Students have learned the fundamental concepts and methods of control in ECE 421. Historically, these were developed for continuous-time systems and this is how they are covered in 421. These days most control systems are implemented in discrete time, using microcontrollers. So students looking for a career in control, or even doing a control related senior design project, need to get acquainted with the operation and design of discrete-time control systems.

Subjects covered in the course are:

- Discrete-time signals and sampling
- Difference equation and shift operator
- Z-transformation
- Discrete equivalents of continuous-time systems
- Root-locus plot and stability
- PI and PID controller in discrete time
- Pole-placement controller design
- Frequency domain analysis of discrete-time systems
- Bilinear transformation and frequency-domain controller design
- Hybrid system analysis

The main sources of course information will be the lectures and instructor notes. In addition, the following textbook will be used as a background resource:

Digital Control Systems Analysis and Design
Charles Phillips and Troy Nagle
Prentice Hall, 1995

The course is very much project oriented. Each student will have a “personal plant” (system); students first simulate this in Matlab then design controllers with various methods learnt in class and check the performance of the closed-loop system by simulation.

Course grade:

Projects  80%
Homework  10%
Class participation  10%
Project 1: Simulation of discrete-time system
Project 2: Root-locus analysis and stability
Project 3: Pole placement controller design
Project 4: Bilinear transformation, controller design in the frequency domain

Week-by-week schedule (tentative):

- Jan. 20  Course introduction. Discrete-time signals and sampling
- Jan. 25 and 27  Difference equation, shift operator, convolution
- Feb. 1 and 3  Z-transformation.
- Feb. 8 and 10  Stability and dynamic response
- Feb. 15 and 17  Discrete equivalents of continuous-time systems. Aliasing
- Feb. 22 and 24  Discrete-time P, PI and PID controllers
- Feb. 29 and March 2  Root-locus plot and stability
- Mar. 7 and 9  Spring break
- Mar. 14 and 16  Pole-placement controller design
- Mar. 21 and 23  Pole-placement controller design
- Mar. 28 and 30  Frequency response in discrete time
- Apr. 4 and 6  Bilinear transformation
- Apr. 11 and 13  Frequency-domain controller design
- Apr. 18 and 20  Frequency-domain controller design
- Apr. 25 and 27  Hybrid system analysis in closed loop
- May 2  System analysis by simulation
- May TBD  Final exam period – project presentation

George Mason’s Honor Code applies. Exams are in-class, closed book and note but a one-page formula sheet is allowed. Homework and projects may be discussed with other students but individual work has to be submitted.