5.10) - There are two zeros and three poles inside the unit circle, so there must be an additonal zero at $z = \infty$

- $H(z)$ is causal.
- ROC of $H(z)$ lies outside the largest pole and includes the unit circle, so the system is stable.
- The inverse of the system will switch the poles and zeros.
- $H^{-1}(z)$ can have a ROC that includes the unit circle making it stable.
- However, $H^{-1}(z)$ will have a pole at $z = \infty$, so, the system cannot be causal.

5.13) For a system to be all-pass, the poles and zeros must occur as conjugate reciprocal pairs.

(a) Yes.

(b) No

(c) Yes.

(d) Yes, because the pole at origin is just a unit delay, and will not change the spectrum.

5.20) For a system to be generalized linear-phase, implemented by a linear const.-coefficient difference eq. with real coefficiens, the zeros must occur as conjugate reciprocals.

(a) yes. Can be a Type I FIR

(b) No. The conjugate reciprocals are missing.

(c) Yes. Type II FIR.

5.40) - A zero phase system has all it's poles and zeros in conjugate reciprocals. GLP systems further have poles at $z = 0, \infty, 1$ or, -1.

(a) - Poles not in conjugate reciprocal pairs, so NOT zero phase or GLP.

- $H_i(z)$ has a pole at $z=0$ and $z=\infty$ so the ROC is $0<|z|<\infty$, so the inverse is stable.

(d) - zeros occur in conj. reciprocal pairs. so the system is zero phase.

- $H_i(z)$ has poles on the unit circle so system is unstable.

*

5.12) (a) Poles $z = \pm j(0.9)$ are inside the unit circle so the system is stable.

(b)

$$H(z) = \underbrace{\frac{1+0.2z^{-1}}{1+0.81z^{-2}}}_{\text{min. Phase}} \cdot \frac{1-9z^{-2}}{1}$$

- Min. Phase system has all it's poles and zeros inside the unit circle.
- All-Pass system poles and zeros occur in conjugate pairs. So we incl. a factor of $(1-\frac{1}{9}z^{-2})$ in both parts of the eq.

$$H(z) = \underbrace{\frac{(1+0.2z^{-1})(1-\frac{1}{9}z^{-2})}{1+0.81z^{-2}}}_{H_1(z)} \cdot \underbrace{\frac{(1-9z^{-2})}{(1-\frac{1}{9}z^{-2})}}_{H_{ap}(z)}$$

5.17) a) There is a zero outside the unit circle at $z=2$ so it's not min. phase.

d) There is a zero outside the unit circle at $z=\infty$, so not min. phase.

5.18) a) - Move all poles and zeros inside the unit circle.

$$H_{min}(z) = 2\left(\frac{(1+\frac{1}{2}z^{-1})}{(1+1/3\,z^{-1})}\right)$$

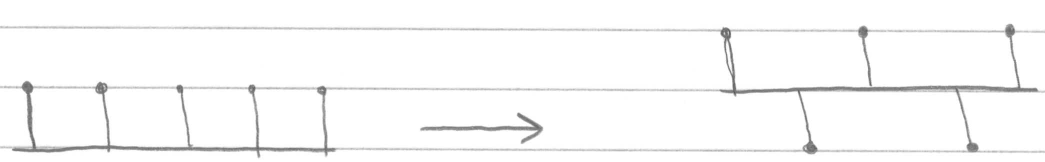
b) Reflect the zero at $z=-3$ to its conjugate reciprocal location at $z=-1/3$, and scale TF.

$$H_{min}(z) = 3\,\frac{(1+1/3\,z^{-1})(1-1/4\,z^{-1})}{z^{-1}(1+1/3\,z^{-1})}$$

5-44) Type II and III cannot be HPF since they both need to have a zero at $z=-1$.

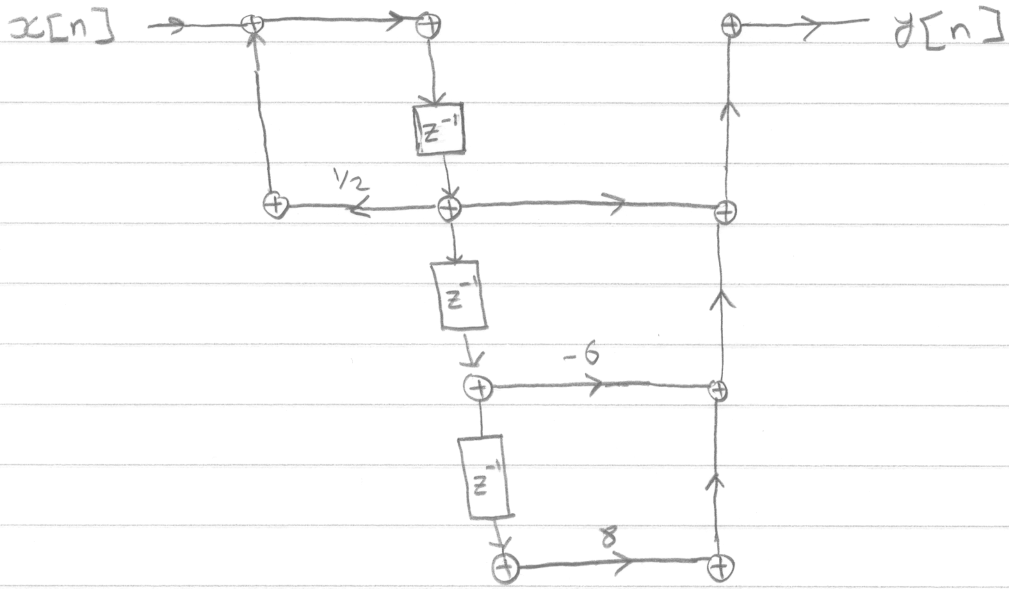
Type I (can be highpass).

Type I
↓
Type I

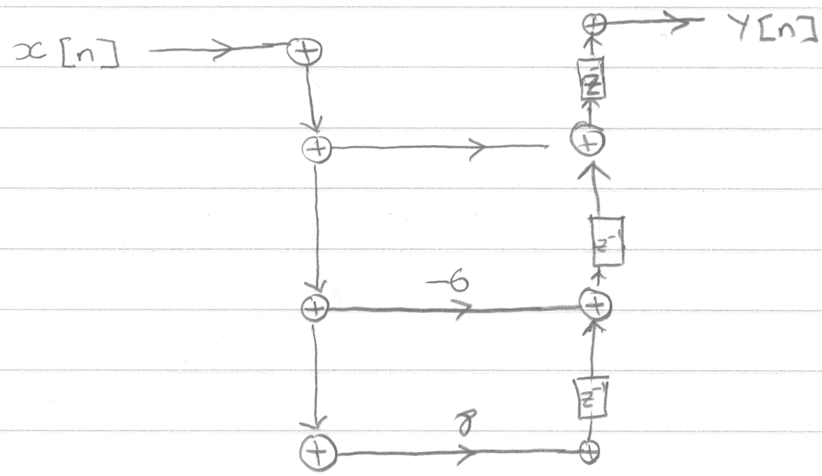


6.11) a

$$H(z) = \frac{z^{-1} - 6z^{-2} + 8z^{3}}{1 - \frac{1}{2}z^{-1}}$$



b



6.13)

$$H(z) = \frac{1 - \frac{1}{2} z^{-2}}{1 - \frac{1}{4} z^{-1} - \frac{1}{8} z^{-2}}$$