Exercise 8

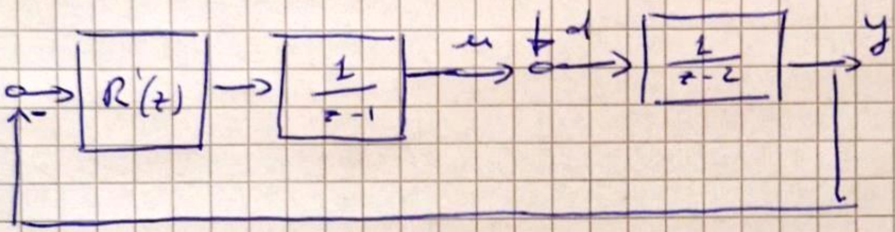
See the notes pp. 54 – 57, 153 – 163

Exercise 9

$$y(k) = \frac{1}{z-2}\left(u(k) + d\right)$$

$\boxed{\text{pole placement + integral action}}$

Solution with transfer functions



$$R'(z) = \frac{f_1 z + f_0}{\gamma_1 z + \gamma_0} \quad , R(z) = R'(z)\frac{1}{z-1}$$

$$P(z) = (z-0.5)^3 = z^3 + p_2 z^2 + p_1 z + p_0$$

$$G'(z) = \frac{1}{z-1}\cdot\frac{1}{z-2} = \frac{1}{z^2 - 3z + 2}$$

$$\begin{vmatrix} 1 & 0 & 0 & 0 \\ -3 & 1 & 0 & 0 \\ 2 & -3 & 1 & 0 \\ 0 & 2 & 0 & 1 \end{vmatrix} \begin{vmatrix} \gamma_1 \\ \gamma_0 \\ f_1 \\ f_0 \end{vmatrix} = \begin{vmatrix} 1 \\ p_2 \\ p_1 \\ p_0 \end{vmatrix}$$

Solution with state space ($y^\circ = d = 0$ for simplicity)

$$\begin{cases} x(k+1) = 2x(k) + u(k) \\ y(k) = x(k) \end{cases}$$

Integrator

$$v(k+1) = v(k) + e(k) = v(k) - y(k) = v(k) - x(k$$

$$\underbrace{\begin{vmatrix} x(k+1) \\ v(k+1) \end{vmatrix}}_{} = \underbrace{\begin{vmatrix} 2 & 0 \\ -1 & 1 \end{vmatrix}}_{A} \begin{vmatrix} x(k) \\ v(k) \end{vmatrix} + \underbrace{\begin{vmatrix} 1 \\ 0 \end{vmatrix}}_{B} u(k)$$

$$u(k) = -K \begin{vmatrix} x(k) \\ v(k) \end{vmatrix}, \quad K = |k_1 \; k_2|$$

$$\cancel{\det A} \; \det(zI - (A - BK)) = (z - 0.5)^2$$

$\boxed{\text{Reduced order observer}}$

$$d(k+1) = d(k)$$

$$\underbrace{y(k+1) - 2y(k) - u(k)}_{\eta(k+1)} = d(k)$$

$$\hat{d}(k+1|k) = \hat{d}(k|k-1) + L\left[\eta(k+1) - \hat{d}(k|k-1)\right]$$

$\boxed{\text{Compensator}}$