

# ECE 463/663 - Homework #12

LQG/LTR. Due Monday, May 1st  
Please submit as a hard copy, email to jacob.glower@ndsu.edu, or submit on BlackBoard

## LQG / LTR

For the cart and pendulum system of homework set #4:

$$s \begin{bmatrix} x \\ \theta \\ \dot{x} \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & -29.4 & 0 & 0 \\ 0 & 26.133 & 0 & 0 \end{bmatrix} \begin{bmatrix} x \\ \theta \\ \dot{x} \\ \dot{\theta} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \\ -0.667 \end{bmatrix} F$$

Design a control law so that the cart and pendulum system behaves like the following reference model:

$$y_m = \left( \frac{0.5}{s^2 + s + 0.5} \right) R$$

### LQG/LTR without a Servo Compensator:

- 1) Give a block diagram for your controller
- 2) (20pt) Plot the step response of the model and the linearized plant for your control law for
  - $Q = 100 e^2$
  - $Q = 1,000 e^2$
  - $Q = 10,000 e^2$

### LQG/LTR with a Servo Compensator:

- 3) Give a block diagram for your controller plus servo compensator
- 4) (20pt) Plot the step response of the model and the linearized plant for your control law for
  - $Q = 100 z^2$
  - $Q = 1,000 z^2$
  - $Q = 10,000 z^2$

