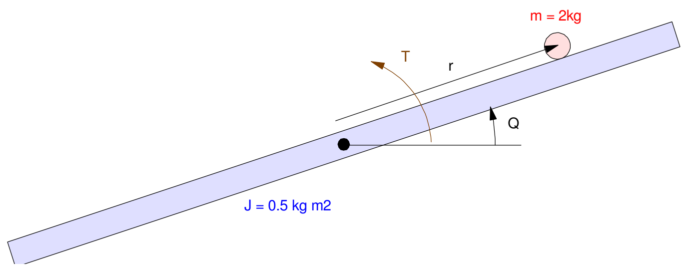
ECE 463/663 - Homework #7

Servo Compensators. Due Monday, March 6th
Please submit as a hard copy, email to jacob.glower@ndsu.edu, or submit on BlackBoard



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

$$s\begin{bmatrix} r \\ \theta \\ \dot{r} \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & -7 & 0 & 0 \\ -7.84 & 0 & 0 & 0 \end{bmatrix}\begin{bmatrix} r \\ \theta \\ \dot{r} \\ \dot{\theta} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0.4 \end{bmatrix} T + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0.4 \end{bmatrix} d$$

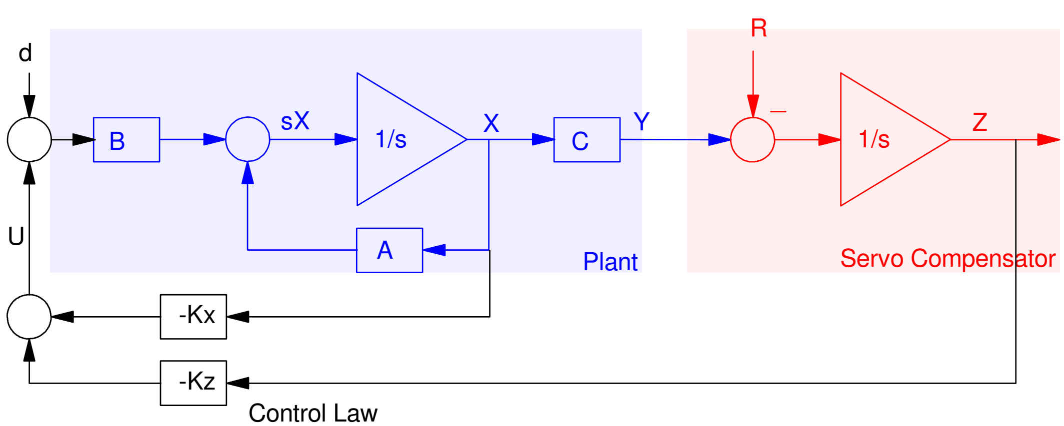
Full-State Feedback with Constant Disturbances

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

- With R = 1 and the mass of the ball = 2.0kg (same result you got for homework #6), and
- With R = 1 and the mass of the ball decreased to 1.5kg

(i.e. a constant disturbance on the system due to a different 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 10 seconds, and
- No overshoot for a step input.

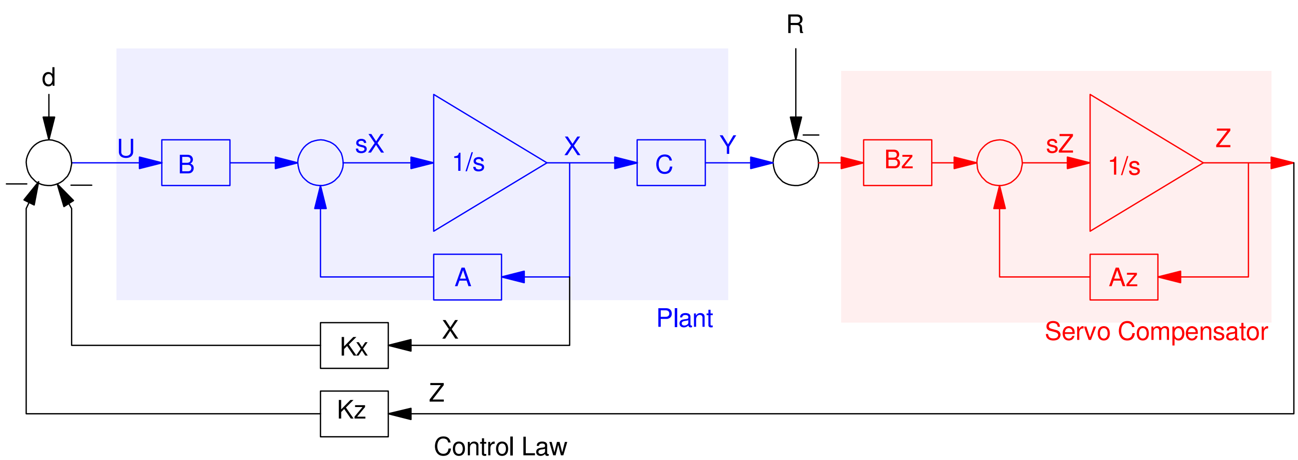
3) For the linear system, plot the step response

- 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 2.0kg, and
- With R = 1 and the mass of the ball being 1.5kg

Servo Compensators with Sinulsoidal Set-Points



5) Assume a 0.5 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(0.6t))
- The ability to reject a constant disturbance (d = sin(0.6t)),
- A 2% settling time of 12 seconds, and

6) For the linear system, plot the response

- With R(t) = sin(0.6t), and
- With d(t) = sin(0.6t)

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

- With R = sin(0.6t) and the mass of the ball being 2.0kg, and
- With R = sin(0.6t) and the mass of the ball being 1.5kg