End of Semester Project
Part 3

ver 2019-2.0

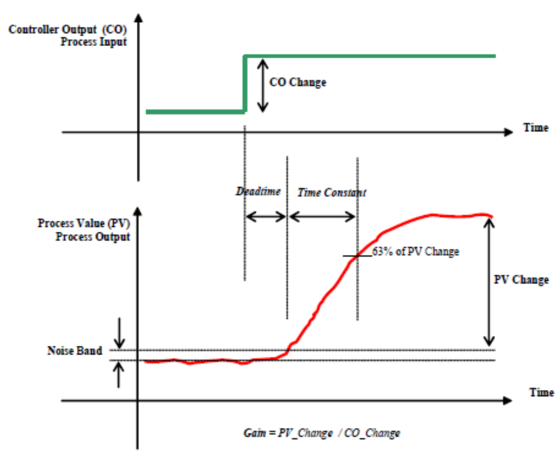
<table>
<tr><td>Objective</td><td>Tune a speed control loop via an open loop response test and to gain an understanding of tuning parameters.</td></tr>
<tr><td>Procedure</td><td>Run the VI, place it in manual mode and turn on the motor and a reasonable speed and allow the speed to stabilize.

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, changing the graph speed.

Save the data from the graph by right clicking on your graph and EXPORT the data and paste it to a new sheet within the file you used for the Motor Speed Calibration. Name the calibration sheet (Cal) and name the new sheet (Tuning). 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).

You should have graphs that look something like:



Please note VI Speed (wait block input), Graph and Speed on the spreadsheet.

Calculate ΔPV, ΔOut, Deadtime and τ using your Data/Graph. All these should be calculated using EXCEL and formulas should be pointing to values within the data or other calculations.</td></tr>
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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 calculate the gains needed for the PID control using the above information:

$$Model\ Gain = \Delta PV/\Delta Out$$

$$Proportional\ Band = \frac{100}{Model\ Gain}$$

$$K_p = 2 * \frac{(Deadtime + \tau)}{Model\ Gain}$$

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

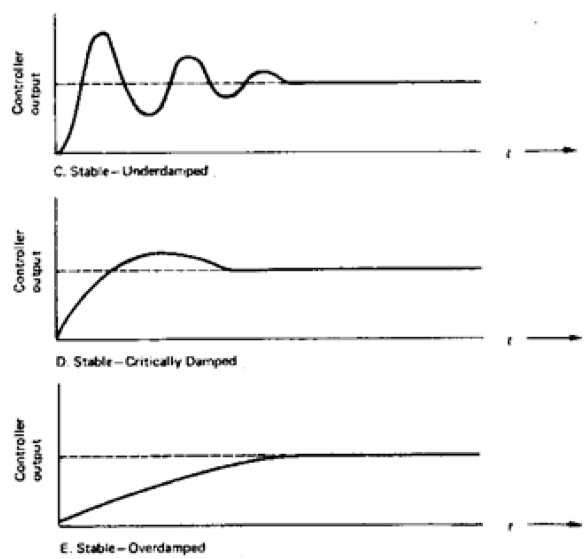
$$T_d = \frac{Deadtime}{3}\ OR\ \frac{\tau}{6}$$

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".

Again these should be calculations pointing to other values on the spreadsheet (not static values).

Enter the above values for the gains. Run the VI in automatic and test to see what response you get from the control (ie when you change the Setpoint, how does the PV respond?)



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).

- Using the Calculated values for gains

    - Start at 1500 RPM and wait for steady state
    - Change SP to 2000 capture data when steady state is reached

    Capture data and place in excel spreadsheet on new sheet called “1st Response” and graph both MV and SP.

- Now set Kp = Calculated Kp*4 (other values as calculated)

    - Start at 1500 RPM and wait for steady state
    - Change SP to 2000 capture data when steady state is reached

    Capture data and place in excel spreadsheet on new sheet called “2nd response” and graph both MV and SP.

- Now set Ti = Calculated Ti * 2 (other values as calculate)

    - Start at 1500 RPM and wait for steady state
    - Change SP to 2000 capture data when steady state is reached

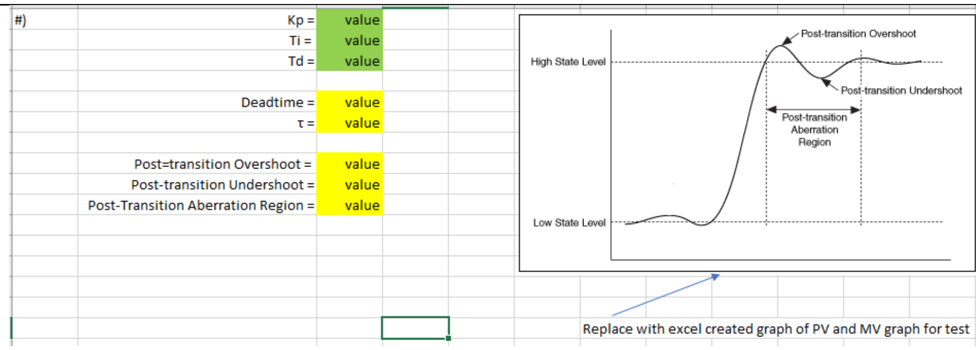
    Capture data and place in excel spreadsheet on new sheet called “3rd response” and graph both MV and SP.

- Now set Td = 0 (Other values as calculated
    - Start at 1500 RPM and wait for steady state
    - Change SP to 2000 capture data when steady state is reached

    Capture data and place in excel spreadsheet on new sheet called “4th response” and graph both MV and SP.

Analyze Data:

Add an additional sheet to the excel file. Name the sheet “Analysis”. For each of the captures above, create the following:



Notes:

- Green highlighted values are from instructions (what you put into the PID control for gains)
- Yellow highlighted values are calculated from the REPONSE data collected
- you might not have overshoot or undershoot for some of the tests, if that is the case, put NA in for value.

On the sheet, draw conclusions from the data. What effect did each change have (relative to the initial tuning)?

What tuning do you feel is the “best response”? Justify your answer with the data collected.

<u>Turn in a zip file for your group containing:</u>

- Excel with the calculations, captures, analysis of captures etc (total of 7 sheets: Cal, Tuning, 1st Response, 2nd Response, 3rd Response, 4th Response and Analysis)
- PID VI
- PID VI Documentation (in RTF file)