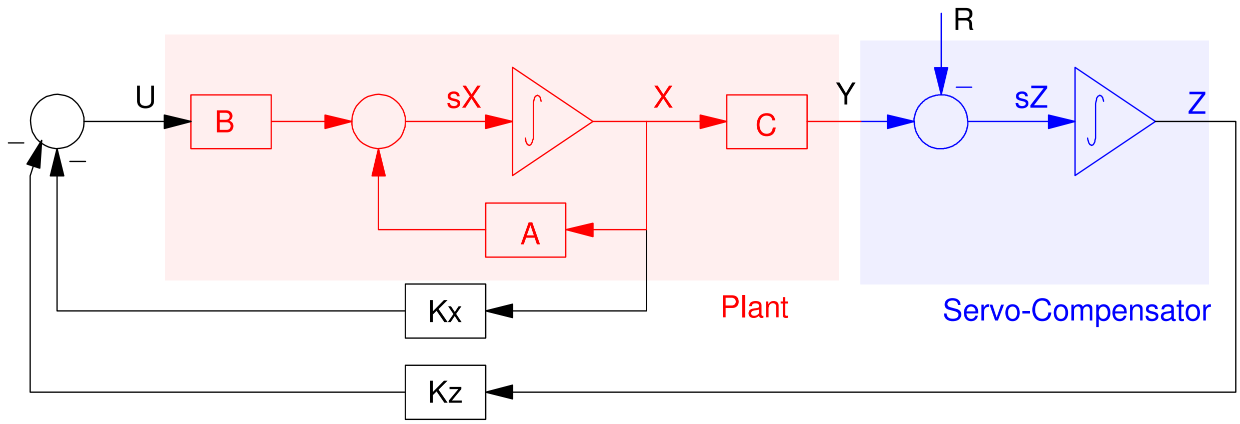
ECE 463/663 - Homework #11

LQG Control with Servo Compensators. Due Monday, April 15th
Please submit as a hard copy, email to jacob.glower@ndsu.edu, or submit on BlackBoard



Cart and Pendulum (HW #4): For the cart and pendulum system of homework #4

$$s\begin{bmatrix} x \\ \theta \\ \dot{x} \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & -2.45 & 0 & 0 \\ 0 & 9.42 & 0 & 0 \end{bmatrix}\begin{bmatrix} x \\ \theta \\ \dot{x} \\ \dot{\theta} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0.25 \\ -0.1923 \end{bmatrix} F$$

Use LQG methods to design a full-state feedback control law of the form

$$F = U = -K_z Z - K_x X$$

$$\dot{Z} = (x - R)$$

for the cart and pendulum system from homework #4 using LQG control so that

- You track constant setpoints,
- You reject constant disturbances,
- The 2% settling time is 8 seconds, and
- There is less than 10% overshoot for a step input.

1) Give the control law (Kx and Kz) and explain how you chose Q and R
2) Plot the step response of the linear system
3) Check your design with the nonlinear simulation of the cart and pendulum system.

Ball and Beam (HW #4): For the ball and beam system of homework #4

$$s\begin{bmatrix} r \\ \theta \\ \dot{r} \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & -7 & 0 & 0 \\ -5.88 & 0 & 0 & 0 \end{bmatrix}\begin{bmatrix} r \\ \theta \\ \dot{r} \\ \dot{\theta} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0.2 \end{bmatrix}T$$

Use LQG methods to design a full-state feedback control law of the form

$$T = U = -K_z Z - K_x X$$

$$\dot{Z} = (x - R)$$

for the ball and beam system from homework #6 using LQG control so that

- You track constant setpoints,
- You reject constant disturbances,
- The 2% settling time is 8 seconds, and
- There is less than 5% overshoot for a step input.

4) Give the control law (Kx and Kx) and explain how you chose Q and R

5) Plot the step response of the linear system

6) Check your design with the nonlinear simulation of the cart and pendulum system.