

# Project 2

1 b)  $\ddot{\theta} = a\theta + bu$   $a = \frac{mgl}{I} \sin\theta^*$   $b = \frac{L}{I}$

$\downarrow L$

$$s^2 \theta(s) = a\theta(s) + bu(s)$$

$$\left| \frac{\theta(s)}{u(s)} = \frac{b}{s^2 - a} \right|$$

c) Undamped 2nd order system equation:  $\frac{1}{s^2 + \omega_n^2}$

$-a = \omega_n^2$  ;  $\omega_n = \frac{2\pi}{T}$

measure period T

5 periods :  $t_0 = 4.9$  ,  $t_1 = 11.96$

$$T = \frac{11.96 - 4.9}{5} = 1.46s$$

assume  $\theta^* = -90^\circ$  ; about bottom of pendulum arc

$$a_{-90^\circ} = \frac{mgl}{I} \sin(-90^\circ) = -\frac{mgl}{I}$$

$$\omega_n^2 = -a_{-90^\circ} = \omega_n^2$$

$$-\left(-\frac{mgl}{I}\right) = \left(\frac{2\pi}{T}\right)^2 = \left(\frac{2\pi}{1.46}\right)^2$$

$$\frac{mgl}{I} = 18.52$$