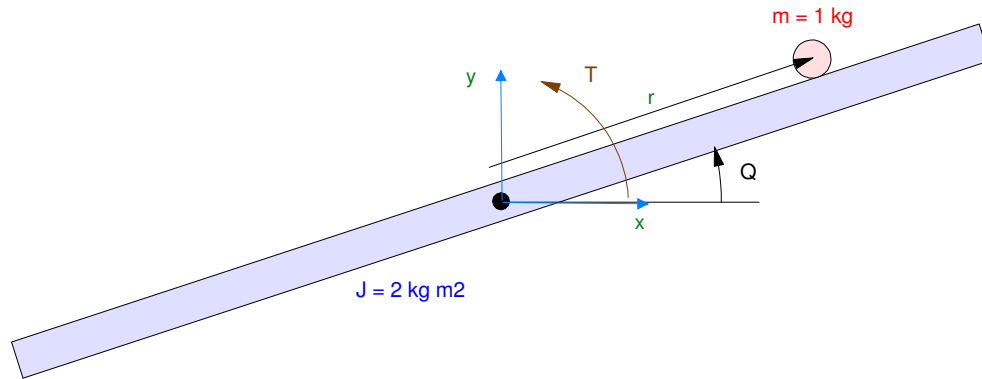# ECE 463/663: Homework #10

Kalman Filters. Due Monday, April 15th



Ball and Beam from homework #4

Use the dynamics for a ball and beam system from previous homework sets

- mass of ball = 1.0kg
- inertia of beam = 2 kg m2
- Closed-Loop System's 2% Settling Time = 6 seconds

Assume that only the beam angle and ball position are measured. Also assume each of these has noise:

$$y_r = r + N(0, 0.01m) \qquad \qquad \textit{Normal( mean, standard deviation )}$$

$$y_\theta = \theta + N(0, 0.002 \text{ radians})$$

Assume that the input (Torque) has a disturbance as well (due to the uncertain ball mass)

$$U_d = N(0, 0.1 \ Nm)$$

1) Design a Kalman filter to estimate the four states of the plant using only position and angle information

2) Design a servo-compensator to track a constant set-point and reject a constant disturbance

3) Simulate the step response of the plant, servo compensator, and observer in Matlab
   - With no noise, and
   - With noise on the sensors and inputs

4) Check your full-order observer design with the nonlinear simulation of the ball and beam system.