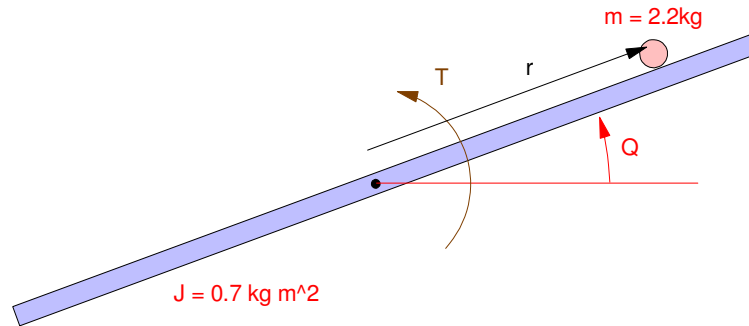


ECE 463/663 - Homework #7

Servo Compensators. Due Monday, March 17th



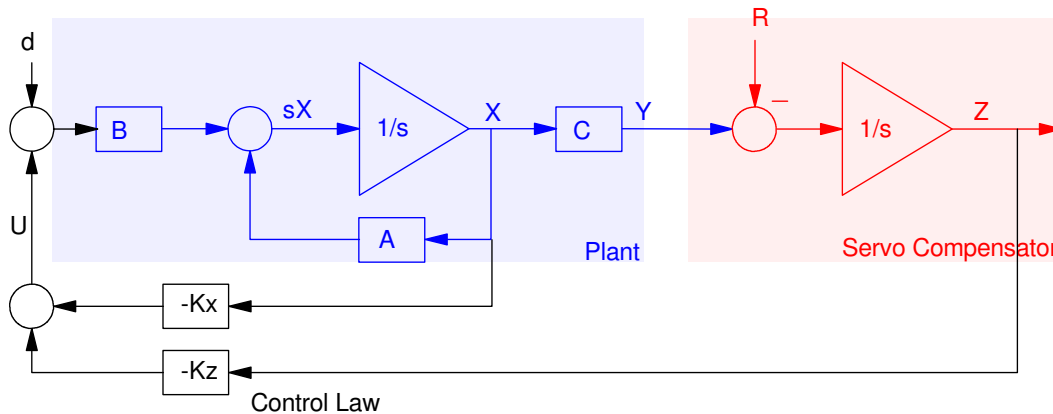
The dynamics of a Ball and Beam System (homework set #4) with a disturbance are

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

Full-State Feedback with Constant Disturbances

- For the nonlinear simulation, use the feedback control law you computed in homework #6
 - With $R = 1$ and the mass of the ball = 2.2kg (same result you got for homework #6), and
 - With $R = 1$ and the mass of the ball decreased to 2.5kg
 (i.e. a constant disturbance on the system due to a different mass of the ball)

Servo Compensators with Constant Set-Points

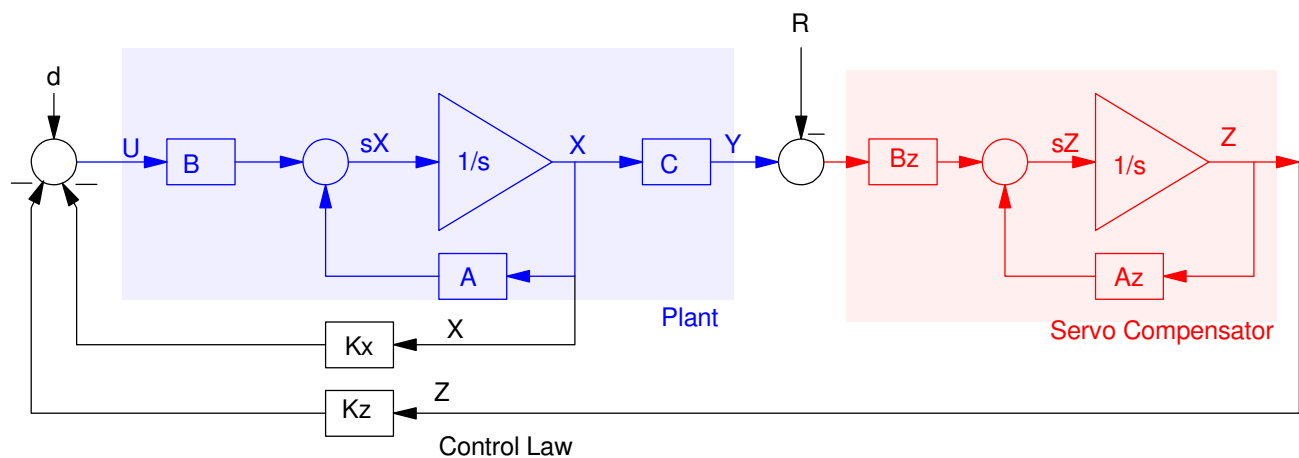


- 2) Assume a constant disturbance and/or a constant set point. Design a feedback control law that results in
 - The ability to track a constant set point ($R = \text{constant}$)
 - The ability to reject a constant disturbance ($d = \text{constant}$),
 - A 2% settling time of 6 seconds, and
 - No overshoot 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 2.2kg, and
 - With $R = 1$ and the mass of the ball being 2.5kg

Servo Compensators with Sinusoidal Set-Points



- 5) Assume a 0.6 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 2.2kg, and
 - With $R = \sin(0.6t)$ and the mass of the ball being 2.5kg