Tutorial #11 Due: NONE, practice problems

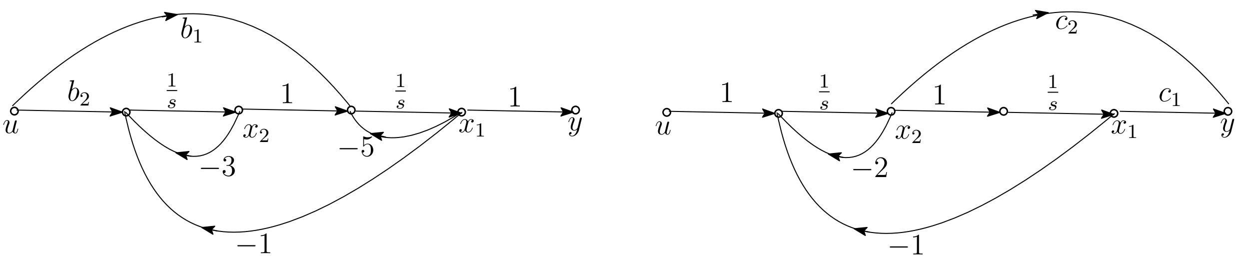
1. Consider a plant represented in state space (controller canonical form) by

$$\dot{x}(t) = Ax(t) + Bu(t)$$
$$y(t) = Cx(t) + Du(t)$$

The transfer function of the plant is then given by $G(s) = D + C(sI - A)^{-1}B$.

   a) Taking a state feedback $u(t) = -Kx(t) + r(t)$ provide the transfer function of the closed loop system $T(s) = \frac{Y(s)}{R(s)}$.

   b) If $G(s) = \frac{P(s)}{Q(s)}$, where $P(s)$ and $Q(s)$ are polynomials with real coefficients, then show that the closed loop transfer function is $T(s) = \frac{P(s)}{Q_d(s)}$, where $Q_d(s) = \det(sI - (A - BK))$. In other words, the state feedback does not alter the zeros of the plant (or) the closed loop zeros are same as the open loop zeros.



(a) Problem 2 (b) Problem 3

Figure 1: Signal flow graph

2. Given the plant shown in figure 1a what relation exists between b_1 and b_2 to make the system uncontrollable?

3. Given the plant shown in figure 1b what relation exists between c_1 and c_2 to make the system unobservable?

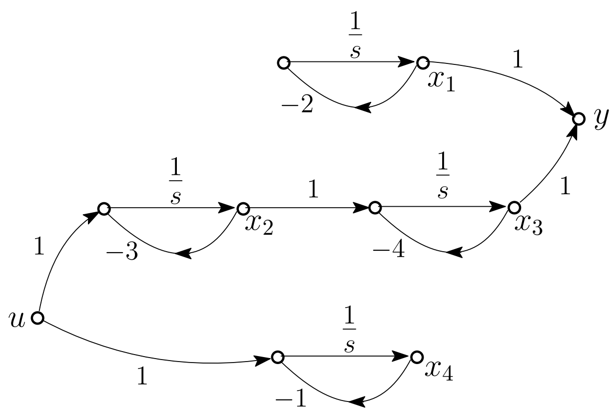


Figure 2: Signal flow graph

4. Given the following open-loop plant $G(s)$ shown in figure 2 design a controller to yield %15 overshoot with a peak time 0.25 seconds.