

ECE 302 - Linear System Analysis

Homework #8

Due Date: November 19, 2025

1. Lathi & Green Problem 10.2-4 (Note the system has two outputs, y_1 and y_2 .)
2. **Input-Output System:** For the circuit in the previous problem, perform the following:
 - (a) Compute each transfer function $Y_i(s)/X(s)$ directly from the state space model.
 - (b) Plot the pole-zero diagram for each transfer function.
 - (c) Is the system BIBO stable? Explain.

Remark: The MATLAB commands `pzmap` and `ss2tf` provide checks for this problem.

3. **Unit Step Response:** Consider the state space system

$$\begin{aligned}\dot{q} &= \begin{bmatrix} -1 & -3 \\ 1 & 2 \end{bmatrix} q + \begin{bmatrix} -1 \\ 0 \end{bmatrix} x \\ y &= \begin{bmatrix} -1 & 1 \end{bmatrix} q.\end{aligned}$$

- (a) Compute the output unit step response of this system when the initial condition is zero.
- (b) Simulate this output response using MATLAB. Plot your response from part (a) and the simulated response on the same graph and comment on how they compare.

Remark: The command `step` is useful in this problem.

4. **Transfer Function to State Space Model:** Consider the transfer function

$$H(s) = \frac{3s + 1}{s^2 + 3s + 7}.$$

- (a) Give two distinct state space realizations for $H(s)$.
- (b) Verify your answers in part (a) by explicitly computing the transfer function for each realization.