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6.302: Lab 1D

My partner for this experiment was fellow classmate Charles Herder. We shared in all parts of the measurement process.

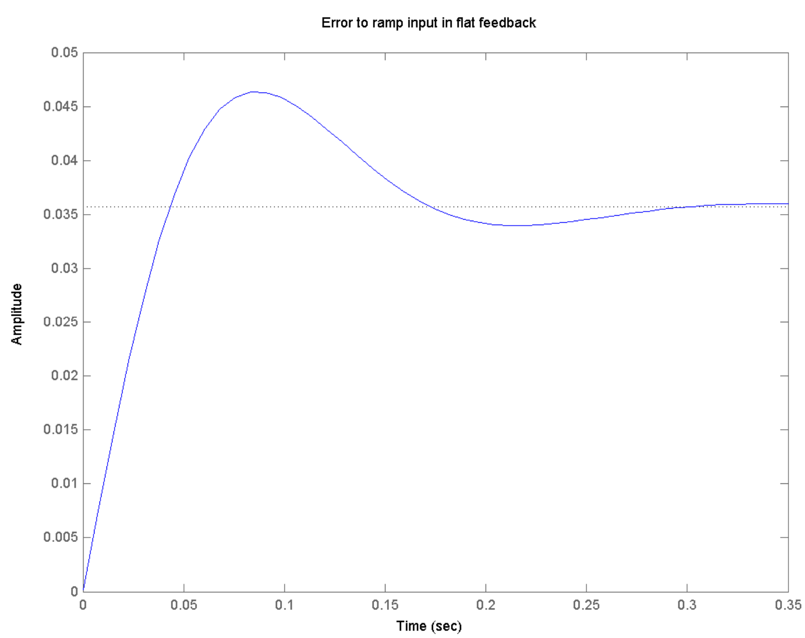
Frequency-independent tachometric feedback

1. We measured $t_p = 97$ ms and $P_0 = 1.15$. This corresponds to a natural frequency of $\omega_n = 38$ radians per second and a damping ratio of $\zeta = 0.51$. While the measurement of natural frequency is above the predicted value of 25 rps, we were able to confirm our measurement on two different apparatuses.

2. We measured the peak frequency to be $\omega_p = 2\pi \cdot 3.1$ Hz, for which the magnitude peaking was $M_p = 1.07$. This yields: $\omega_n = 33.1$ rps and $\zeta = 0.57$. This is consistent with our time-domain measurements.

3. We utilized a 2V peak-to-peak 0.25 Hz triangle wave, which corresponds exactly to a ramp rate of 1V/s. With this input, we measured the steady-state error to be 56mV. This is to be compared to the predicted value of 35mV. We can attribute our larger error to unmodeled friction in the motor system.

4. The plot of the error response is given below:



The following variables decrease the error decay time constant (as they are made larger): G_1, G_2, K_t and K_p; while the variables J, K_{tach} increase the time constant.

Lead-network in tachometric feedback

1. We measured $t_p = 147.4$ ms and $P_0 = 1.06$, which can be translated into $\omega_n = 28.4$ radians per second and a damping ratio of $\zeta = 0.66$. This is in reasonable agreement with the theoretically predicted values of $\omega_n = 24.7$ rps and $\zeta = 0.54$. In particular, we note that it was difficult to measure the peak overshoot accurately, for such low peaking.

2. We measured $\omega_p = 2\pi \cdot 2.8$ Hz and $M_p = 1.16$. This corresponds to $\omega_n = 24.5$ rps and $\zeta = 0.49$. This measurement was hampered by a disfigurement of the output sinusoid. In order to overcome this effect, we drove the system as hard as possible without entering saturation.

3. Using the same input triangle wave as before, we measured the total output error to be 0mV. This agrees with our theoretical prediction.

4. The dependencies of the error time constant are the same as before. However, we add that the time constant increases along with τ of the lead-network. The calculated ramp response error is shown below: