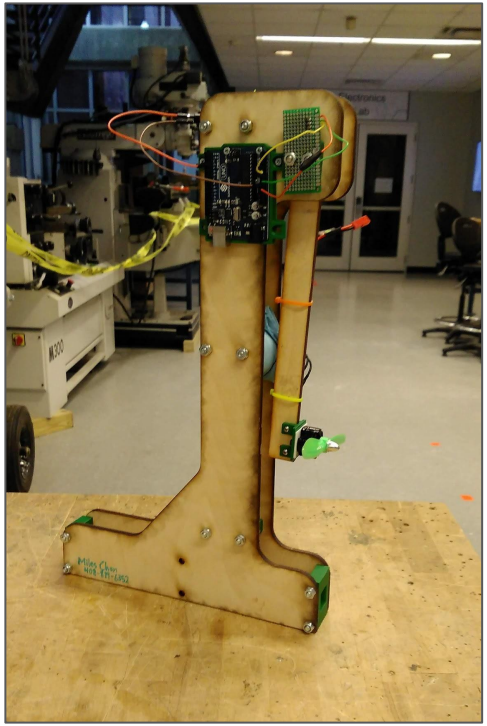
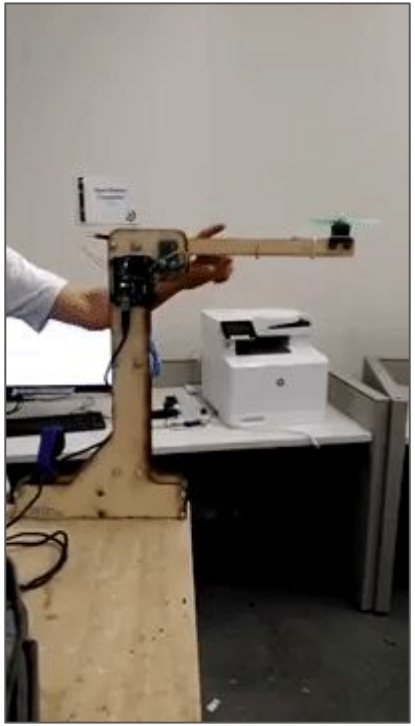
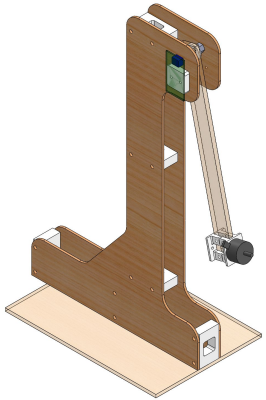
Angular position control of propeller pendulum

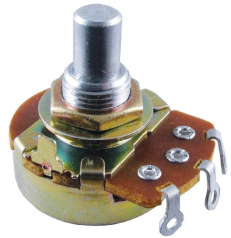




$$\frac{\Theta(s)}{T(s)} = \frac{\frac{L}{J}}{s^2 + \frac{c}{J}s + \frac{gL}{J}\left(\frac{m_1}{2} + m_2\right)}$$



ARDUINO



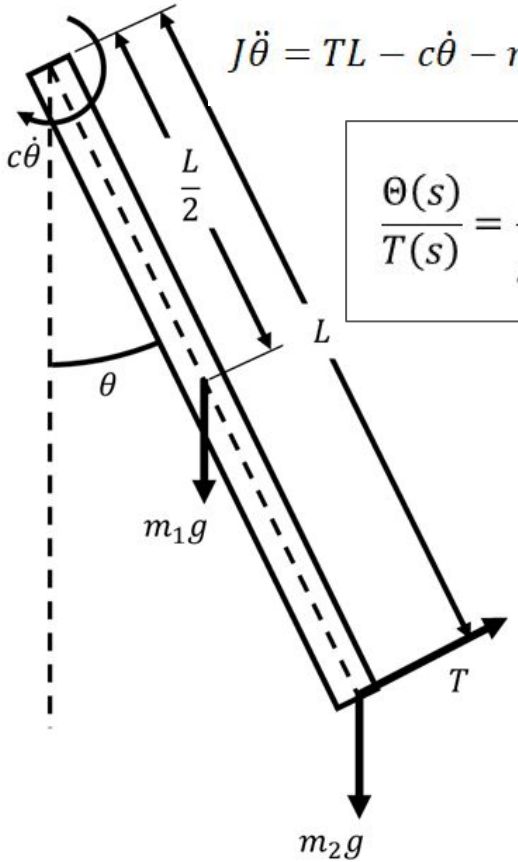
Tyler Boone, Miles Chan

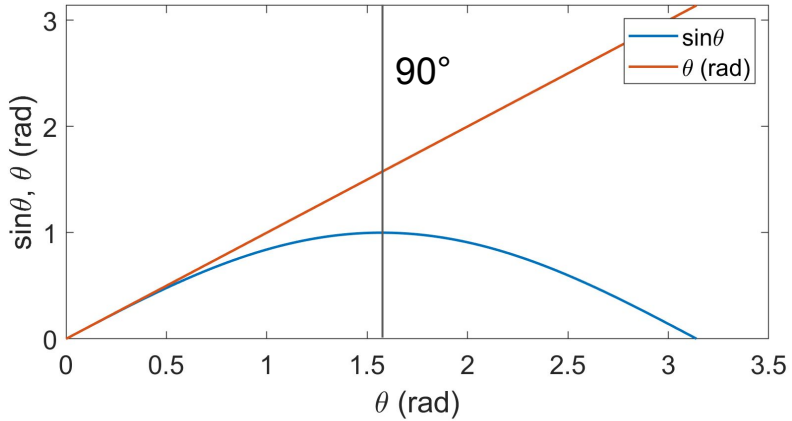
July 25, 2018

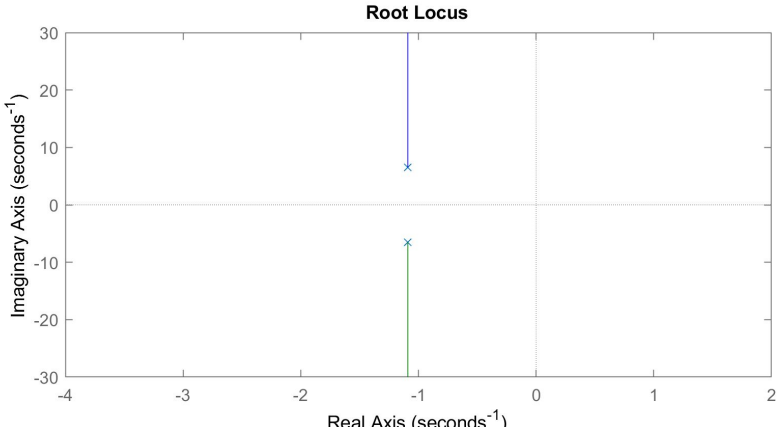
Linearized 2nd order system model

$$J\ddot{\theta} = TL - c\dot{\theta} - m_1 g\frac{L}{2}\sin(\theta) - m_2 gL\sin(\theta)$$

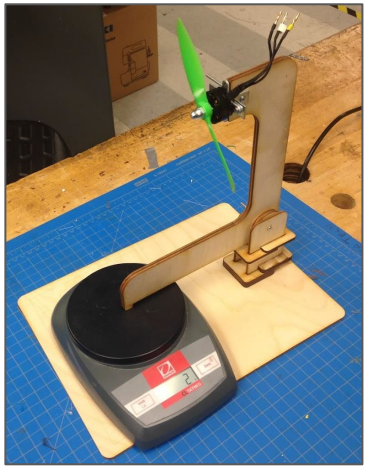
$$\frac{\Theta(s)}{T(s)} = \frac{\frac{L}{J}}{s^2 + \frac{c}{J}s + \frac{gL}{J}\left(\frac{m_1}{2} + m_2\right)}$$

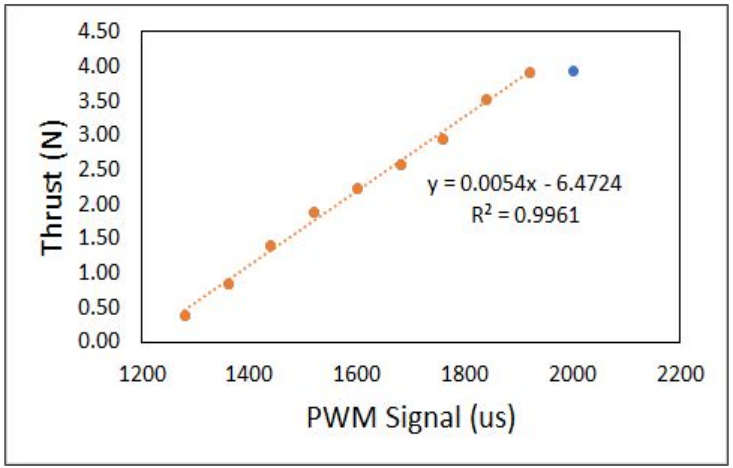


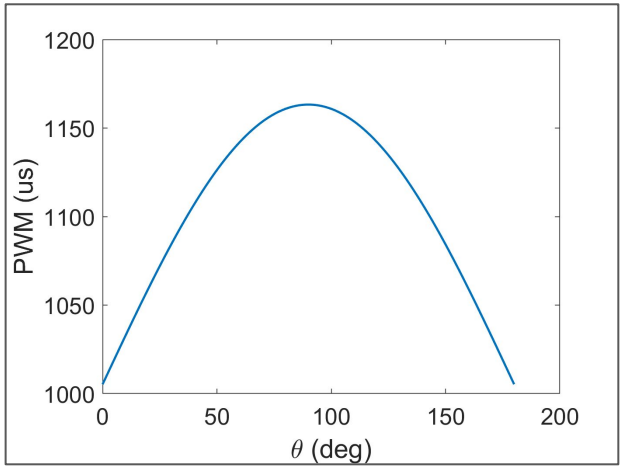


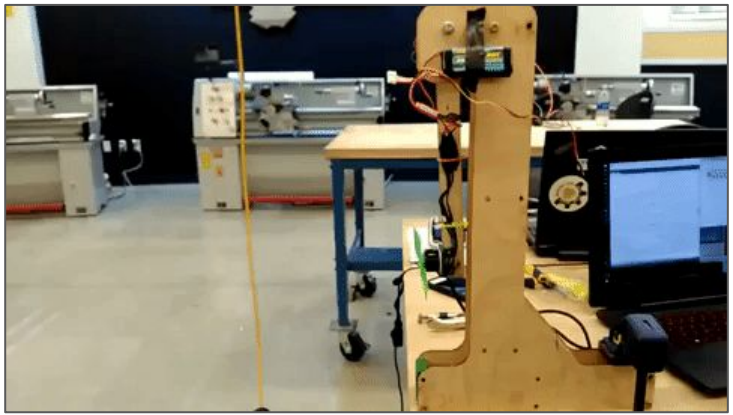


Damping determined from open loop experiment







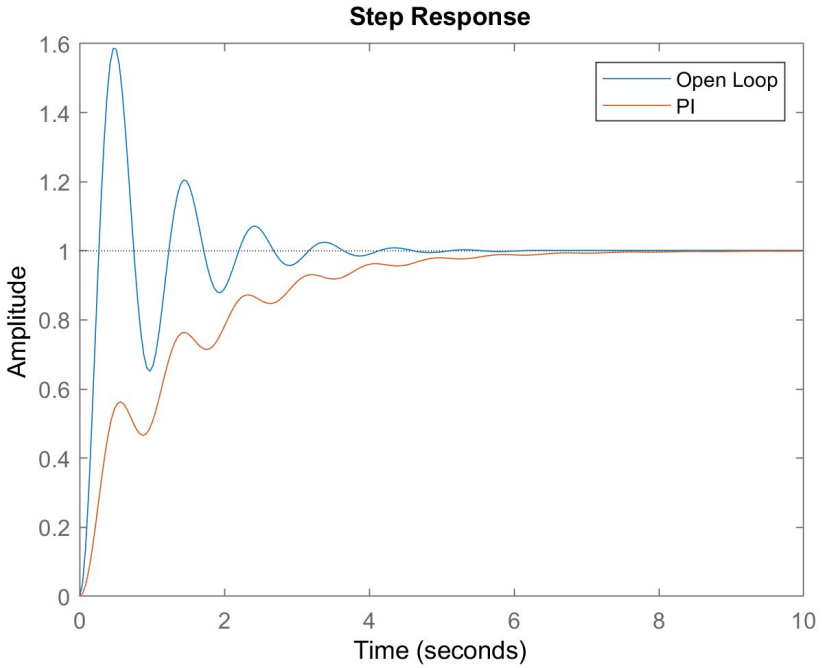


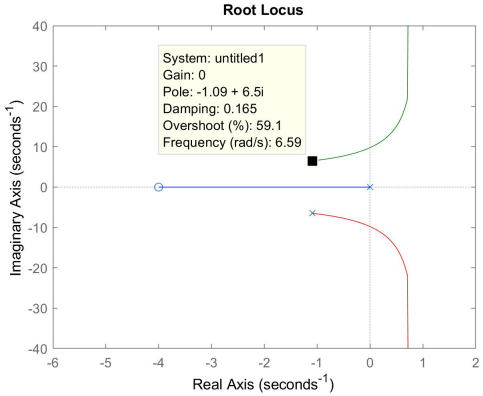
$$T_s = 3.68 = \frac{4}{\omega_n \zeta} = \frac{4}{6.45\zeta}$$

$$\zeta = .1685$$

$$\frac{\theta(s)}{T(s)} = \frac{55.08}{s^2 + 2.166s + 41.6}$$

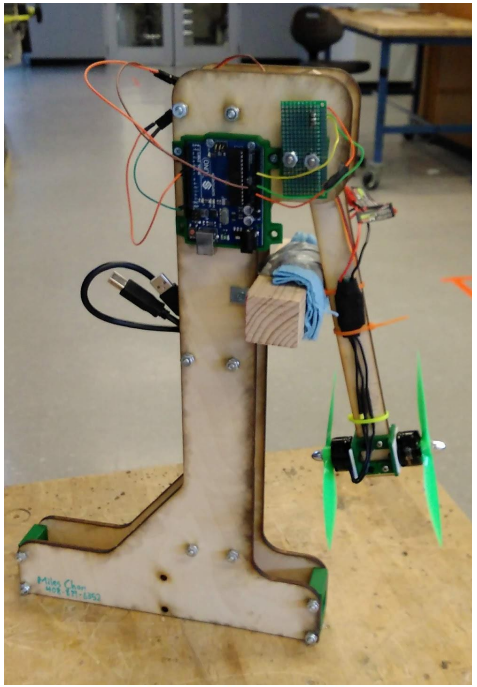
PI control has slow settling time





	Experiment	Simulation
Kp	0.14	0.14
Ki	0.04	0.4

Improved response with thrust in opposite direction

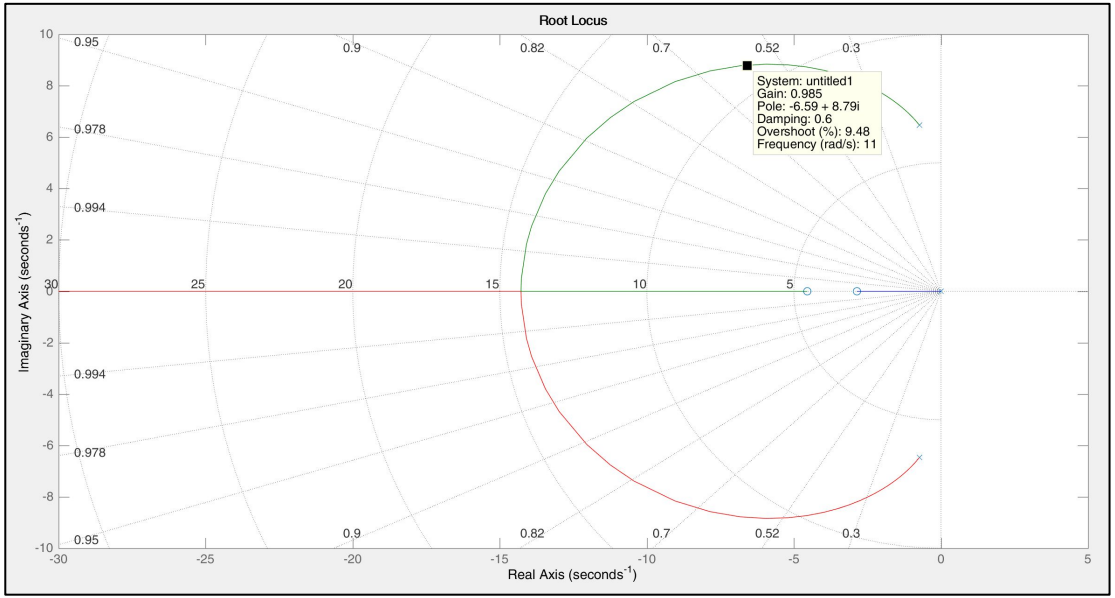


$$T = T_1 - T_2$$
$$T_2 = RT_1$$

PID Control

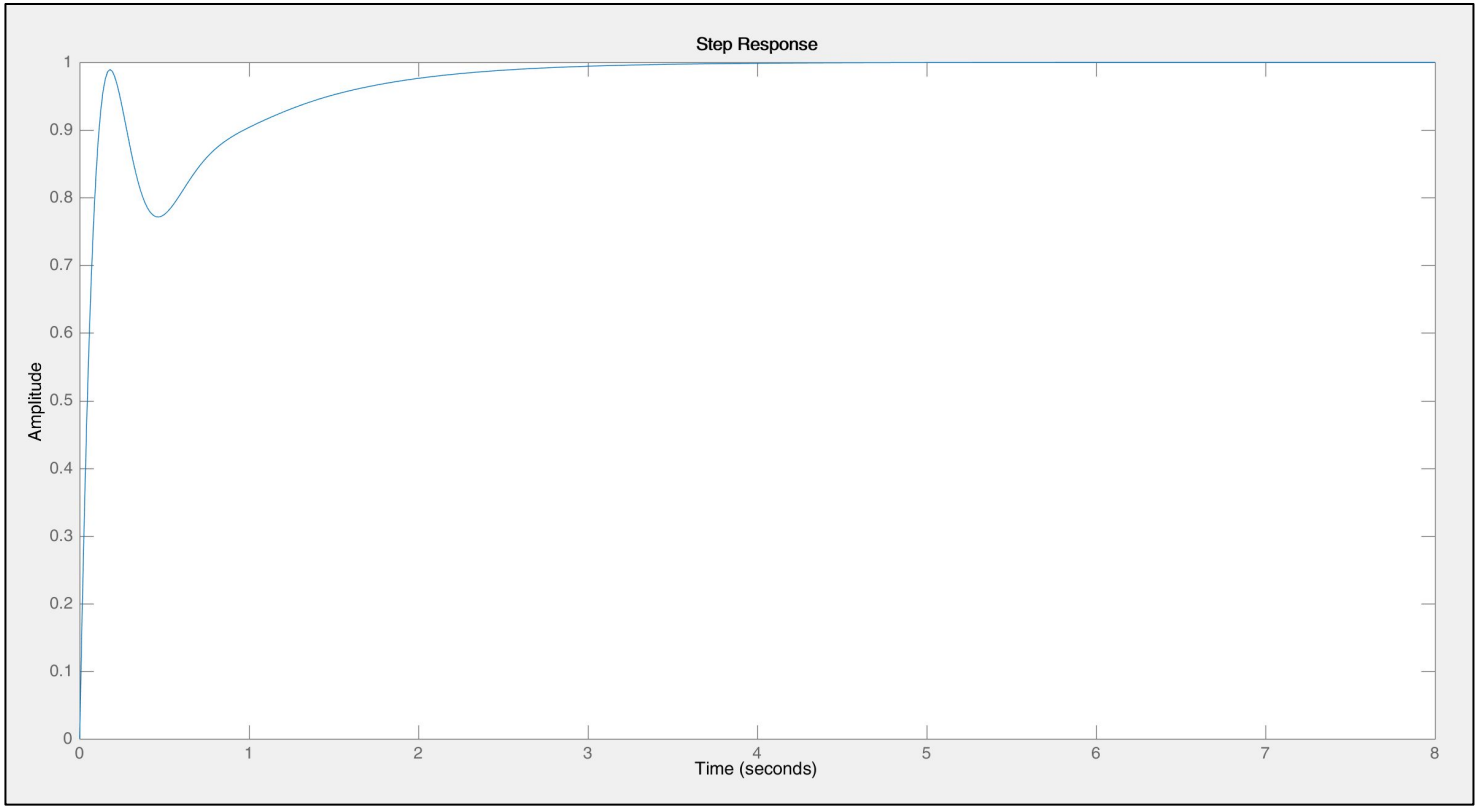
$$M_p = 10\%$$

$$\zeta = \frac{\left|\ln(M_p)\right|}{\sqrt{\pi^2 + \ln(M_p)^2}} = 0.6$$



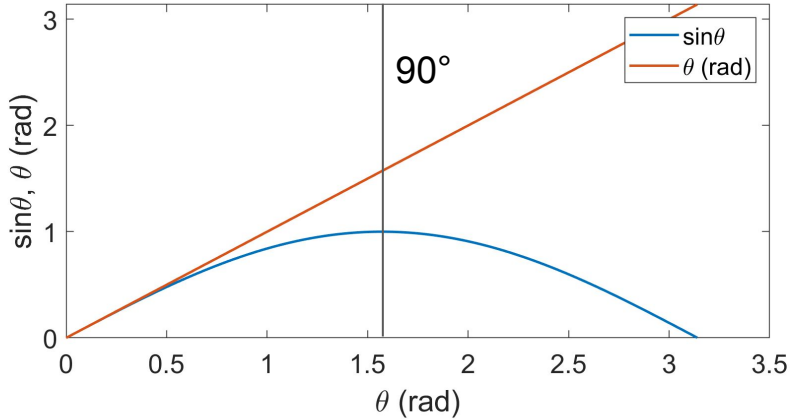
$$PID = \frac{4.7724(0.35s + 1)(0.22s + 1)}{s} = .367s + 2.72 + \frac{4.77}{s}$$

PID Control (cont.)



$$K_d = .367$$
$$K_p = 2.72$$
$$K_i = 4.77$$

Discussion and Future Work



$$T = T_1 - T_2$$
$$T_2 = RT_1$$

$$J\ddot{\theta} = TL - c\dot{\theta} - m_1 g \frac{L}{2}\sin(\theta) - m_2 g L \sin(\theta)$$