Homework: Pole Placement and PID Simulation

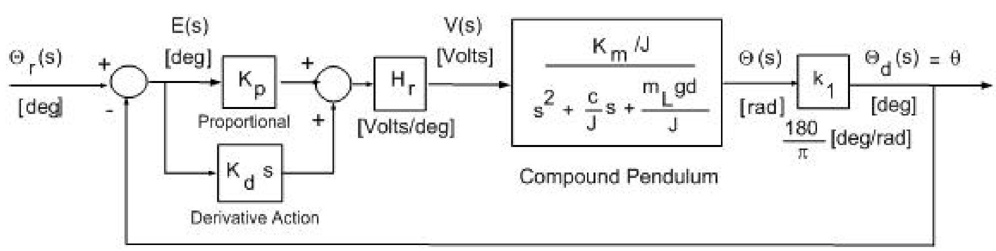
1. In Lab 5, you designed a pole placement controller for the following system

$$\frac{\Theta(s)}{V(s)} = \frac{1.89}{s^2 + 0.039s + 10.77} = G_{ol}(s)$$

Create a pole placement controller in Simulink so that the rise time $t_s = 3.0\sec$ with damping $z = 1.0$. Submit and/or answer the following:

A. Simulink block diagram (use screen capture) (5 points)
B. Printout of Matlab code for pole and gain calculations (5 points)
C. Screen capture displaying the resulting poles and gains from Matlab code (5 points)
D. Scope output hardcopy (angle versus time response) to a 2.0 Volt step input (5 points)

2. Given $k_1 G_{cp} H_r = \dfrac{10.823}{s^2 + 0.039s + 10.77}$ where G_{cp} represents the compound pendulum block, the following is a block diagram of PD control:



Where recall that:

L	Bar length	0.495	m	J	Moment of Inertia	0.0090	kgm^2
d	Pivot to CG distance	0.023	m	c	Viscous damping	0.00035	Nms/rad
m_L	Mass of pendulum	0.43	kg				

A. Show that the closed-loop transfer function is given by (10 points)

$$\frac{\Theta_d}{\Theta_r} = \frac{10.823(K_p + K_d s)}{s^2 + (0.039 + 10.823K_d)s + (10.77 + 10.823K_p)} = G_{cl}$$

B. Look up the Final Value Theorem and state what it is (5 points)
C. Use the Final Value Theorem to show $q_d(\infty) \approx 20$ when K_p is large and a step input $\Theta_r(s) = 20/s$ is applied to the system in Question A above (5 points)
D. Provide a hard copy printout of the scope output using gains $K_p = 0.25$, $K_D = 0.5$ (5 points)
E. Provide a set of gains so that the settling time is less than 3.0 seconds and no overshoot. Include a hard copy printout of the scope output at these gains (5 points)