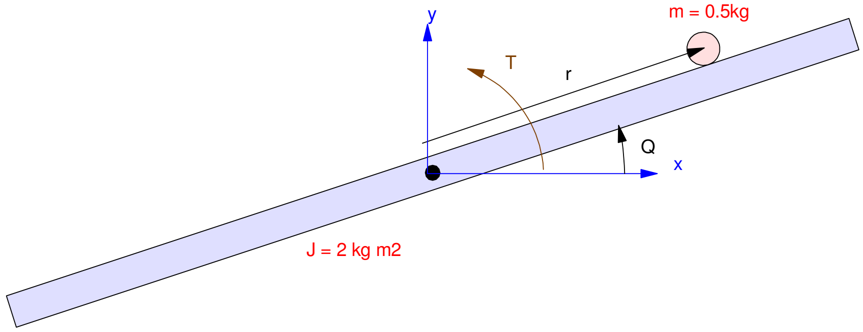
ECE 463/663 - Homework #7

Servo Compensators. Due Monday, March 8th



The dynamics of a Ball and Beam System (homework set #4) with a disturbance are

$$s\begin{bmatrix} r \\ \theta \\ \dot{r} \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & -7 & 0 & 0 \\ -1.96 & 0 & 0 & 0 \end{bmatrix}\begin{bmatrix} r \\ \theta \\ \dot{r} \\ \dot{\theta} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0.4 \end{bmatrix} T + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0.4 \end{bmatrix} d$$

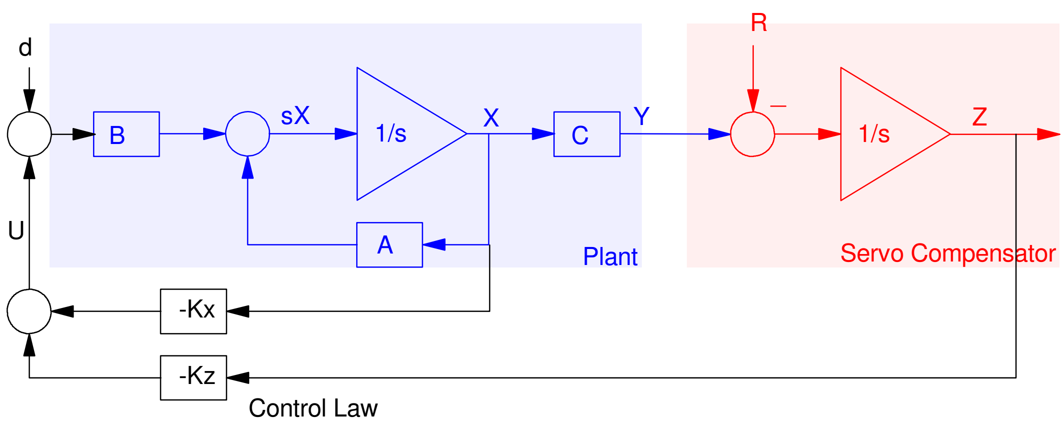
Full-State Feedback with Constant Disturbances

1) For the nonlinear simulation, use the feedback control law you computed in homework #6

- With R = 1 and the mass of the ball = 0.5kg (same result you got for homework #6), and
- With R = 1 and the mass of the ball increased to 0.6kg

(i.e. a constant disturbance on the system due to the extra mass of the ball)

Servo Compensators with Constant Set-Points



2) Assume a constant disturbance and/or a constant set point. Design a feedback control law that results in

- The ability to track a constant set point (R = constant)
- The ability to reject a constant disturbance (d = constant),
- A 2% settling time of 6 seconds, and
- No overshoot for a step input.

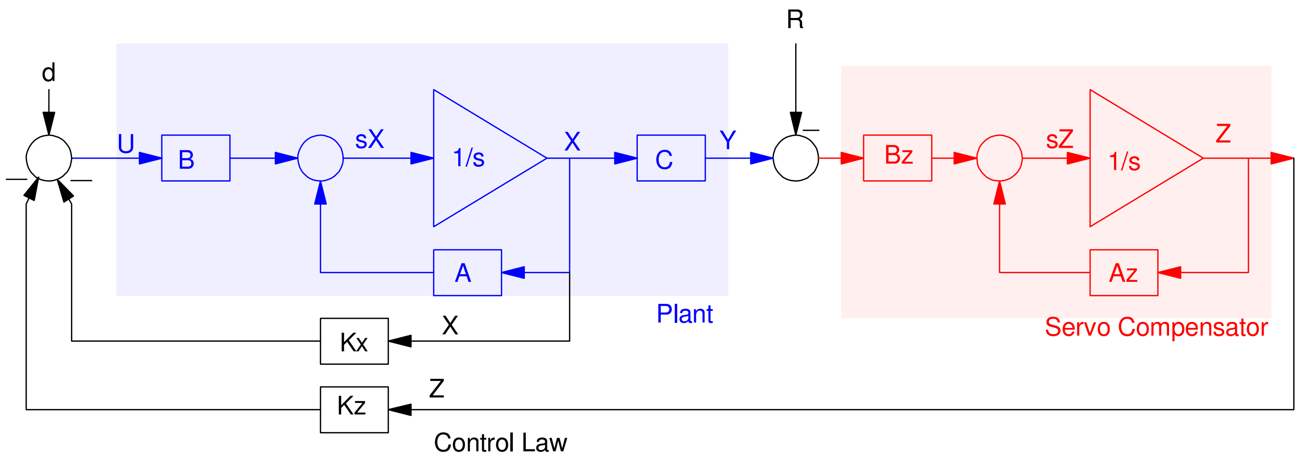
3) For the linear system, plot the step response

- With respect to a step change in R, and
- With respect to a step change in d

4) Implement your control law on the nonlinear ball and beam system

- With R = 1 and the mass of the ball being 0.5kg, and
- With R = 1 and the mass of the ball being 0.6kg

Servo Compensators with Sinulsoidal Set-Points



5) Assume a 1 rad/sec disturbance and/or set point (R). Design a feedback control law that results in

- The ability to track a constant set point (R = sin(t))
- The ability to reject a constant disturbance (d = sin(t)),
- A 2% settling time of 6 seconds, and
- ~~No overshoot for a step input.~~ *the input is a sine wave, so the overshoot for a step input doesn't matter*

6) For the linear system, plot the response

- With R(t) = sin(t), and
- With d(t) = sin(t)

7) Implement your control law on the nonlinear ball and beam system

- With R = sin(t) and the mass of the ball being 0.5kg (nominal), and
- With R = sin(t) and the mass of the ball being 0.6kg (ball has an extra 0.1kg)