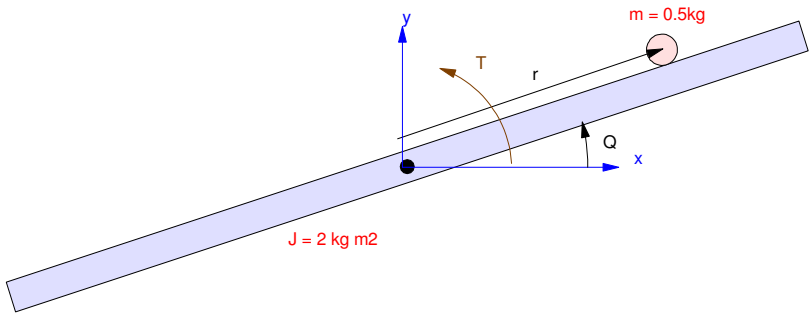
ECE 463/663 - Final Exam

Open book, open notes, internet & matlab permitted. Individual Effort

No giving or receiving help from other people or web sites where other people help you solve these problems

Due Monday, May 10th



Expand homework set #11 to include

- Two sensors (position and angle)
- Noise on both sensors, and
- A constant disturbance on the angle measurement (the angle it reports is slightly off)

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

$y_r = r + n_r$ *position is measured with noise*

$y_\theta = \theta + n_\theta + d$ *angle is also measured, with a constant disturbance*

where there is Gaussian noise at the input and output

$n_u \sim N(0, 0.02^2)$ *mean zero, standard deviation 0.02*

$n_r \sim N(0, 0.01^2)$ *mean zero, standard deviation 0.01*

$n_\theta \sim N(0, 0.03^2)$ *mean zero, standard deviation 0.03*

d *constant disturbance (offset) on the measured angle*

1) Design a feedback control law so that the step response to position (x) has

- No error for a step input,
- A 2% settling time of 8 seconds
- The overshoot for a step input is 5% or less

2) Design a Kalman filter to estimate the states and the constant disturbance using both position and angle

3) Simulate the step response of the linear system with d = 0.1 radian and

- Without any noise, and
- With noise

4) Simulate the step response of the nonlinear system with

- the Kalman filter (full-order observer), and
- A disturbance: d = 0.1 radian.