Individual problem

January 11, 2008

Analysis and modeling

1. Choose a system with the following properties: 1) two complex stable poles in the right half plane, 2) one zero at -1 and 3) one delay. Illustrate the poles an zero in a pole-zero diagram (useful Sysquake functions: `scale equal; hgrid; plotroots`).
2. Describe the system as a recursive difference equation and show how the step response can be calculated recursively a couple of steps.
3. Use the backward-shift operator to describe the system in polynomial form. Then use this representation to calculate the steady-state gain. Compare this analytical steady-state gain with the simulated step response (useful Sysquake function: `filter`).
4. Choose a sinusoidal input to the system and verify that the output approaches the stationary response that can be calculated from the frequency response function.
5. Analyze feedback stability margins by finding a P-controller gain that would give the closed-loop system the gain margin 2. Plot the Nyquist curve for the compensated system and estimate the phase margin (useful Sysquake function: `dnyquist`). Calculate the critical and cross-over frequencies and mark them on the Nyquist curve.
6. Simulate the system by generating input and output data where the output data includes measurement noise (useful Sysquake function: `filter`). Show how to estimate the model from input-output data using the least-squares method.

Design and implementation

1. Design a discretized PI-controller based on Ziegler-Nichols tuning rules.
2. Show how the controller can be implemented with anti-windup.
3. Design a RST-controller with integral action by the pole-placement method. Choose closed-loop poles to get adequate robustness margins.
4. What are the resulting gain and phase margins in the design above?
5. Change the T-polynomial in the previous design to get a faster reference step response without increase of noise feedback.
6. Change the T-polynomial in the previous design for ramp tracking.
7. Design a controller that rejects ramp disturbances.