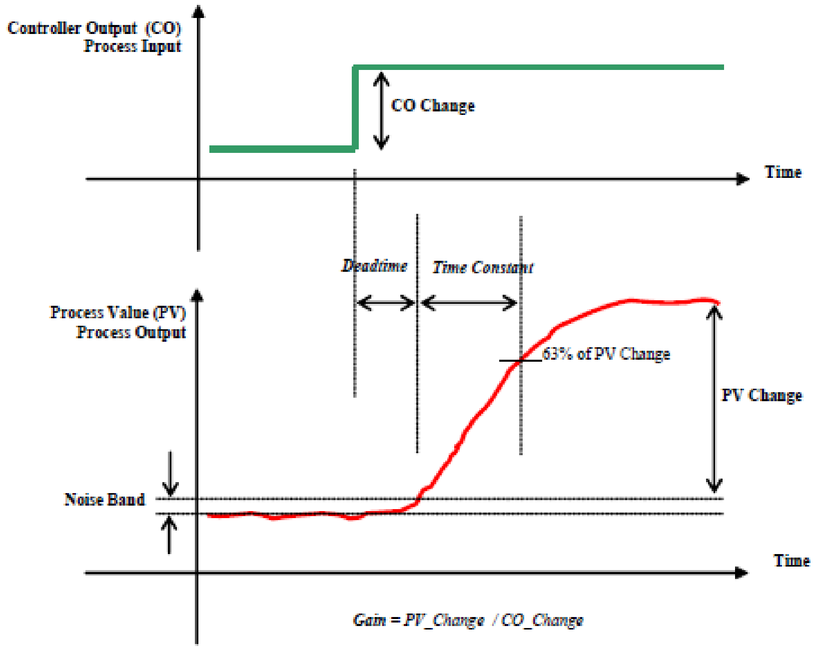
End of Semester Project
Part 3

ver 1.1

Note: Due to limited lab equipment, you will probably have to work on this lab outside of normal lab times.

Objective	Tune a speed control loop via an open loop response test and to gain an understanding of tuning parameters.
Procedure	Using the VI created in Part 1, you will perform an Open Loop Response test as follows: Verify that your graphs are displaying the output and the speed (in RPM) and verify the X-axes match up and are aligned on the screen. Turn on Gridlines on your graphs by right clicking on the graph then Select Properties | Scales. Select the Amplitude (Y-Axis) and change the Major and Minor grids to white or grey. Do the same for the X-Axis. Run the VI and turn on the motor and a reasonable speed and allow the speed to stabilize. Now you will make a significant change to the output (say 0.5V) and then stop the VI before the change in the output scrolls off the graph. If the motor speed did not stabilize, redo the above steps, using a smaller change. Right click on your graph and EXPORT the data to Excel. Use the spreadsheet to redraw the graph and to find values / do calculations. This spreadsheet WILL be handed in as part of the lab (so make it intuitive and as clear as possible). Please rename the excel sheet “Initial Tuning” You should have graphs that look something like:

	 Use your graphs to determine the PV change (ΔPV) , Control Output Change (ΔOut), Deadtime and Time Constant (τ)[1]. ΔPV = ______________________ ΔOut = ______________________ Deadtime = __________________ τ = _________________________ NOTE: **your times need to be in seconds, not counts** (make sure you take into account how often the graph(s) get their data and how often does the loop in the VI run). Now we will estimate the gains needed for the PID control using the above information: $$Model\ Gain = \Delta PV/\Delta Out$$ $$K_p = 2 * \frac{(Deadtime + \tau)}{Model\ Gain}$$

[1] https://www.controlglobal.com/assets/Media/MediaManager/ControlSoftInc_PID.pdf

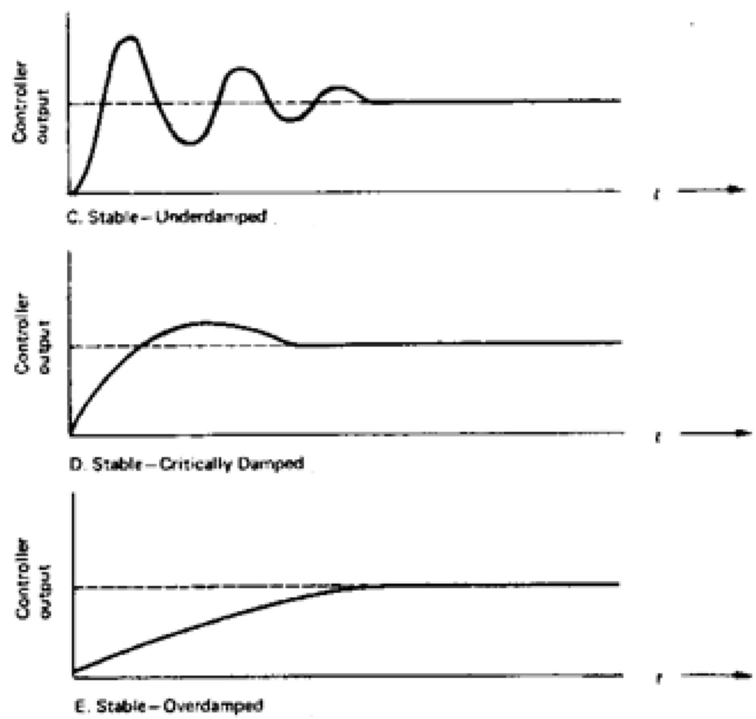
$$T_i = (Deadtime + \tau)$$

$$T_d = \frac{Deadtime}{3} \; OR \; \frac{\tau}{6}$$

Use the rule of thumb: *For a slow loop, select whichever is greater, for a fast loop, select the smaller value*.

Speed is considered a “Fast Loop”.

Now open your PID VI and use the above values for the gains. Run the VI and test to see what response you get from the control (ie when you change the Setpoint, how does the PV respond?)



Hint: you might want to turn on gridlines for your PID VI.

You should have gotten a response somewhere between the Underdamped and Critically Damped graphs above, if you did not, go back and check your work above (paying special attention to the note about the Time Scale).

Capture the following Data (put in same spreadsheet on a different page and name the sheet as shown. Include a PV and MV Graphs for EACH):

- +1000 RPM setpoint change response (using calculated values)
- -1000 RPM setpoint change response (using calculated values)

Call the sheet "First Response Test" and graph both MV and SP.

Now set T_d to zero and capture the following images:

- +1000 RPM setpoint change response
- -1000 RPM setpoint change response

Call this sheet "TD=0"

Did the response get better or worse (answer in spreadsheet and try to explain why)?

With T_d set back, change K_p a small amount in the positive direction and capture the following images:

- +1000 RPM setpoint change response
- -1000 RPM setpoint change response

If you did not see a change in the response, change K_p a little more and repeat.

Call this sheet "KP+"

What effect did it have? Did the response get better or worse (answer in spreadsheet and try to explain why)?

Now change K_p a small amount in the negative direction (from the calculated value) and capture the following images:

- +1000 RPM setpoint change response
- -1000 RPM setpoint change response

If you did not see a change in the response, change K_p a little more and repeat.

Call this sheet "KP-"

What effect did it have? Did the response get better or worse (answer in spreadsheet and try to explain why)?

With K_p set back, change T_i a small amount in the positive direction and capture the following images:

- +1000 RPM setpoint change response
- -1000 RPM setpoint change response

If you did not see a change in the response, change T_i a little more and repeat.

	Call this sheet "TI+" What effect did it have? Did the response get better or worse (answer in spreadsheet and try to explain why)? Now change T_i a small amount in the negative direction (from the calculated value) and capture the following images: - +1000 RPM setpoint change response - -1000 RPM setpoint change response If you did not see a change in the response, change T_i a little more and repeat. Call this sheet "TI-" What effect did it have? Did the response get better or worse (answer in spreadsheet and try to explain why)? Lastly, with T_i set back, find a K_p that will generate each of the following: - Underdamped - Overdamped - Critically Damped Capture the same responses for each, making sure to record the values of K_p. Put on individual sheets called "Underdamped", "Overdamped" and "Critically Damped" respectively. Turn in a zip file containing: - Excel with the calculations, captures, analysis of captures etc - All VI's for Labs