Assignment No 2

曹正阳 1210623

1

a) the function of filter input is

$$I(t) = a[m(t) + \cos(2\pi f_c t)] + b[m(t) + \cos(2\pi f_c t)]^2 - a\cos 2\pi f_c t$$

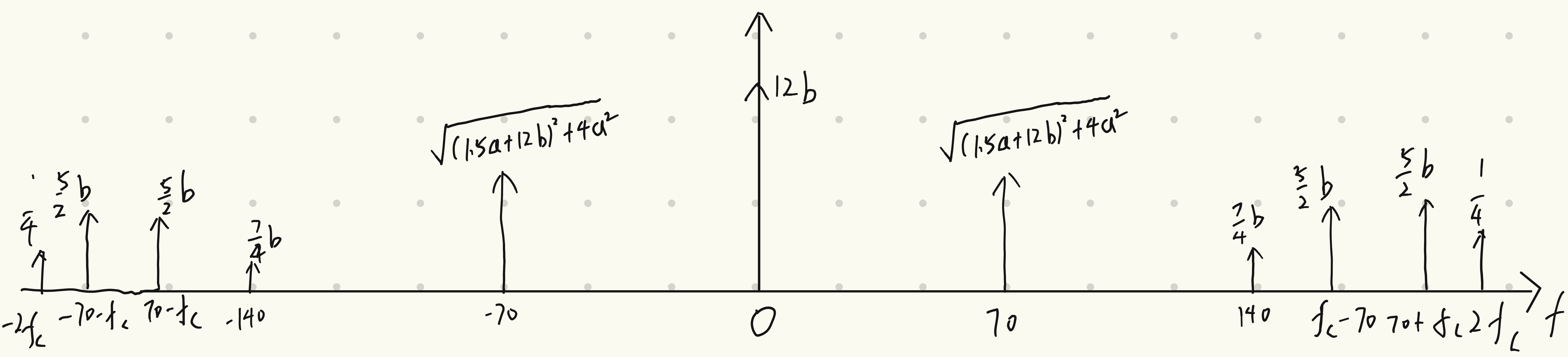
$$I(t) = a\,m(t) + b\,m^2(t) + 2b\,m(t)\cos(2\pi f_c t) + b\cos^2(2\pi f t)$$

$$I(t) = (3a+24b)\cos(2\pi 70t) + 4a\sin(2\pi 70 t) - \tfrac{7}{2}b\cos(2\pi 140t) + 3b\cos[2\pi(70-f_c)t] + 3b\cos[2\pi(70+f_c)t]$$
$$+ 4b\sin[2\pi(70-f_c)t] - 4b\sin[2\pi(70+f_c)t] + \tfrac{1}{2}\cos(4\pi f_c t) + 12b$$

After F.T. we get (let $F(f_c) = \delta(f-f_c) + \delta(f+f_c)$)

$$I(f) = (1.5a+12b-2aj)F_{70} - \tfrac{7}{4}b\,F_{(140)} + (\tfrac{3}{2}b - 2bj)F(70-f_c) + (\tfrac{3}{2}b+2bj)F(70+f_c) + \tfrac{1}{4}F(2f_c) + 12b\,\delta(f)$$

So, the amplitude spectrum is as below



b) to generate the DSBSC-AM signal, we need to keep $2b\,m(t)\cos(2\pi f_c t)$ in $I(t)$

let $f(t) = 2b\,m(t)\cos(2\pi f_c t) = 6b\cos(2\pi 70t)\cos(2\pi f_c t) + 8b\sin(2\pi 70 t)\cos(2\pi f_c t)$

the $F(f) = (\tfrac{3}{2}b - 2bj)F(70-f_c) + (\tfrac{3}{2}b+2bj)F(70+f_c)$

So, $X(t)$ is around f_c-70 and f_c+70

which means that we need a bandpass filter whose center freq is at f_c and $BW \in (140, f_c-140)$

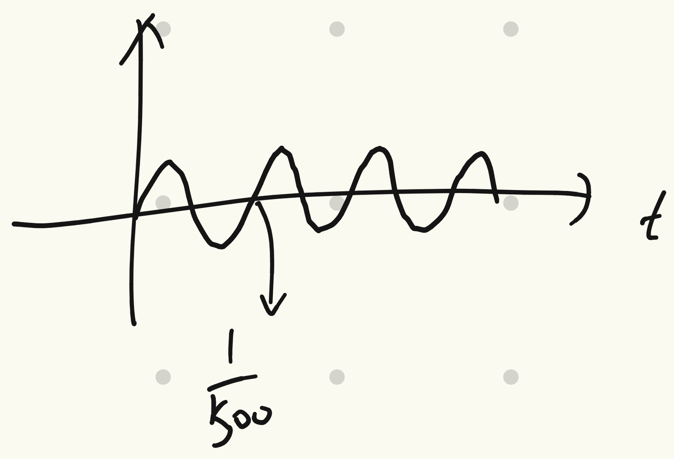
c) $f_c - 70 > 140 \Rightarrow f_c > 210$, so the minimum value of f_c is 140 Hz.

#2

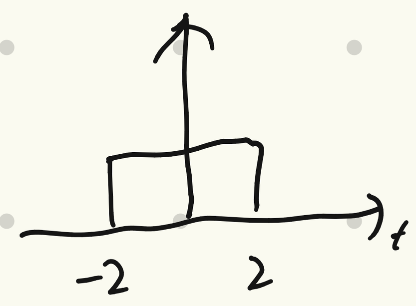
$$X_1(t) = S_1(t)\,\sin(1000\pi t) = rect(\tfrac{t}{4})\cdot \sin(1000\pi t) + 2rect(\tfrac{t-4}{4})\,\sin(1000\pi t)$$

$$T_{sin} = \frac{2\pi}{w} = \frac{1}{500}$$

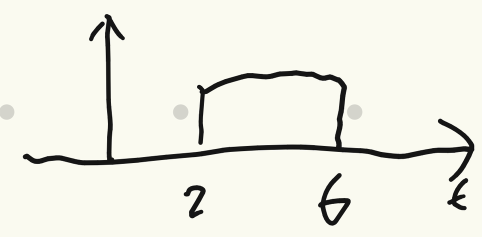
$\sin(1000\pi t)$:



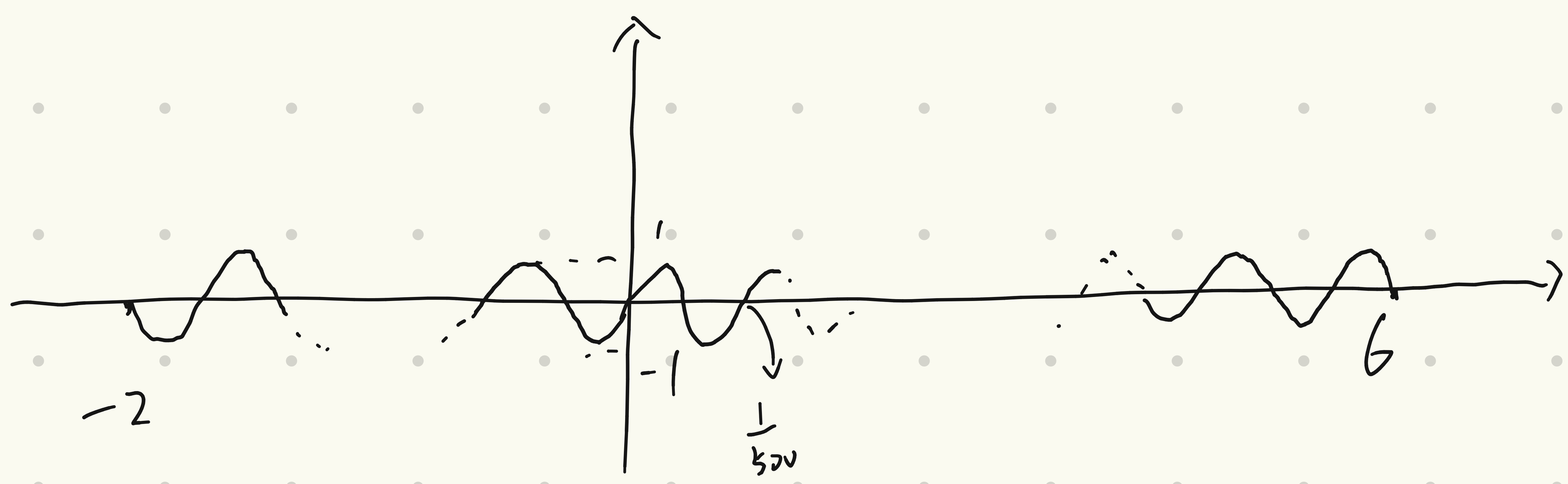
$rect(\frac{t}{4})$:



$rect(\frac{t-4}{4})$:



So the time waveform of $x_1(t)$ is as below:

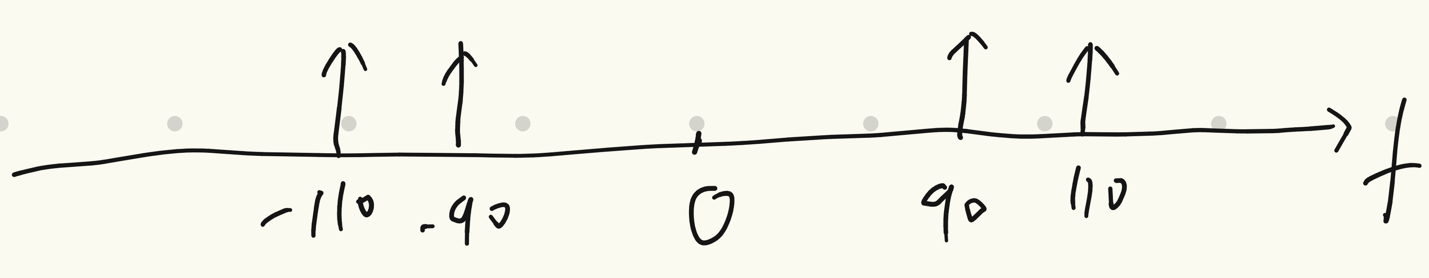


#3

a) After F.T. we get

$$X(f) = \frac{3}{2j}\left[\delta(f-90) - \delta(f+90) + \delta(f-110) - \delta(f+110)\right]$$

So amplitude spectrum is as.



so, the carrier freq is $\frac{90+110}{2} = 100Hz$

b) $V(t) = X(t)\cdot\sin(2\pi f_c t) = A_c m(t)\sin^2(2\pi f_c t) = \frac{A_c}{2}m(t) - \frac{A_c}{2}m(t)\cdot\cos(4\pi f_c t) = \frac{A_c}{2}m(t) - \frac{A_c}{2}m(t)\cdot\cos(400\pi t)$

with a HPF remove $\cos(400\pi t)$, $V_o(t) = \frac{A_c}{2}m(t)$

$$V(t)\ X(t)\sin(200\pi t) = \frac{3}{2}\left[\cos(20\pi t) - \cos(380\pi t) + \cos(20\pi t) - \cos(400\pi t)\right]$$

$$= \frac{3}{2}\left[\cos(20\pi t) - \cos(380\pi t) + \cos(20\pi t)\right] - \frac{3}{2}\cos(400\pi t)$$

$\therefore A=3$, $m(t) = 2\cos(20\pi t) - \cos(380\pi t)$