# EC574 HW8

8.1 a) $\delta_p = \delta_s = 0.15$ $\quad w_p = 0.5\pi$ $\quad w_s = 0.75\pi$

$A = -20\log_{10}(\delta)$ $\quad$ $\delta$ means smaller of the passband ripple

$= -20\log_{10}(0.15) \approx 16.478\,dB$.

Since $A \leq 21$ so $\beta = 0$.

$$N = \frac{A-8}{2.285(w_s - w_p)} = \frac{16.478-8}{2.285(0.75\pi - 0.5\pi)} = \frac{8.478}{2.285 \times 0.25\pi}$$

$N \approx 5.39$

Since filter length must be integer and odd

So $N = 7$

b) $\delta_p = \delta_s = 0.15$ $\quad w_p = 0.5\pi$ $\quad w_s = 0.65\pi$

$A = -20\log_{10}(\delta) = 16.478\,dB$

Same as previous, $\beta = 0$.

$$N = \frac{A-8}{2.285(\underbrace{w_s}_{0.65\pi} - \underbrace{w_p}_{0.5\pi})} = \frac{8.478}{2.285 \times 0.15\pi} \approx 7.87$$

must be integer and odd so $N = 9$

c) $\delta_p = \delta_s = 0.09$ $\quad w_p = 0.5\pi$ $\quad w_s = 0.75\pi$

$A = -20\log_{10}(\delta) = -20\log_{10}(0.09) \approx 20.916\,dB$.

$A < 21$, so $\beta = 0$

$$N = \frac{A-8}{2.285(w_s - w_p)} = \frac{20.916-8}{2.285 \times 0.25\pi} \approx 8.22$$

Since $N$ is odd and integer

$N = 9$.

d) $\delta_p = \delta_s = 0.09$ $\quad w_p = 0.5\pi$ $\quad w_s = 0.65\pi$

$A = -20\log_{10}(\delta) = -20\log_{10}(0.09) \approx 20.916\,dB$

$A < 21$, so $\beta = 0$

$$N = \frac{A-8}{2.285(w_s - w_p)} = \frac{20.916-8}{2.285 \cdot 0.15\pi} \approx 11.99$$

Since N is integer and odd

$N = 13$

8.)

a) We prefer Optimal FIR Filter Design because it yields a more efficient filter with better frequency responce control and a shorter filter length. It will be able to minimizing the overall error in passband and stopband.

b) $\delta_p = 0.10$, $\delta_s = 0.05$, $w_p = 0.5\pi$, $w_s = 0.75\pi$

$2L+1$ = smallest odd integer greater than $\dfrac{-10\log_{10}(\delta_p\delta_s) - 13}{14.6(w_s - w_p)/2\pi}$ ①

$\delta_p\delta_s = 0.005$ $\quad \log_{10}(0.005) \approx -2.301$

$w_s - w_p = 0.25\pi$

so ① $\approx 5.49$ $\quad$ so $2L+1 = 7$

c) $N = \dfrac{A-8}{2.285(w_s - w_p)}$ $\quad A = -20\log_{10}(\delta_s)$

$\approx 26.02\,dB.$

$$N = \frac{A-8}{2.285 \times (w_s - w_p)} \approx 11.47$$

N is odd and integer $\quad N = 13$

d) $2L+1 = 7 \Rightarrow L = 3$

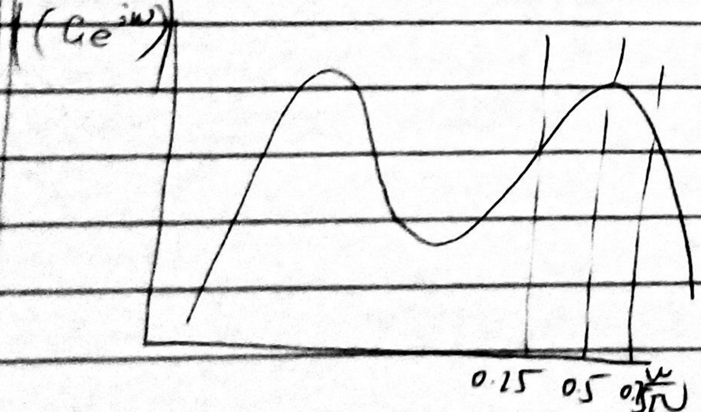
Since $L=3$, the highest power of $\cos(\omega)$ in $R(\omega)$

$\cos^3(\omega)$

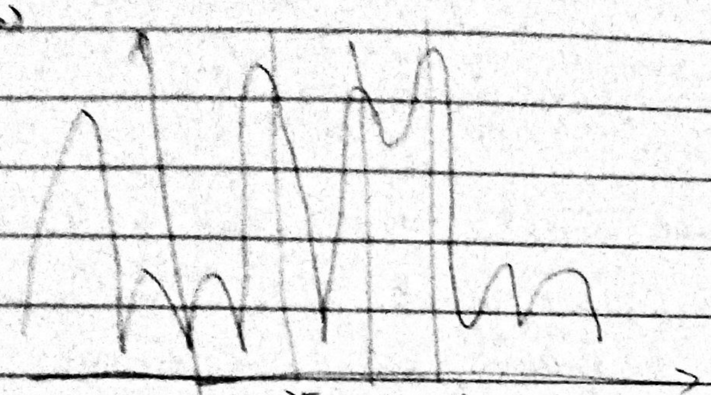
This is because the filter length is $N=7$ and it allows the cos to have at max power of 3. This is the natural of type I FIR because of the symmetry and length of the impulse response in a Type I FIR filter.

8.3

a) So for $x[n]$ the cos components will become actually sinc in the frequency domain. The max width of the sinc is the central lobe and its length depends inversely to N.
So Given $N=4$, the since will have relatively wide main Lobe which will make the three frequency kind of merge into each other.



b)




when $N = 16$

they are separateble

c) So when $N \to \infty$, the rectangular window's frequency response would become ideal needle like aliasing the exact frequency out acurately

8.4.

a) Frequency Resolution

b) Length shape Design