Problem Set

5.15 5.23 5.25 6.26 6.29

5.15

(a) $H(e^{jw}) = 2 + e^{-jw} + 2e^{-2jw}$

$= (1+4\cos w)e^{-jw}$

Generalized Linear Phase filter.

(b) This sequence has no even or odd symmetry

So. it is neither generalized linear or linear.

(c) $H(e^{jw}) = 1+3e^{-jw} + e^{-2jw}$

$= (3+2\cos w)e^{-jw}$

it is linear Phase.

(d) $H(e^{jw}) = 1+e^{-jw}$

$= 2\cos(w/2)e^{-j1/2w}$

it is generalised linear phase

(e) $H(e^{jw}) = 1-e^{-2jw}$

$= (2\sin w)e^{-jw+j\frac{\pi}{2}}$

it is generalized linear Phase

5.23

(a) Type I:

$$A(\omega) = \sum_{n=0}^{M/2} a[n] \cos \omega n .$$

There is no restriction on $\omega = 0$ or π

Type II:

$$A(\omega) = \sum_{n=1}^{(M+1)/2} b[n] \cos \omega(n-\tfrac{1}{2})$$

$$\cos\omega(n-\tfrac{1}{2})\Big|_{\omega=\pi} = \cos(n\pi - \tfrac{\pi}{2}) = 0, \quad \Rightarrow \quad H(e^{j\pi}) = 0$$

There is no restriction on $\omega = 0$

Type III:

$$A(\omega) = \sum_{n=0}^{M/2} c[n] \sin \omega n$$

$$\sin \omega n\Big|_{\omega=0} = \sin \omega n\Big|_{\omega=\pi} = 0 \Rightarrow H(e^{j0}) = H(e^{j\pi}) = 0$$

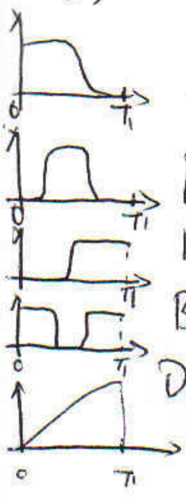
Type IV

$$A(\omega) = \sum_{n=1}^{(M+1)/2} d[n] \sin \omega(n-\tfrac{1}{2})$$

~~$\sin \omega n\big|_{\omega=0}$~~ $\sin \omega(n-\tfrac{1}{2})\Big|_{\omega=0} = 0 \Rightarrow H(e^{j0}) = 0$

There is no restriction on $\omega = \pi$

(b)



	Type I	Type II	Type III	Type IV
Lowpass	Y	Y	N	N
Band pass	Y	Y	Y	Y
High Pass	Y	N	N	Y
Bandstop	Y	N	N	N
Differentiator	Y	N	N	Y.

.25. The statement is false. The noncausal system can have a positive constant group delay.

Consider the causal FIR system

$$h[n] = \delta[n] + \delta[n-1] + 8\delta[n-2] + \delta[n-3] + \delta[n-4]$$

it is a linear phased system, with the positive constant group delay as '2'.

Now, consider

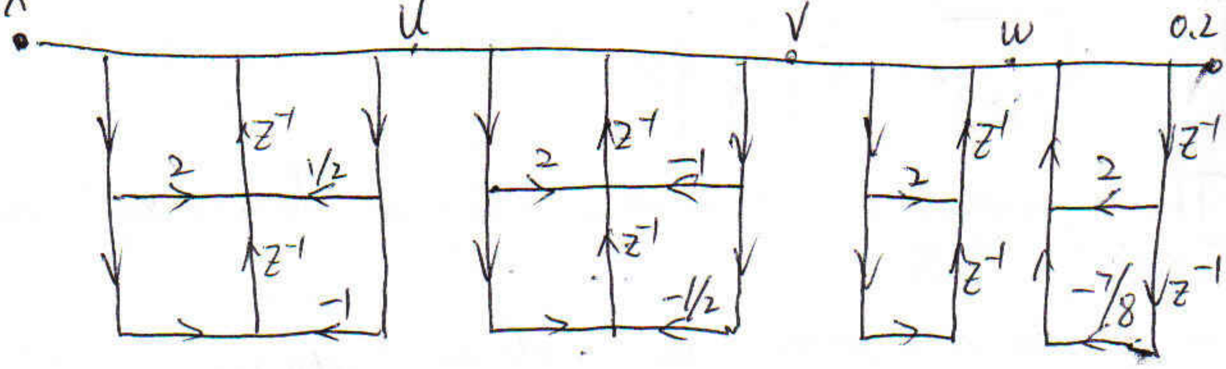
$$h_1[n] = \delta[n+1] + \delta[n] + 8\delta[n-1] + \delta[n-2] + \delta[n-3]$$

$$= h[n+1]$$

it is a noncausal system. But since $h_1[n] = h[n+1]$, $h_1[n]$ is also a linear phase system, with the positive constant group delay as '1'.

6.26.

(a) $$H(z) = \frac{(1+z^{-1})^2}{1-\frac{1}{2}z^{-1}+z^{-2}} \cdot \frac{(1+z^{-1})^2}{1+z^{-1}+\frac{1}{2}z^{-2}} (1+z^{-1})^2 \cdot \frac{1}{1-2z^{-1}+\frac{7}{8}z^{-2}} \cdot 0.2$$



H is not unique, since the order of 2-order denominator can be rearranged.

(b) $u[n] = x[n] + 2x[n-1] + x[n-2] + \frac{1}{2}u[n-1] - u[n-2]$

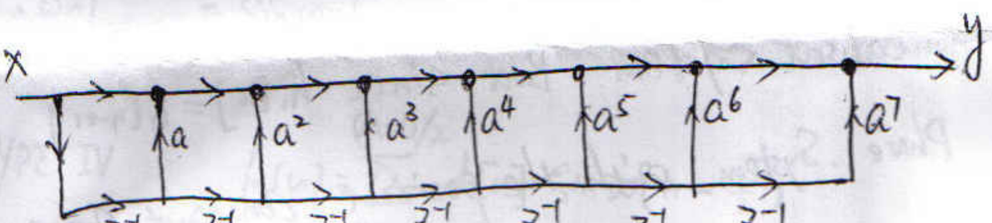
$V[n] = u[n] + 2u[n-1] + u[n-2] - V[n-1] - \frac{1}{2}V[n-2]$

$W[n] = V[n] + 2V[n-1] + V[n-2]$

$Y[n] = 0.2\,W[n] + 2\,Y[n-1] - \frac{7}{8}Y[n-2]$

6.29

(a)

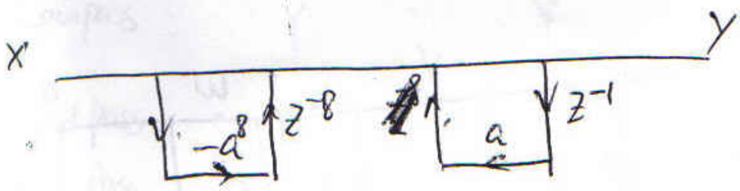


(b) Geometrical Series

$$\sum_{n=0}^{7} a^n z^{-n} = \frac{1-a^8z^{-8}}{1-az^{-1}}$$

The ROC is $|z| > |a|$, since it is a causal system

(c)



(d) The implementation in Part (c) is recursive, however the overall system is FIR

(e) (c) has the most storage. (a) has the most arithmetic.