2.737 Lab 1 Addendum

Assigned: Sept. 22, 2014
Due: There is no formal requirement to complete this addendum.
If you have time, check out the items listed herein, as you will learn important ideas about controller design in the presence of limited quantization resolution.

You will likely have noticed that your controller in Lab 1 designed for 1000 rad/sec crossover had a very strong oscillation in the control effort. This is due to the limited quantization levels of the myRIO 12-bit converter. For the relatively high loop bandwidth, the quantization is not sufficient to support a linear control mode of operation. Also, the capacitors used in the lab have a large error tolerance, and typically measure about 0.16 μF rather than the nominal 0.1 μF. We can create a more accurate plant model on the basis of experimental measurements.

With the gain limitations, the loop crossover frequency needs to be reduced, or alternately, some amount of gain needs to be taken in the analog domain.

Further, it is helpful to use a dynamic analyzer to measure the plant transfer function and loop return ratio. We are providing a dynamic analyzer which runs in Labview to allow you to make these measurements.

To understand these issues better:

a) Create a more accurate plant model, and verify experimentally.

b) Design a control loop for a crossover frequency of $\omega_c = 100$ rad/sec. Implement this loop and carefully compare with predicted results. Also, measure the loop return ratio and plant transfer functions using the dynamic analyzer. How do these compare with your design values?

c) Another approach is to implement an analog gain stage at the input or output of the plant. Try some gain value (10?) and implement using an op amp circuit. Can you close the loop with the crossover frequency back up to $\omega_c = 1000$ rad/sec, and have acceptable dynamic response? Can you measure the loop return ratio successfully with this high crossover?