

**1. Controllable Canonical Form - Eigenvalues Placement**

Consider the following linear discrete time system

$$\vec{x}(t+1) = \begin{bmatrix} 2 & -3 & 4 \\ 0 & 0 & 4 \\ 3 & 4 & 7 \end{bmatrix} \vec{x}(t) + \begin{bmatrix} 2 \\ -3 \\ 6 \end{bmatrix} u(t)$$

- (a) Is this system controllable?
- (b) Is the linear discrete time system stable?
- (c) Bring the system in a controllable canonical form as

$$\vec{z}(t+1) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -a_1 & -a_2 & -a_3 \end{bmatrix} \vec{z}(t) + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(t)$$

using transformation  $\vec{z}(t) = T\vec{x}(t)$

- (d) Using state feedback  $u(t) = -[f_1 \ f_2 \ f_3]\vec{z}(t)$  place the eigenvalues at  $0, 1/2, -1/2$ .
- (e) Is the system now stable?

**Contributors:**

- Ioannis Konstantakopoulos.