2.171 Problem Set 1

Assigned: Wednesday, September 6, 2006
Due: Wednesday, September 13, 2006 (in class)
Reading: Franklin, Powell, and Workman (FPW) Ch 1, Ch 2, Ch. 3

Problem 1: FPW 2.9 a-f (not g) Calculate the transfer function $\frac{T_c(s)}{Y(s)}$ for the complete controller including the estimator and state feedback. Use Matlab to plot the loop transfer function for the controller plus plant. What are the crossover frequency and phase margin for this loop?

Problem 2: FPW 2.17

Problem 3: FPW 2.18

Problem 4: FPW 2.19

Problem 5: FPW 3.1

Problem 6: FPW 3.3

Problem 7: FPW 3.5
Note: You are to design a continuous-time PID controller to meet the problem specifications, and then map this controller to discrete-time via any of the approximations presented in class or in the text. Carefully show your design approach and calculations. (For the purposes of this problem, do the approximations by hand, rather than directly using Matlab to generate the transformations.)
Use Matlab/Simulink to simulate the step response of your closed-loop system with
i) the continuous-time PID controller, and
ii) the approximating discrete-time controller which you designed. Please include plots of the control signal (plant input) and the plant output for each case. How do these repsonses compare?
In your Simulink simulations, reduce the sample rate from 6 kHz, and comment on the effect of longer sample times in the resulting signals. Include relevant plots to show these effects. At about what reduced sample rate does the system go unstable? FPW 2.9 a-f (not g) Calculate the transfer function $\frac{T_c(s)}{Y(s)}$ for the complete controller including the estimator and state feedback. Use Matlab to plot the loop transfer function for the controller plus plant. What are the crossover frequency and phase margin for this loop?