Revised: October 13, 2025

ECE 601 Linear Systems

Homework #7

Due Date: November 13, 2025

1. Kailath Problem 2.6-3
2. Kailath Problem 2.6-4
3. **Testing for Stability:** For each continuous-time realization below, determine whether the system is BIBO stable and internally asymptotically stable. Repeat the exercise if the realizations are instead for discrete-time systems.

   (a) $A = \begin{bmatrix} 2.5 & 0 & 3 \\ -2.5 & 2.5 & -2.5 \\ -4.5 & 2 & -5 \end{bmatrix}, \quad b = \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix}, \quad c = \begin{bmatrix} 0 & 3 & -1 \end{bmatrix}$

   (b) $A = \begin{bmatrix} 0.5 & -0.5 & 2.5 \\ -1.25 & 1.25 & -1.25 \\ -2.5 & 2.5 & -4.5 \end{bmatrix}, \quad b = \begin{bmatrix} -2 \\ 1 \\ 2 \end{bmatrix}, \quad c = \begin{bmatrix} 2 & 1 & 1 \end{bmatrix}$

4. **Definiteness of Quadratic Forms:** Let $V(x) = x^T P x$ be a quadratic form, where P is an $n \times n$ real symmetric matrix.

   (a) A fundamental theorem in linear algebra is that every real symmetric P can be diagonalized by an orthogonal change of coordinates $z = Tx$. Show that this implies that $V(z)$ can be written as the sum of squares $V(z) = \sum_{i=1}^{n} \lambda_i(P) z_i^2$.

   (b) How can one determine the definiteness of $V(z)$?

   (c) How can the definiteness of $V(x)$ be determined from that of $V(z)$?

   (d) How can the definiteness of $V(x)$ be determined directly from P?