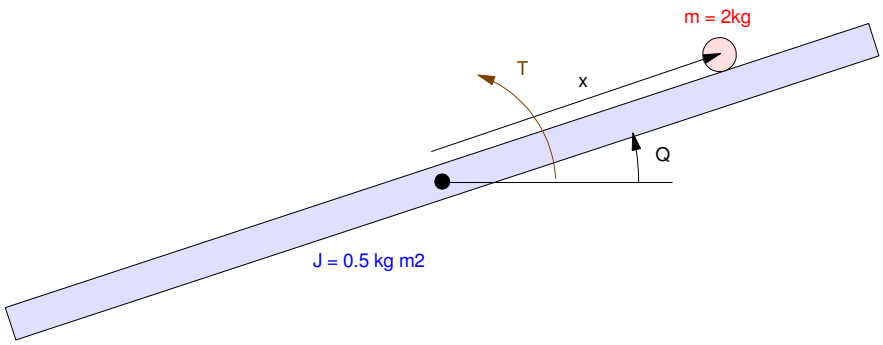
# ECE 463/663 - Homework #5

Servo Compensators. Due Monday, March 2nd




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

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

1) Use the feedaback control you you designed in homeowork #5 of the form

U = Kr * R - Kx * X

to determine the step response of the nonlinear system

- When the mass of the ball is 2.00kg (same as homework #5), and
- When the mass of the ball is 2.2kg

**Constant Disturbance / Set Point**

2) Design a servo-compensator so that it can track a contant set-point and reject a constant disturbance. Provide:

- A block-diagram for the plant - servo compensator - full-state feedback system
- The feedback control law, and
- A step response for
  - d = 0. Ref = 1 (step change in the set point), and
  - d = 1, Ref = 0 (step change in the disturbance)

3) Add the servo-compensator to the nonlinear simulation and find the step response for

- m = 2.0kg, and
- m = 2.2kg

**Sinusoidal Disturbance / Setpoint**

4) Design a servo-compensator so that it can track an 0.5 rad/sec sinusoidal set-point of the form

$$Ref = \sin( 0.5t )$$

Provide:

- A block-diagram for the plant - servo compensator - full-state feedback system
- The feedback control law, and
- A response for
  - $d = 0$. $Ref = \sin(0.5t)$, and
  - $Ref = 0$, $d = \sin(0.5t)$

5) Add the servo-compensator to the nonlinear simulation and find the response for

- $Ref = \sin(0.5t)$

and

- $m = 2.0kg$, and
- $m = 2.2kg$