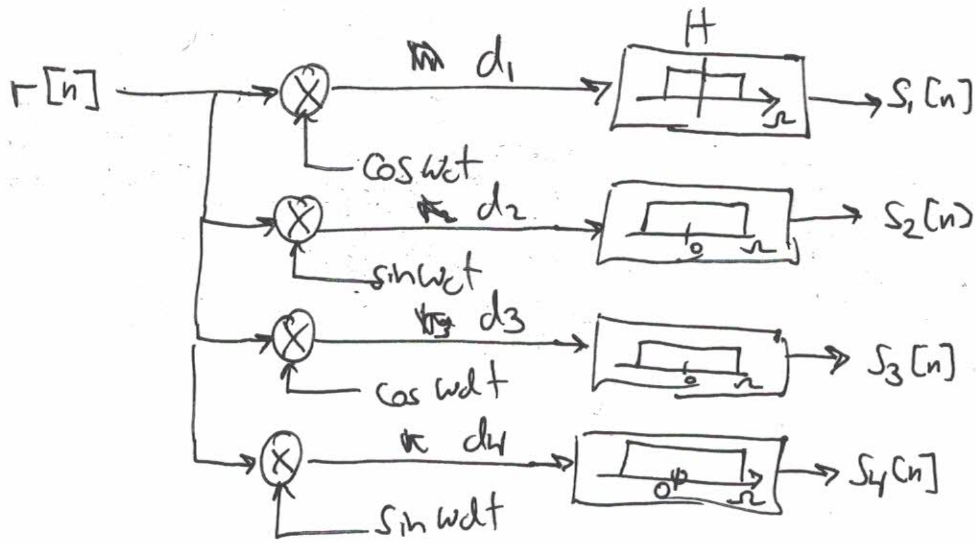
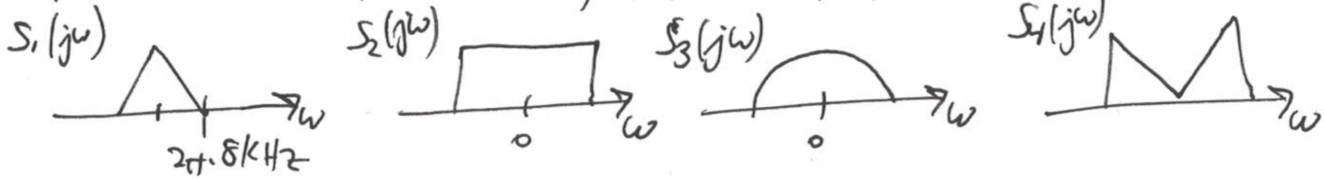
EE120 Fall 2016 Python minilab2

1.



2 spectra of $s_1(t)$, $s_2(t)$, $s_3(t)$, $s_4(t)$ chosen for convenience

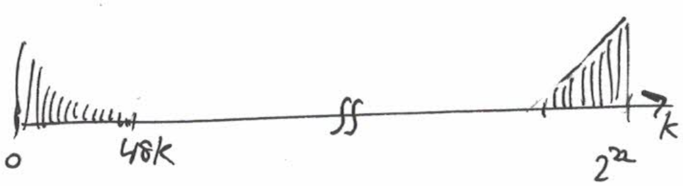


$N = 2^{22}$, $T_s = 16 \cdot 44.1kHz$, $T_0 = 5.94$ sec, k spacing $= \frac{2\pi}{T_0}$

$2\pi \cdot 8kHz \longrightarrow k \cdot \frac{2\pi}{T_0}$, $\Longrightarrow$ $k = 8000 \times sec^{-1} \cdot T_0$

$\approx 48 \times 10^3$

$S_1[K]$



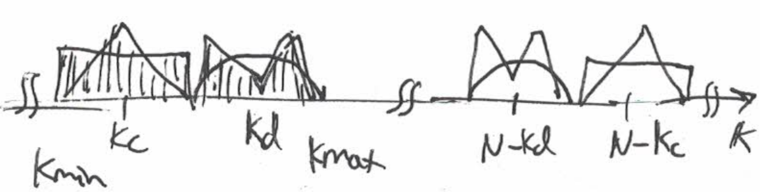
R[K] has modulated $s_1 \dots s_4$ in range ω_c to ω_d. $K_c \cdot \frac{2\pi}{T_0} = \omega_c$

in range $k_{min} < k < k_{max}$

$k_c = \frac{T_0}{2\pi} \cdot \omega_c \approx (3 \times 10^5) T_0$

$= 1.78e6$

real+imag R[k]



$K_d = \frac{T_0}{2\pi} \cdot \omega_c = 1.878e6$

$K_{min} = K_c - 48000$

$K_{max} = K_d + 48000$

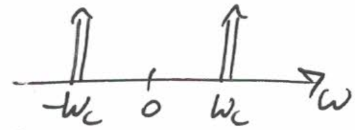
2. cont after mult by cos/sin before filter

$2j\sin w_c t = e^{jw_c t} - e^{-jw_c t}$

$\to \frac{2}{2\pi}\delta(w+w_c) \frac{2}{\pi}\delta(w-w_c)$

$\sin w_c t \to \pi j(\delta(w+w_c) - \delta(w-w_c))$

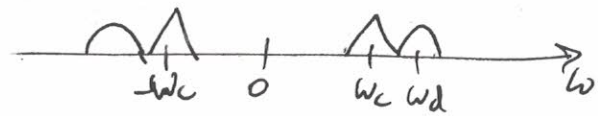
$d_1[n] = r[n] \cdot \cos w_c n T_s$ in CT:



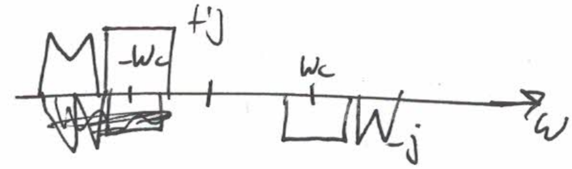
in CT, then make analogy to DT.

$d_1(t) = r(t) \cdot \cos w_c t$

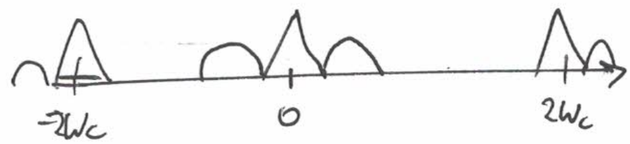
Re $R(jw)$



Im $R(jw)$



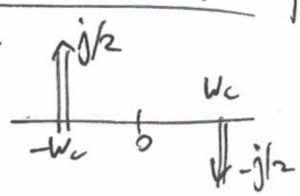
Re $D_1(jw)$



Im $D_1(jw)$

note 0 for $-8kHz \cdot 2\pi < w < 8kHz \cdot 2\pi$.

for $D_2(jw)$ *



Re $D_2(jw)$

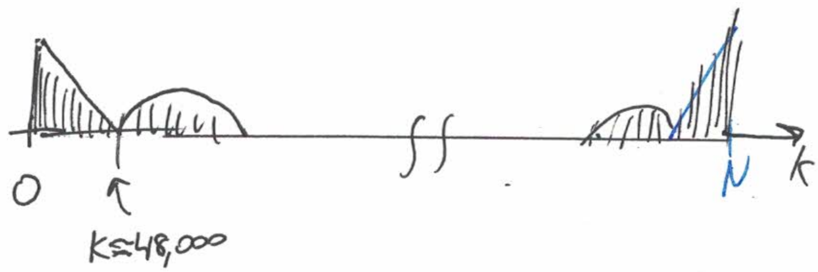
double copy.

Im $D_2(jw)$

cancels

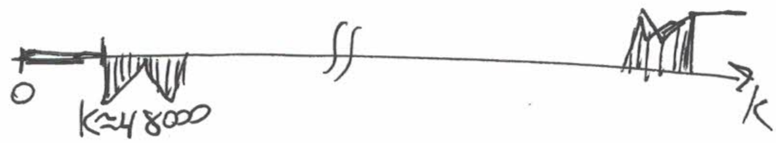
approximate

Re $D_1[k]$



~~note 2wc=~~

Im $D_1[k]$



$D_2[k]$, $D_3[k]$, $D_4[k]$ follow similar pattern.

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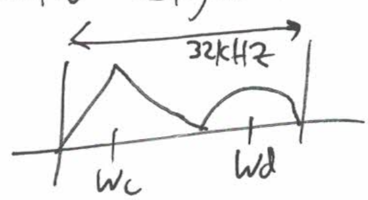
3. $k_c \approx 1.783 \times 10^6$ $\quad k_{min} = k_c - 48000$

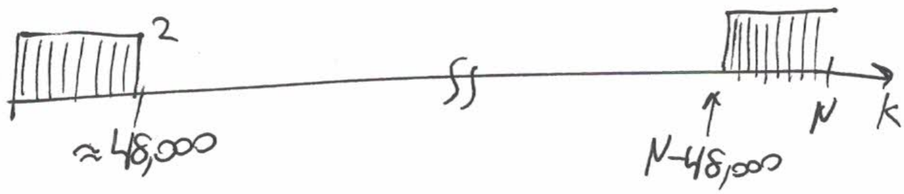
$k_d \approx 1.878 \times 10^6$ $\quad k_{max} = k_d + 48000$

bandwidth of modulated signal

$= 2\pi \cdot 32kHz$



4.



Could set height = ~~4~~2 to compensate for

$$s_1(t)\cdot \cos w_c t \cdot \cos w_c t \longrightarrow S_1(jw) * \frac{1}{2}\left[\delta(w-w_c)+\delta(w+w_c)\right]$$

$$* \frac{1}{2}\left[\delta(w-w_c)+\delta(w+w_c)\right]$$

$$= S_1(jw) * \frac{1}{4}\left[\delta(w-2w_c) + \underbrace{\delta(w)+\delta(w)} + \delta(w+2w_c)\right]$$

$$k_{cutoff} = \frac{2\pi \cdot 8kHz}{2\pi/T_0} = 8kHz \cdot T_0$$