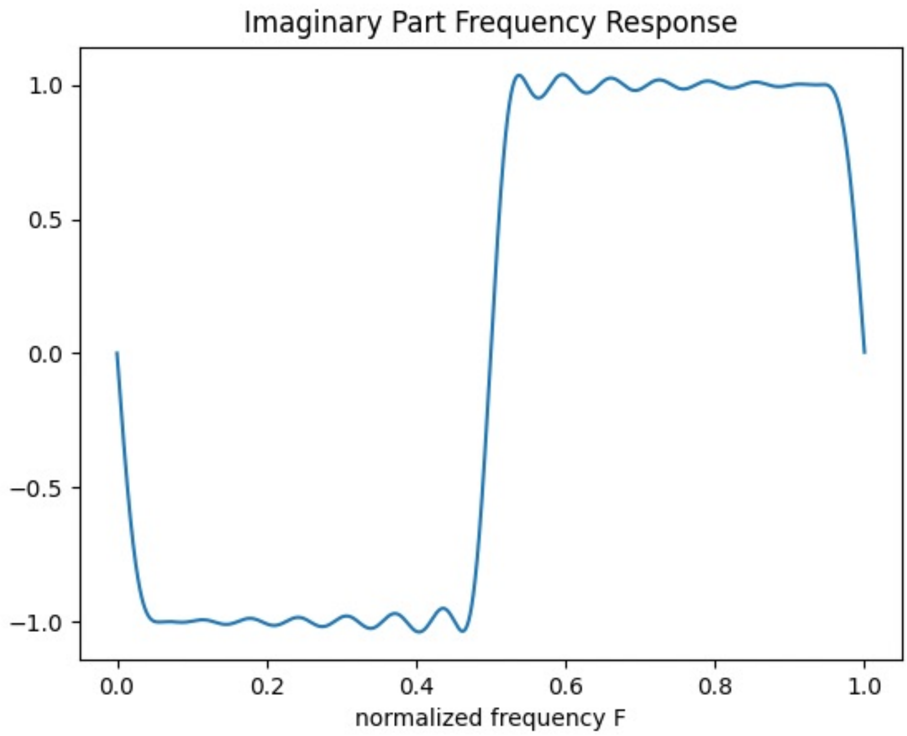
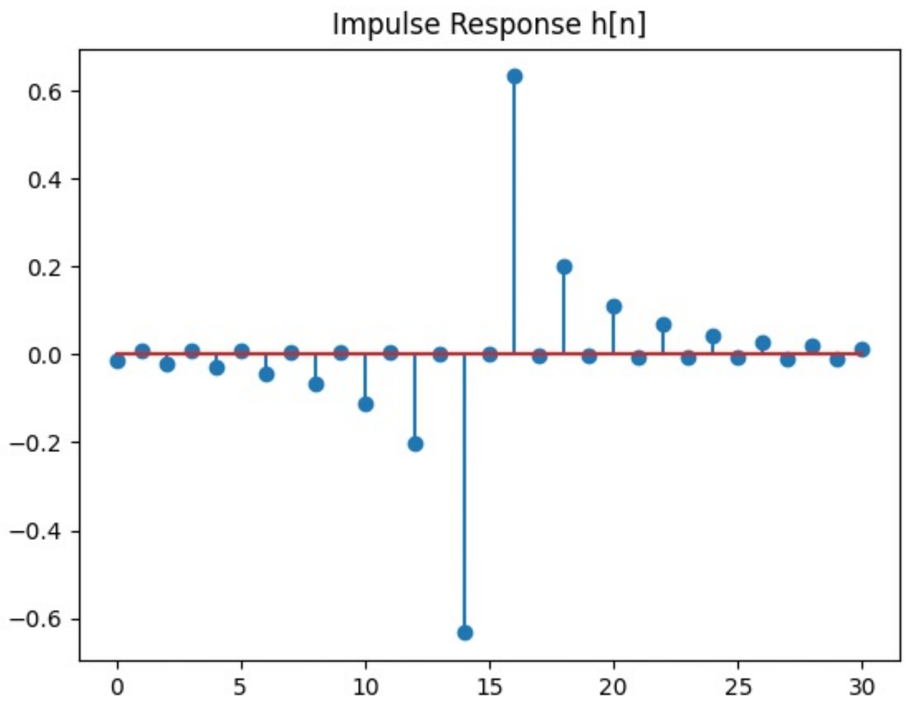
1. Imaginary part of frequency response



impulse response of designed filter



2.

(a)

1. make the energy concentrating on the region near to $n=0$

2. make both the forward and the inverse transform stable

(b)

若信號和雜訊在頻帶上有overlap情形, pass-stop filter就不能很好地濾除noise, Wiener filter能藉統計得到最佳化濾波器, 無特定pass和stop band

(c)

1. α, τ 不用事先得知, 直接將其他路徑產生的訊號視為雜訊, 直接用lifter濾除

2. equalizer的$H(z)$可能unstable, cepstrum 轉為加法, 利用lifter來濾除雜訊, 避免$H(z)$為不穩定系統

3.

(a) $H(z) = \dfrac{2z^3+4z^2+z+2}{2z^2+z+1} = \dfrac{2\left(1-\frac{1}{\sqrt{2}}jz^{-1}\right)\left(1+\frac{1}{\sqrt{2}}jz^{-1}\right)\left(1+\frac{1}{2}z\right)}{\left(1-\frac{-1+\sqrt{7}j}{4}z^{-1}\right)\left(1-\frac{-1-\sqrt{7}j}{4}z^{-1}\right)}$

$$\hat{x}[n] = \begin{cases} \log(2), & n=0 \\ -\dfrac{\left(\frac{1}{\sqrt{2}}j\right)^n+\left(-\frac{1}{\sqrt{2}}j\right)^n}{n} + \dfrac{\left(\frac{-1+\sqrt{7}j}{4}\right)^n+\left(\frac{-1-\sqrt{7}j}{4}\right)^n}{n}, & n>0 \\ \dfrac{\left(-\frac{1}{2}\right)^{-n}}{n}, & n<0 \end{cases}$$

(b)

$H(z) = \dfrac{2z^3+4z^2+z+2}{2z^2+z+1} = \dfrac{(2z^2+1)(z+2)}{2z^2+z+1}$

$z' = -2 \quad , \quad \overline{z'^{-1}} = -\frac{1}{2}$

$H_1(z) = -2\,\dfrac{(2z^2+1)\left(z+\frac{1}{2}\right)}{2z^2+z+1}$

4.

(a) even

(i) notch, pass-stop filter 皆為 even

(ii) smoothers, 一般皆用能量隨著|n|遞減的 even function

(vi) 2 times of differentiations, 微分為 odd, odd 做兩次為 even

(b) odd

(iii) edge detectors, 一般皆用能量隨|n|遞減的 odd function

(v) 3 times of integrals, 積分為 odd, odd 做三次為 odd

5.

$$y[n] = x[n] * p[n] = \alpha_1 x[n] + \alpha_2 x[n-30] + \alpha_3 x[n-40] + \alpha_4 x[n-50]$$

$$p[n] = \alpha_1 \delta[n] + \alpha_2 \delta[n-30] + \alpha_3 \delta[n-40] + \alpha_4 \delta[n-50]$$

$$P(z) = \alpha_1 \left(1 + \frac{\alpha_2}{\alpha_1} z^{-30} + \frac{\alpha_3}{\alpha_1} z^{-40} + \frac{\alpha_4}{\alpha_1} z^{-50}\right)$$

令 $\left(\frac{\alpha_2}{\alpha_1} z^{-30} + \frac{\alpha_3}{\alpha_1} z^{-40} + \frac{\alpha_4}{\alpha_1} z^{-50}\right) = A$

$$\hat{P}(z) = \log(P(z)) = \log(\alpha_1) + \left(A - \frac{A^2}{2} + \frac{A^3}{3} + \cdots\right)$$

可知 $\hat{P}(z)$ 中, z 次方有 $-30, -40, -50, -60, -70 \ldots$

故 lifter: $\begin{cases} 0, & n = 10k + 30,\ k \geq 1,\ k \in N \\ 1, & \text{elsewhere} \end{cases}$

最後得到之 $\alpha_1 x[n]$ 需除 α_1 得 $x[n]$

6.

(1) Since $\sum_k |X[k]|^2 B_m[k]$ has much less probability to be zero, the problem of $\log(\cdot) = -\infty$ can avoid

(2) Since $\sum_k |X[k]|^2 B_m[k]$ is real, the phase ambiguity problem can be avoided

(3) $B_m[k]$ matches human perception about voice

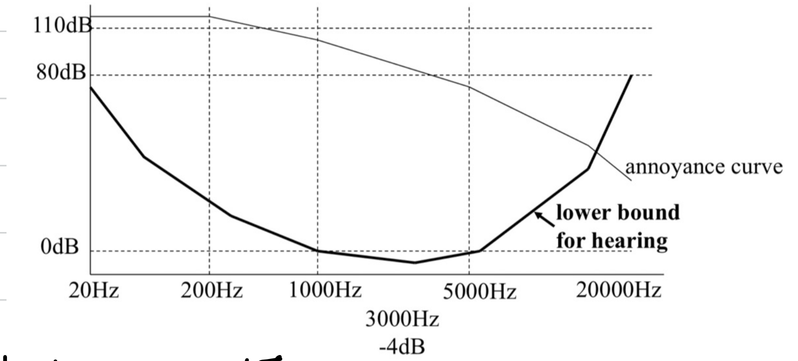
(4) Uce DCT to replace IFT to save computation

7. DFT 及IDFT 之 complexity 為 $O(N\log N)$，此法需經 DFT再經 IDFT，complexity高，運算久，故很少使用

8.

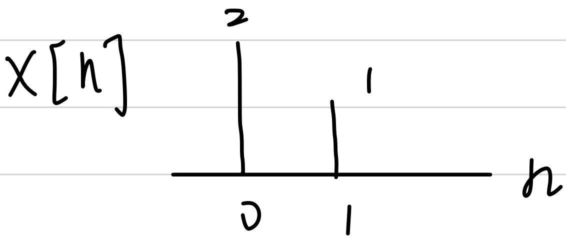
(a)

從下圖知，越接近3000Hz越明顯，選(iii) $\cos(1800\pi t)$



(b) 波長越長，傳播越遠，選(i) $\cos(200\pi t)$

Extra: (尾扠?)



$$X(z) = 2 + z^{-1} = 2\left(1 + \frac{1}{2}z^{-1}\right)$$

$$a_1 = -\frac{1}{2}, \quad A = 2$$

$$\hat{x}[n] \begin{cases} \log(2) & , n = 0 \\ -\frac{(-0.5)^n}{n} & , n > 0 \\ 0 & , \text{elsewhere} \end{cases}$$