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ECEN 380
2/11/2026

PS06: 2.66(b), 2.68(b), 2.69(a), 2.70(b), 2.72(a), MATLAB 2.94

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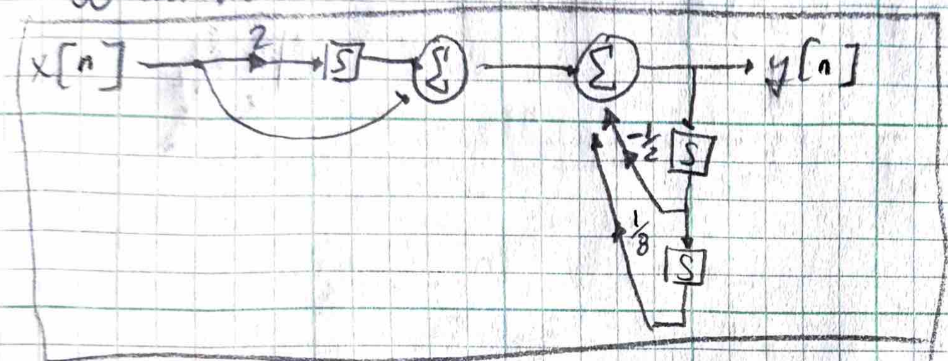
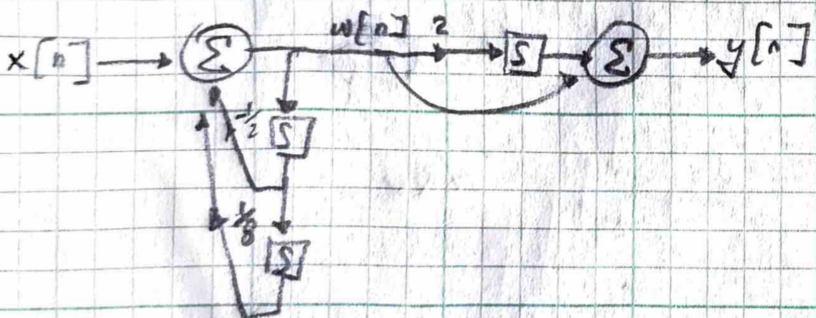
2.66(b) Draw direct form I and II for:

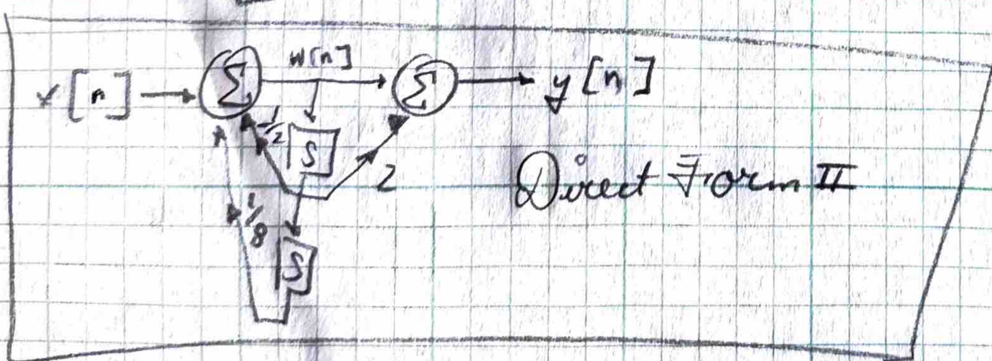
$$y[n]+\tfrac{1}{2}y[n-1]-\tfrac{1}{8}y[n-2]=x[n]+2x[n-1]$$

$$y[n]=x[n]+2x[n-1]-\tfrac{1}{2}y[n-1]+\tfrac{1}{8}y[n-2]$$

Direct Form I

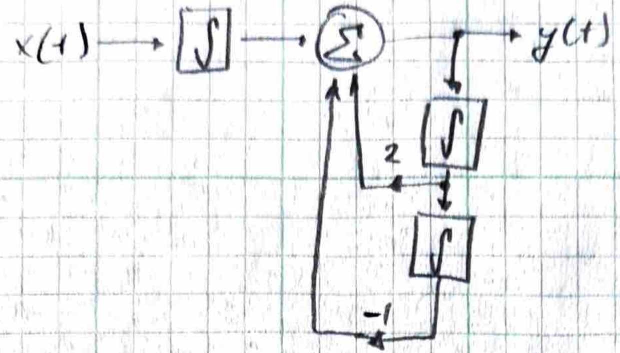






Direct Form II

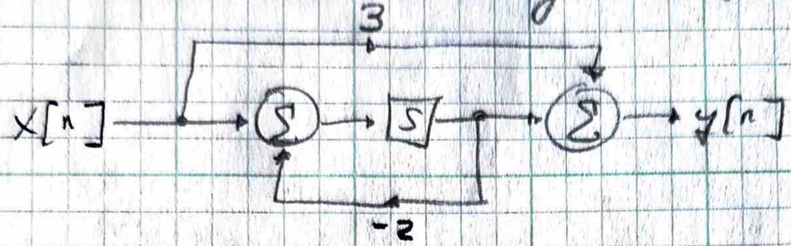
2.68 (b) Find differential-equation description for the system below:

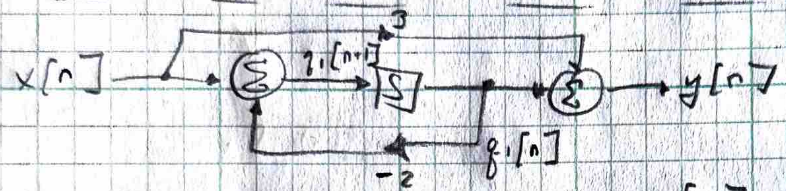


$y(t) = x^{(1)}(t) + 2y^{(1)}(t) - y^{(2)}(t)$ ← w/ integrals

$\boxed{y''(t) = x'(t) + 2y'(t) - y(t)}$ ← w/ derivatives

2.69(a) Determine a state-variable description for the discrete-time system below:





$$q_1[n+1] = -2q_1[n] + x[n] \quad ; \quad y[n] = q_1[n] + 3x[n]$$

define $q = \begin{bmatrix} q_1[n] \\ 0 \end{bmatrix}$

$A = -2$; $b = 1$

$C = 1$; $D = 3$

$\rightarrow$

$$q[n+1] = Aq[n] + bx[n]$$
$$y[n] = Cq[n] + Dx[n]$$

2.70 (b) Draw block diagram representation of the following state-variable description of LTI system:

$$A = \begin{bmatrix} 1 & -\frac{1}{2} \\ \frac{1}{3} & 0 \end{bmatrix}; \quad b = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$$

$$c = [1, -1]; \quad D = [0]$$

General Form State Variable Descriptions:

$$q[n] = \begin{bmatrix} q_1[n] \\ q_2[n] \end{bmatrix}; \quad q[n+1] = Aq[n] + b\,x[n];$$

$$y[n] = c\,q[n] + D\,x[n]$$

substitute vectors:

$$\begin{bmatrix} q_1[n+1] \\ q_2[n+1] \end{bmatrix} = \begin{bmatrix} 1 & -\frac{1}{2} \\ \frac{1}{3} & 0 \end{bmatrix} \begin{bmatrix} q_1[n] \\ q_2[n] \end{bmatrix} + \begin{bmatrix} 1 \\ 2 \end{bmatrix} x[n];$$

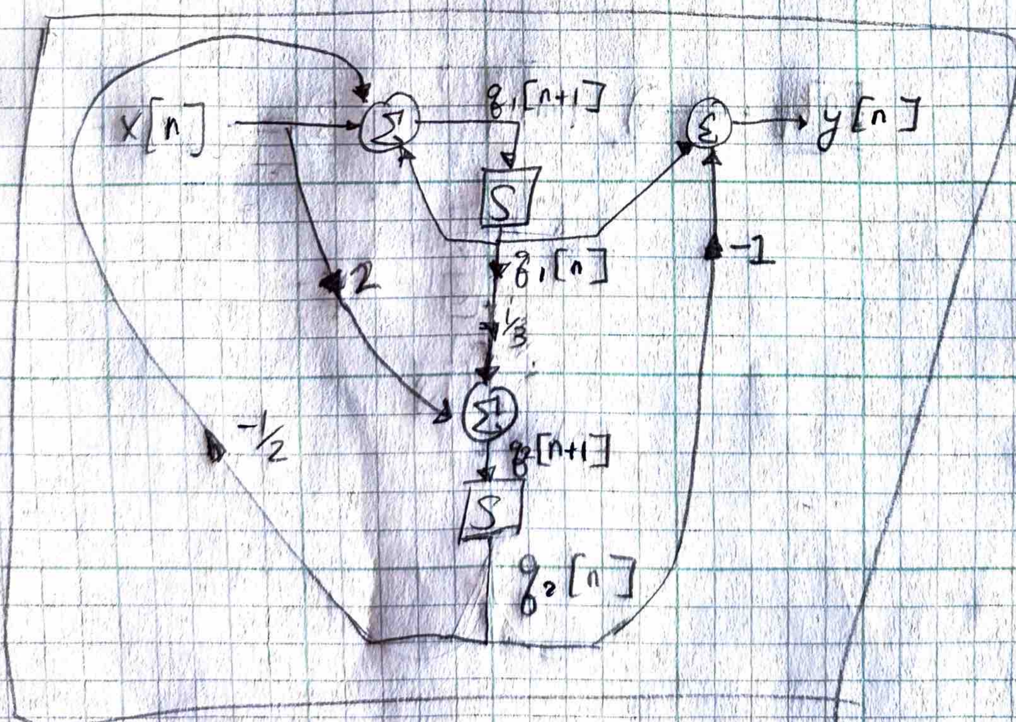
$$y[n] = [1, -1] \begin{bmatrix} q_1[n] \\ q_2[n] \end{bmatrix} + [0]\,x[n]$$

expanded:

$$q_1[n+1] = q_1[n] - \tfrac{1}{2} q_2[n] + x[n]$$

$$q_2[n+1] = \tfrac{1}{3} q_1[n] + 2x[n]$$

$$y[n] = q_1[n] - q_2[n]$$



2.72(a)

Draw the block diagram representation corresponding to the continuous time state-variable description of the following system:

$$A = \begin{bmatrix} \frac{1}{3} & 0 \\ 0 & -\frac{1}{2} \end{bmatrix}; \quad b = \begin{bmatrix} -1 \\ 2 \end{bmatrix}; \quad c = [1, 1]; \quad D = [0]$$

General form: $q(t) = \begin{bmatrix} q_1(t) \\ q_2(t) \end{bmatrix}$; $\frac{d}{dt}q(t) = Aq(t) + bx(t)$

$$y(t) = cq(t) + Dx(t)$$

substitute vectors:

$$\begin{bmatrix} \frac{d}{dt}q_1(t) \\ \frac{d}{dt}q_2(t) \end{bmatrix} = \begin{bmatrix} \frac{1}{3} & 0 \\ 0 & -\frac{1}{2} \end{bmatrix} \begin{bmatrix} q_1(t) \\ q_2(t) \end{bmatrix} + \begin{bmatrix} -1 \\ 2 \end{bmatrix} x(t)$$

$$y(t) = [1 \; 1] \begin{bmatrix} q_1(t) \\ q_2(t) \end{bmatrix} + [0]x(t)$$

expanded: $\frac{d}{dt}q_1(t) = \frac{1}{3}q_1(t) - x(t)$

$$\frac{d}{dt}q_2(t) = -\frac{1}{2}q_2(t) + 2x(t)$$

$$y(t) = q_1(t) + q_2(t)$$