EE-561
Digital Control Systems
Problem Set # 1

Fall 2013, LUMS

Due Date : Sept 11, 2013 in class.
Total Points : 100.

Problem 1 (20 Points)

1. Setup a general difference equation for PID control using backward Euler, forward Euler and trapezoidal approximation rules.
2. Give pseudo-code to implement each controller.

Problem 2 (20 Points)

Reproduce the results of Example 4.8 (Franklin) of a PI controller for motor speed control using SIMULINK. Compare analog control with the suggested digital control.

Problem 3 (20 Points)

Setup and simulate digital controllers to implement the lead compensator $D(S) = 70\frac{s+2}{s+10}$ for the plant $G(s) = \frac{1}{s(s+1)}$ at clock frequencies of 20 Hz and 40 Hz. Compare your results with analog control.

Problem 4 (20 Points)

Refer to the previous problem and let

$$D(s) = 70\frac{s+2}{s+10}e^{-Ts/2}.$$

1. Obtain the overall closed loop transfer function between reference and output.

2. Estimate the damping constant of the closed loop system when $T = 1/10, 1/20, 1/40$ both my hand calculation and by looking at simulation results (such as step responses). For hand calculations you may use an approximation such as
$$e^{-sT/2} \cong \frac{2/T}{s + 2/T}.$$

3. If $e^{-Ts/2}$ models the delay caused by ZOH, what are your conclusions from the above calculation?

Problem 5 (20 Points)

A computer disk drive is modeled by the plant
$$G(s) = \frac{1000}{s^2}.$$

1. Design and simulate a digital PID controller to meet a bandwidth of 100 Hz; phase margin of 50 degrees and zero error against step input torque. Use a sampling rate of 6KHz for your design.

2. Analyze (in simulation) the change in PM due to the introduction of digital control by varying sampling rate.