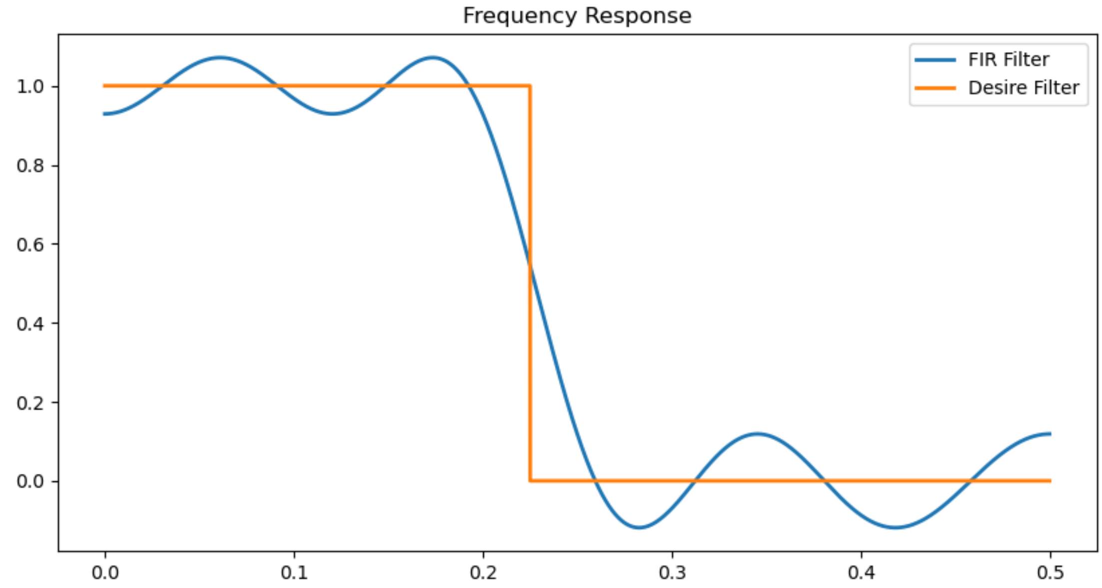
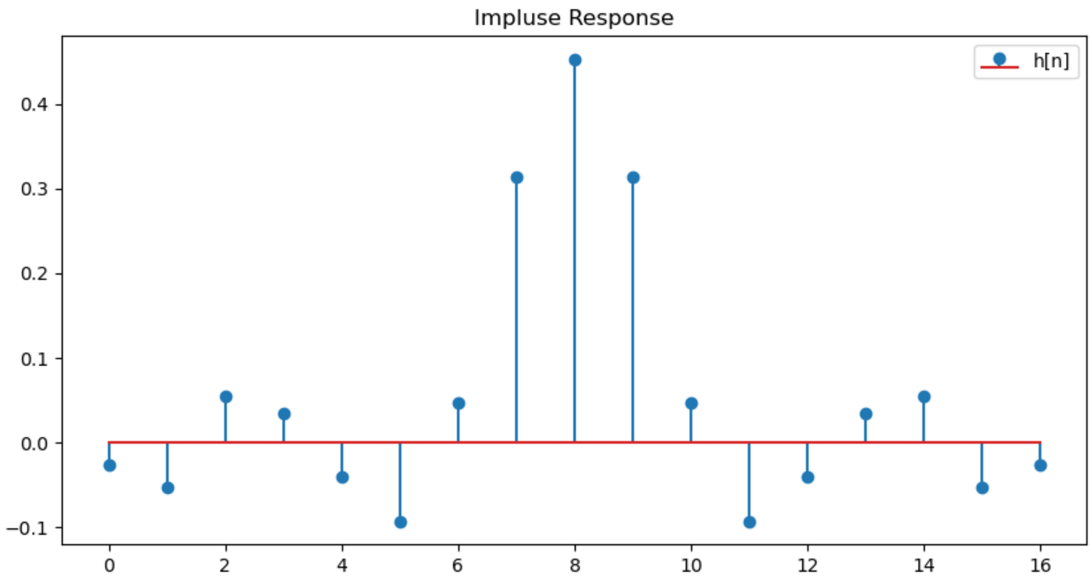
ADSP HW1 r12631055 林東甫

(1)

(a) the frequency response



(b) the impulse response h[n]



(c) the maximal error for each iteration

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1st_iteration_MaxErr = 0.12362984401511301
2nd_iteration_MaxErr = 0.07704144356675102
3rd_iteration_MaxErr = 0.07127611617996485
4th_iteration_MaxErr = 0.0712072852346789
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$$H(z) = \sum_{n=-\infty}^{\infty} h[n] z^{-n} = \sum_{n=-\infty}^{\infty} [0.8^n u[n] + 0.5^n u[n]] z^{-n}$$

$$= \sum_{n=0}^{\infty} (0.8^n + 0.5^n) z^{-n} = \sum_{n=0}^{\infty} 0.8^n z^{-n} + \sum_{n=0}^{\infty} 0.5^n z^{-n}$$

$$= \frac{1}{1-0.8z^{-1}} + \frac{1}{1-0.5z^{-1}} = \frac{1-\frac{0.5}{z}+1-\frac{0.8}{z}}{(1-\frac{0.8}{z})(1-\frac{0.5}{z})} = \frac{2-\frac{1.3}{z}}{1-\frac{1.3}{z}+\frac{0.4}{z^2}}$$

$$Y(z) = X(z) \cdot H(z) = X(z) \cdot \frac{2-\frac{1.3}{z}}{1-\frac{1.3}{z}+\frac{0.4}{z^2}}$$

$$Y(z) = X(z) + \left[1 - \frac{1-1.3z^{-1}+0.4z^{-2}}{2-1.3z^{-1}}\right] Y(z)$$

$$= X(z) + \left[\frac{2-1.3z^{-1}-1+1.3z^{-1}-0.4z^{-2}}{2-1.3z^{-1}}\right] Y(z)$$

$$= X(z) + \frac{1-0.4z^{-2}}{2-1.3z^{-1}} Y(z)$$

$$\therefore 2Y(z) - 1.3z^{-1}Y(z) = 2X(z) - 1.3z^{-1}X(z) + Y(z) - 0.4z^{-2}Y(z)$$

$$Y(z) = 2X(z) - 1.3z^{-1}X(z) + 1.3z^{-1}Y(z) - 0.4z^{-2}Y(z)$$

$$\Rightarrow y[n] = 2x[n] - 1.3x[n-1] + 1.3y[n-1] - 0.4y[n-2]$$

#

3. (a) ① 可以用來做頻譜分析 (spectrum analysis) 能將時域與空間域的訊號作轉換產生頻域訊號，應用於多方面。

② 可以將卷積(convolution)變為便於計算的乘法以致於線性非時變(LTI)系統好作分析

(b) ① FT並非是實數的運算，意味複數的計算量大於實數~~來良~~。

② 需要使用無理數計算。

4~5

4. $f_s = \frac{1}{0.002} = 500\,Hz$, $N = 2000$, known $f = m \cdot \frac{f_s}{N}$

(a) $f = 200 \cdot \frac{500}{2000} = \underline{50\,Hz}$ #

(b.) Since $1600 > \frac{N}{2} = 1000$, $f = 1600 \cdot \frac{500}{2000} - 500$

$= \underline{-100\,Hz}$ #

5.

(a) Step invarience 透過積分的方式將高頻的能量壓下來，故能降低常在高頻部份出現~~的~~ aliasing effect.

(b) bilinear transform 將整個 $-\infty \sim \infty$ 的頻域給 mapping 到 $-\frac{f_s}{2}$, $\frac{f_s}{2}$ 之間，使得 aliasing effect 完全消失

6~7~Extra

6. (a) (i) Notch filter
(iv) Integral
(v) Differentiation 4 times
(vii) Matched filter

(b) (ii) Highpass filter
(iii) Edge detector
(vi) particle filter

7. $s[0] = \int_{-\frac{1}{2}}^{\frac{1}{2}} H_d(F)\,dF = 0.5$ $\quad s[n] = 2\int_{-\frac{1}{2}}^{\frac{1}{2}} \cos(2\pi n F) H_d(F)\,dF$

$s[1] = 2\int_{-\frac{1}{2}}^{\frac{1}{2}} \cos(2\pi F) H_d(F)\,dF = \frac{2}{\pi}\sin(\frac{1}{2}\pi) = 0.6366$

$s[2] = 2\int_{-0.25}^{0.25} \cos(4\pi F)\,dF = \frac{1}{\pi}\sin(\pi) = 0$

$s[3] = 2\int_{-0.25}^{0.25} \cos(6\pi F)\,dF = 2\left[\sin(6\pi F)\frac{1}{6\pi}\right]_{-0.25}^{0.25} = \frac{2}{3\pi}\sin(\frac{3}{2}\pi) =$

$\frac{s[n]}{2} = r[n]$

s[0]	s[1]	s[2]	s[3]
0.5	0.6366	0	−0.2122
r[0]	r[1]	r[2]	r[3]
0.5	0.3183	0	−0.1061

#

h[0] = −0.1061
h[1] = 0
h[2] = 0.3183
h[3] = 0.5
h[4] = 0.3183
h[5] = 0
h[6] = −0.1061

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Extra: $x[n] = y(\frac{n}{6000})$, $N = 30000$

$f = -150\,Hz$, $m = ?$

$m\frac{f_s}{N} - f_s = -150 \Rightarrow m\frac{6000}{30000} - 6000$

$\frac{m}{5} - 6000 = -150$, $m = 29250$

#