

SFWR ENG 4A03 Lab 1: Introduction to Labview and Review of Continuous Control Systems

Due: 1850 Monday September 30, 2002

Introduction to Labview

You will find an introductory handout on Labview in the lab. More information on Labview is available at <http://www.ni.com>. As you complete each of the sections, demonstrate the working instrument to one of the TAs.

1. Do the Labview exercises 1 from the handout.
2. Do exercise 2(a) from the handout.
3. Once you have completed Exercise 2(a) from the handout, go back to your exercise 1 virtual instrument (VI) and replace the Input knob with the temperature sensor reading from the DAQ (ask the TA for help if you need it). Set the upper and lower limits so that you can move the temperature value in and out of the safe range by putting a finger on the temperature sensor. Save this new vi as **Exercise 1b.vi**.
4. Go to <http://www.ni.com> and search for information on the BNC-2120 encoder. You should find a document that describes the connections required on the connector board and provides a downloadable VI titled:

Measure the Rotation of a Quadrature Encoder Using a BNC-2120

as well as a short overview document titled:

How Do I Use a Quadrature Encoder with My Data Acquisition Board?

Download the VI and configure it to work with your board. Make sure that the encoder connections are properly wired.

BONUS: Modify the BNC-2120 Encoder instrument to add an “angular odometer”, i.e. a readout of the total angular distance travelled by the knob (regardless of direction) since the time the VI was last restarted.

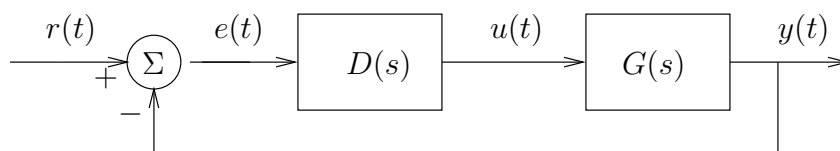
Create a zip file called **lab1.zip** containing all of the VIs you created. Submit the file by following instructions that will be available on the course website (<http://www.cas.mcmaster.ca/~lawford/4A03>).

Review of Continuous Control

1. Consider the unstable system:

$$G(s) = \frac{Y(s)}{U(s)} = \frac{1}{s-1}$$

in the feedback loop:



- a) It is decided to use a combination of the proportional control to stabilize the system and the integral control to provide tracking of steps using the compensator

$$D(s) = \frac{K(s+1)}{s}$$

Is it possible to stabilize the resulting system? If so, for what values of K is the system stable? In this case, when $K = 2$, what is the steady state error in response to a unit step input $r(t) = 1(t)$?

- b) Sketch the root locus of the system for the compensator:

$$D(s) = \frac{K(s+1)}{s(s+10)}$$

Confirm your sketch using Matlab. For K large enough that the system is stable, what is the steady state error of the closed loop system to a ramp input $r(t) = t$? It is decided to use a high gain K to reduce the error to a ramp input. If $D(s)$ is going to be implemented by a discrete equivalent $D(z)$ with fixed sampling time T , what is a potential problem?

2. Sketch the root locus for the system where:

$$D(s)G(s) = \frac{K(s+3)}{s(s+2)(s+1)^2}$$

Confirm your sketch using Matlab.

3. Consider the system with dynamics given by the following equation

$$\frac{d^2y}{dt^2}(t) = -3\frac{dy}{dt}(t) - 2y(t) + u(t)$$

- a) What is the transfer function $G(s) = \frac{Y(s)}{U(s)}$?
- b) What is the bandwidth of the system?
- c) Assuming zero initial conditions, what is the time domain response of the system when $u(t) = \sin \omega_1 t$?
- d) Show that for t large, the system response is approximately:

$$y(t) = AU_o \sin(\omega_1 t + \phi)$$

where

$$A = |G(j\omega_1)|$$

$$\phi = \angle G(j\omega_1) = \tan^{-1} \frac{\text{Im}[G(j\omega_1)]}{\text{Re}[G(j\omega_1)]}$$