete
- Discussion is allowed but no copying; make sure you understand what you write down.
- Due next week. No late homework.
- Homework solutions will be posted a week after the due date.

**Attendance**: will be taken occasionally. Positive attitude is a key to success.