EE 105 Midterm study guide

1. Introduction

- Give examples of feedback control systems, and describe the parameters of interest (stability, settling time, overshoot, etc)
- Define "linear system", and identify systems as linear or non-linear
- Sketch the general matrix form of an LTI system ($\dot{x} = Ax + Bu$; $y = Cx$)

2. LTI systems and state space

- Write differential equations for a system with known dynamics (e.g., a circuit or basic mechanical system)
- Use the Laplace transform to find the transfer function of a system
- Formulate a state-space matrix equation for a system with known dynamics

3. Matrix theory

- Define the range of a matrix, "full rank", and invertibility
- Explain why eigenvalues and eigenvectors are special
- Use MATLAB to compute an eigenvalue decomposition

4. Matrix exponential, response, and stability

- Use MATLAB to compute a matrix exponential, and use this to plot the time-domain response
- Given a matrix representing an LTI system, determine whether it is stable

5. Converting between state space and transfer functions

- Given a state-space representation of a system, write the corresponding transfer function
- Explain how the eigenvalues of a system relate to the roots of the transfer function
- Use MATLAB to convert between state space and transfer function representations

6. Manipulating transfer functions

- Simplify a block diagram by rearranging and combining transfer functions
- Use MATLAB `series`, `parallel`, and `feedback` commands

7. Time-domain responses

- Use the inverse Laplace transform to calculate the step response of a system
- Use MATLAB to plot the step response of a system
- Define delay time, rise time, peak time, overshoot, and settling time, and annotate them on a graph
- Determine whether a system is underdamped, critically damped, or overdamped

8. Poles, zeros, and stability

- Plot the poles and zeros of a transfer function
- Given a pole-zero plot, comment on the transient response and stability

9. First look at feedback: PID control

- Given a system, implement a P/PI/PD/PID controller
- Explain qualitatively what the P, I, and D terms do in a PID controller.

10. PID control and tuning rules

- Given a system, implement a PID controller mathematically (i.e., as a transfer function) and calculate gain values to achieve particular responses.
- Use MATLAB/Simulink to implement a PID controller
- Tune parameters for a PID controller to achieve a desired behavior

11. Creating root locus plots

- Given a transfer function, sketch the root locus