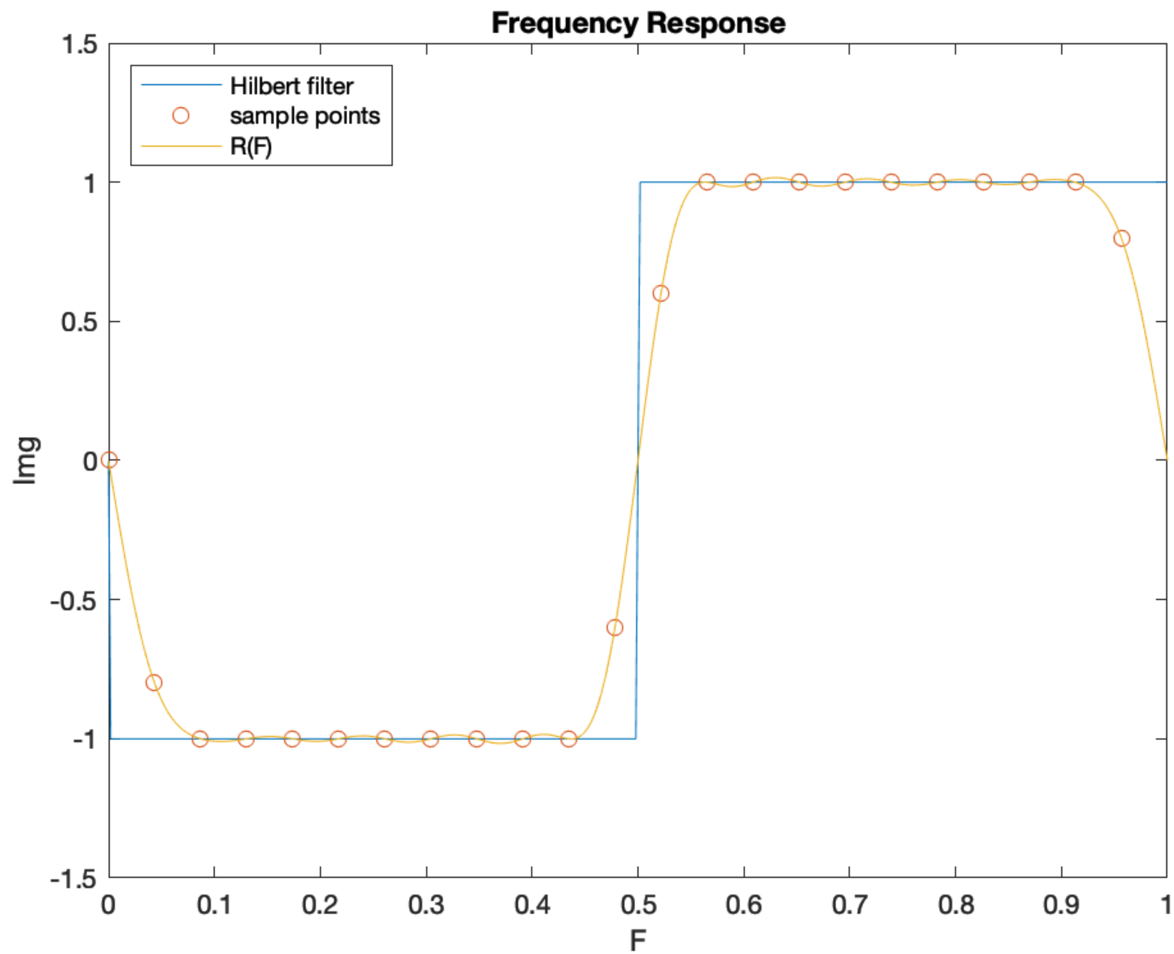
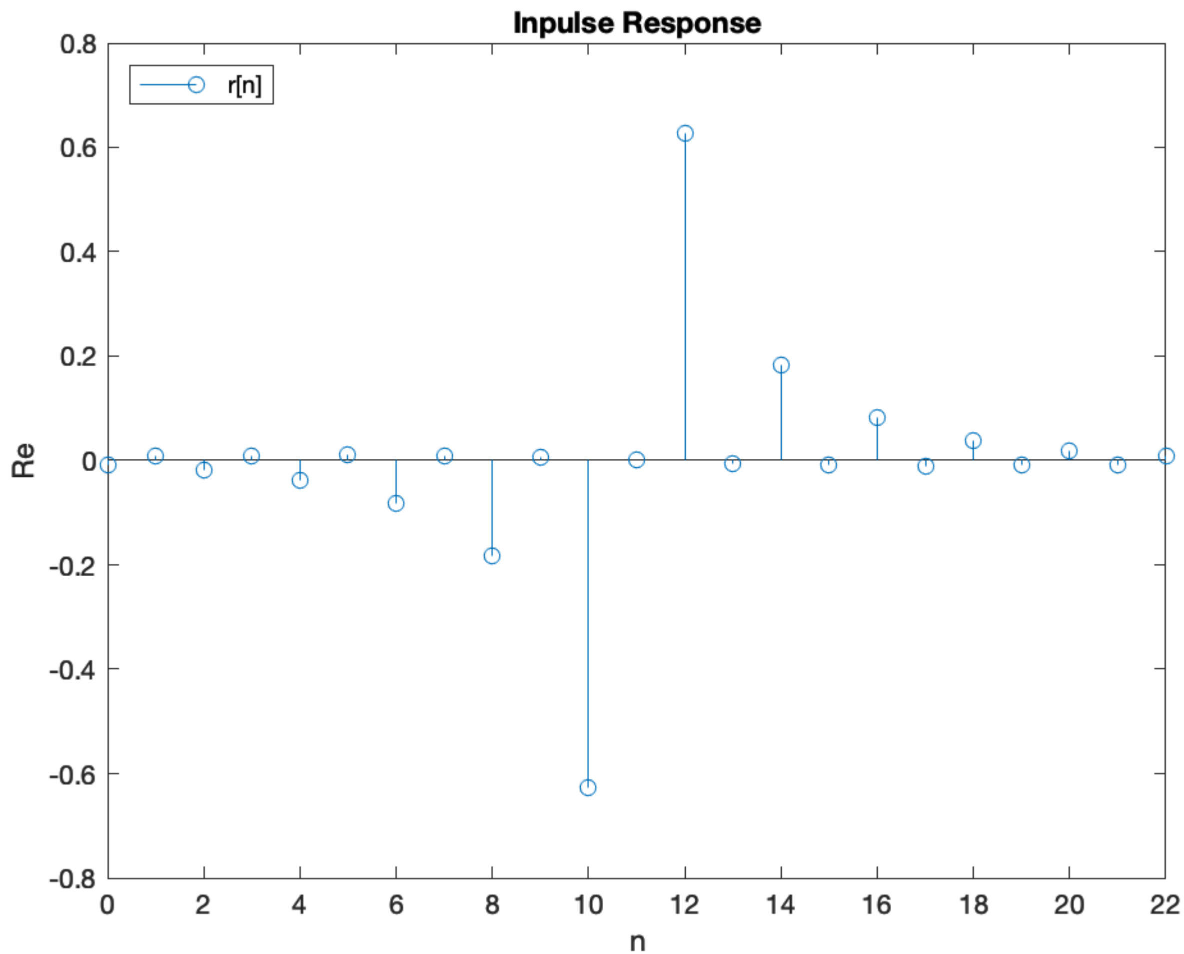

Frequency Response
Hilbert filter
sample points
R(F)
1.5
1
0.5
0
-0.5
-1
-1.5
Img
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
F



Inpulse Response
r[n]
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
Re
0
2
4
6
8
10
12
14
16
18
20
22
n

2. (a)

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

$$= \frac{z(1+2z^{-1})(1 - \frac{1+\sqrt{7}i}{4} z^{-1})(1 - \frac{1-\sqrt{7}i}{4} z^{-1})}{(1 + \frac{1-\sqrt{7}i}{4} z^{-1})(1 + \frac{1+\sqrt{7}i}{4} z^{-1})}$$

$A = 1$, $a_1 = -2$, $a_2 = \frac{1+\sqrt{7}i}{4}$, $a_3 = \frac{1-\sqrt{7}i}{4}$

$c_1 = \frac{-1+\sqrt{7}i}{4}$, $c_2 = \frac{-1-\sqrt{7}i}{4}$

$$\hat{h}[n] = \begin{cases} -\frac{(-2)^n}{n}, & n > 0 \\ 0, & n \le 0 \end{cases}$$

(b)

$|a_1| = 2$, $|a_2| = |a_3| = |c_1| = |c_2| = \frac{1}{\sqrt{2}}$

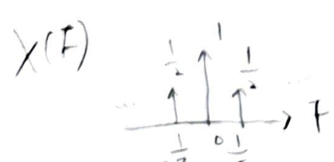
$$H_1(z) = H(z) \cdot a_1 \frac{z - \bar{a}_1^{-1}}{z - a_1} = -2H(z) \frac{1 + \frac{1}{2} z^{-1}}{1 + 2z^{-1}}$$

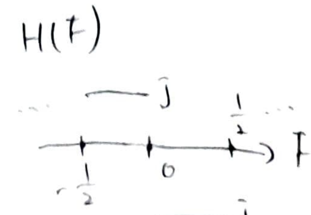
(c)

The minimum phase filter is stable and causal.

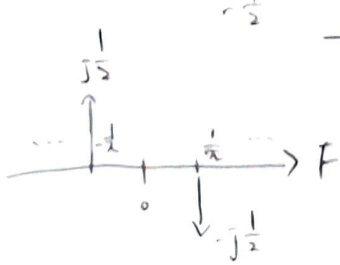
3. (a)

$1 \xrightarrow{DTFT} \sum_{k=-\infty}^{\infty} \delta(F-k)$, $\cos(\pi n) \xrightarrow{DTFT} \frac{1}{2} \sum_{k=-\infty}^{\infty} [\delta(F - \frac{1}{2} - k) + \delta(F + \frac{1}{2} - k)]$



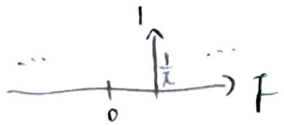


$X_H(F) = X(F) \cdot H(F)$



(b).

$$X_a(F) = \begin{cases} 2X(F), & 0 < F < 0.5 \\ X(F), & F = 0 \\ 0, & -0.5 < F < 0 \end{cases}$$



4.

(a). Difference filter and Hilbert filter

(b). Kalman filter and particle filter

5.

$$l[n] = \begin{cases} 0, & n = 40, 60, 80 \\ 1, & \text{other} \end{cases}$$

$$c_X[n] = y[n] \cdot l[n]$$

6.

(a). 1. it's easier to obtain the channel

2. echos can be filtered out by removing higher quefrencies

(b). 1. no phase ambiguity

2. much less probability for $Y[m] \to -\infty$

3. $B_m[k]$ fits human preception

4. using DCT instead of IDFT to reduce the complexity

7. (a). $\sin(3000\pi t)$ sounds the loudest because human hearing is most sensitive around 3000Hz.

(b). $\sin(400\pi t)$ can propagated longest because it's of lowest frequency.

Extra:

1. What is the absolute value of 0.4-0.3j?

$|0.4-0.3j| = \sqrt{(0.4)^2+(0.3)^2} = 0.5$

2. What problem might occur when taking log in obtaining cepstrum?

1. $X(f)=0 \rightarrow \log(X(f)) = -\infty$
2. $\arg(X(f))$ has inf number of solutions.