Assignment 13

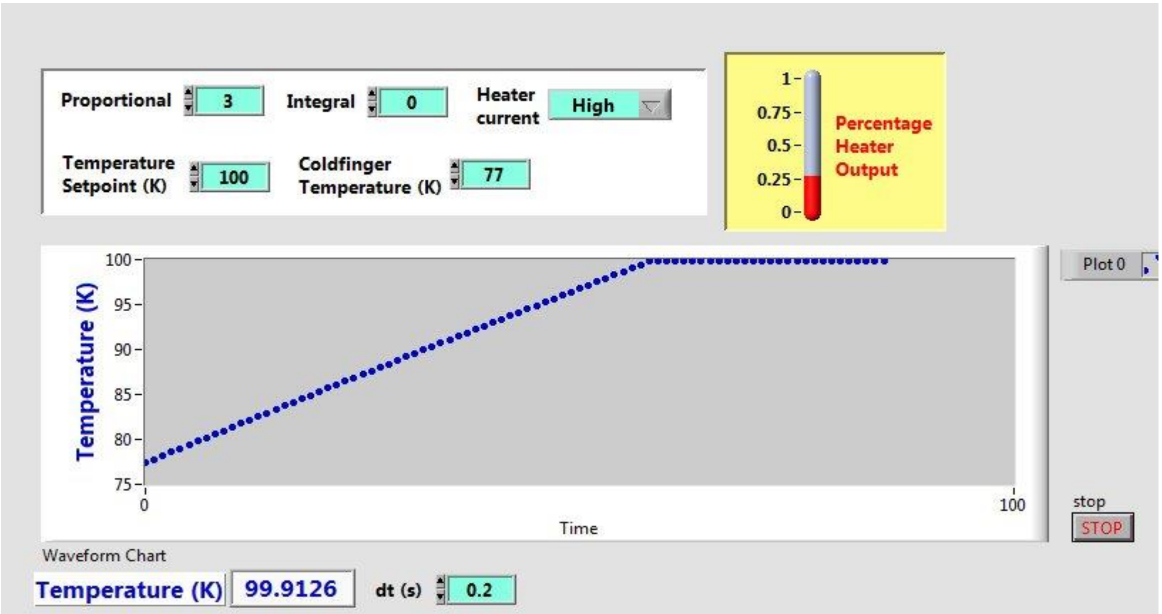
(Due Monday 28 November)

P-I Controller

This LabView project modifies the simple binary (on/off) thermostat controller of Assignment 12. A more powerful P-I control algorithm replaces the thermostat. There is a single temperature setpoint instead of separate high/low setpoints. Generate an error signal ($\boldsymbol{\varepsilon_i}$) by subtracting the measured temperature from the setpoint temperature (*i* is the loop index). Implement the control signal using this equation:

$$K_P\ \varepsilon_i + K_I \sum_i \varepsilon_i \Delta t$$

where K_P and K_I are coefficients set by Front Panel controls. Multiply the selected heater current with this control signal. The second term of the control signal is a discrete integral where Δt is the wait time of the loop. You will need a shift-register to implement the sum that forms the integral. Keep other controls and indicators the same as Assignment 12 with three heater currents and a temperature chart. Modify the heater current indicator to show percentage of maximum for each of the three ranges (High, Med, Low). The Front Panel should look similar to this, which shows a P-controller asymptotically approaching the temperature setpoint:



This VI must handle two new issues introduced by the magnitude and phase of the control signal: i) What to do when the amount of current demanded exceeds the capacity of the heater? ii) How to interpret a negative sign on the control signal, i.e. what causes the system to cool?

First, it is impossible for the heater to produce more current than its maximum output. When the control signal attempts to set this condition, the VI must clamp the output at its maximum level.

Second, current can only introduce *heat* into the system. When the control signal is negative, it is unphysical to ask the heater to produce a “negative” current that somehow produces cooling. The only mechanism available for cooling is thermal conduction to ambient (coldfinger temperature); this is done by setting the current to zero when the control signal is < 0.

This VI will be interfaced to the Elvis board to control the temperature of a power resistor, replacing the thermostat of Lab 13.