Proportional-Integral Motor Speed Control Homework

1. **a.** Load into Multisim the PI simulation in this Brightspace homework module.

b. Verify that SP=100% and PV=0% (grounded) and $k_p = 1$, $k_i = 0$, and $CO_{max} = 100$ (**Upper Voltage Limit)**

c. Run the simulation to verify:

error = 100%, $V_{out\ power\ interface} = 18V$, rev/sec = 29 rev/sec, sensor out = 59 kHz

d. Set V1 to provide an Initial and a Final voltage of 0 V.

e. Run the simulation to verify:

error ~0, $V_{out\ power} \sim 0$, rev/sec ~ 0, sensor out ~0

f. This verifies that the complete loop is properly calibrated in %. So ***m*** **= 1**.

g. Reset V1, the SP, with a step that goes from 25 to 75 at 1 sec.

h. Remove the output of the B input of the error summer from ground and connect it to -1V/V calibration triangle.

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2. **a.** To be sure that the controller is never driven to its maximum or to 0 (even for a full-scale step in set point), set $k_p = 1$, $k_i = 0$, and $CO_{max} = 100$ (**Upper Voltage Limit)**. This creates a Proportional controller.

b. Change the **Analysis & Simulation** to **Transient.** **TSTOP = 2sec**
Output $V_{set\ point\%}$, $V_{controller\ out\%}$, and $V_{revpersec\ \%}$

c. Run the Transient Analysis. Place data marks on the highest and lowest values of $V_{set\ point}$, $V_{controller\ out}$, and $V_{revpersec\ \%}$. Save this plot to submit.

d. Write and submit a paragraph describing the performance, rating it as outstanding, ok, or crappy. Explain why the system is performing this way.

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3. **a.** Leave $k_p = 1$. Calculate the value for k_i that will make the system ***critically*** damped. Include your calculations with the plots. Enter that value for k_i.

b. Run the Transient Analysis. Place data marks on the highest and lowest values of $V_{set\ point}$, $V_{controller\ out}$, and V_{RPM}. Submit this plot.

c. Write and submit a paragraph describing the performance, rating it as excellent, getting there, or no improvement. Explain why the system is performing this way.

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4. **a.** Leave $k_p = 1$. Cut k_i to half of its value in step 3.a..

b. Run the Transient Analysis. Place data marks on the highest and lowest values of $V_{set\ point}$, $V_{controller\ out}$, and $V_{RPM\ \%}$. Submit this plot.

c. Write and submit a paragraph describing the performance. Explain why the system is performing this way.

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5. **a.** Leave $k_p = 1$. Double k_i to twice its value in step 3.a..

b. Run the Transient Analysis. Place data marks on the highest and lowest values of $V_{set\ point}$, $V_{controller\ out}$, and $V_{RPM\ \%}$. Submit this plot.

c. Write and submit a paragraph describing the performance. Explain why the system is performing this way.

6. **a.** As the motor ages or if it is replaced, its gain and time constant change. Return k_i to the value that caused critical damping. Lower the motor's gain to 1.2 (25% reduction in gain) and increase its time constant to 0.15 (50% slower).

b. Run the Transient Analysis again. Place all of the markers as described above.

c. Write and submit a paragraph describing the performance of the system with different motor constants. Is the performance identical, acceptable, or crappy?