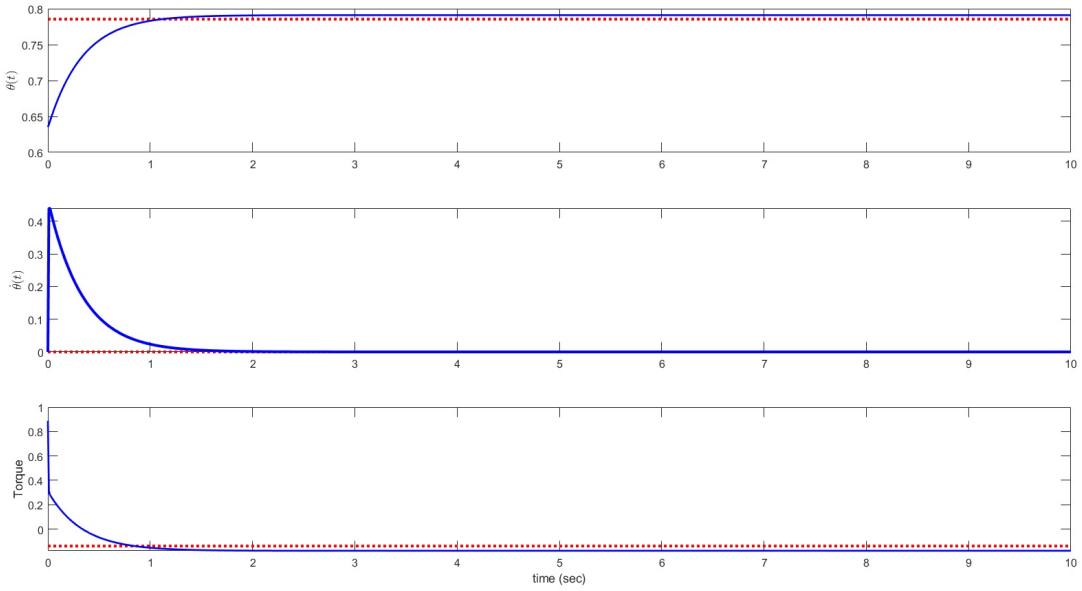
12/02/24	ECE6320/HW14	Howes, Kade

a)

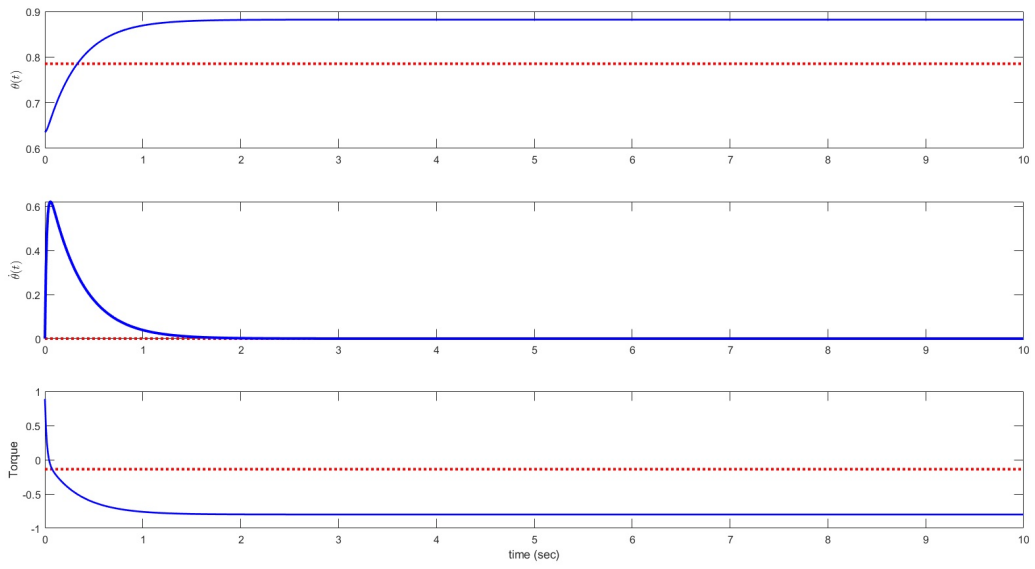
$$Q = \begin{bmatrix} 44.7 & 0 \\ 0 & 4 \end{bmatrix} \qquad R = [1]$$

$$K = \begin{bmatrix} 6.8458 & 1.25 \end{bmatrix} \qquad u_{ff} = -0.1388$$

Without disturbance



With disturbance



Note that with a constant disturbance due to error in our dynamic modeling, our control law without integral control results in a constant steady-state error. The states still converge to a value, but the value is not our desired state. This is expected since our control is calculated without integration or without knowledge of the error in our dynamics modeling.

b) $A_{hat} = \begin{bmatrix} 0 & 1 & 0 \\ 27.72 & -156.8 & 0 \\ 1 & 0 & 0 \end{bmatrix}$, $B_{hat} = \begin{bmatrix} 0 \\ 156.8 \\ 0 \end{bmatrix}$

$Q = \begin{bmatrix} \frac{1}{0.15^2} & 0 & 0 \\ 0 & \frac{1}{0.5^2} & 0 \\ 0 & 0 & \frac{1}{0.2^2} \end{bmatrix}$ $\quad R = [1]$

$K = lqr(A_{hat}, B_{hat}, Q, R)$

$\Rightarrow K = [8.36 \quad 1.2598 \quad 5]$

Control Law:

$u = -0.1388 - [8.36 \quad 1.2598 \quad 5]\left(\begin{bmatrix} \theta \\ \dot{\theta} \\ \sigma \end{bmatrix} - \begin{bmatrix} \pi/4 \\ 0 \\ 0 \end{bmatrix}\right)$

Plot: