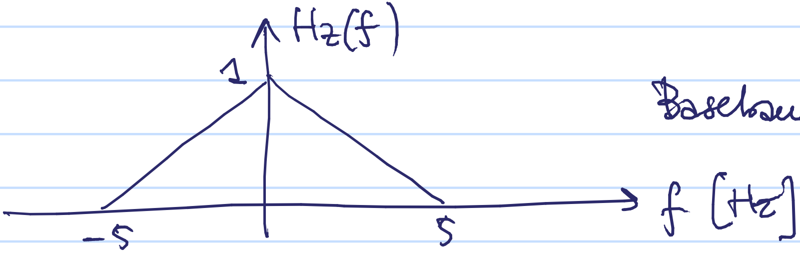
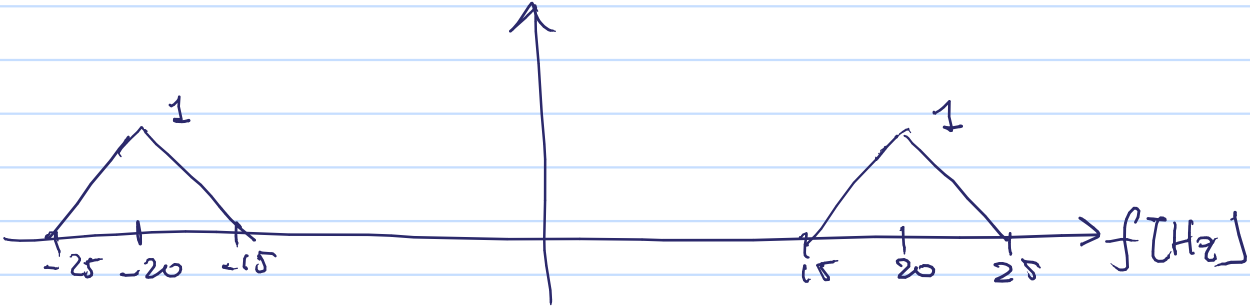
1.



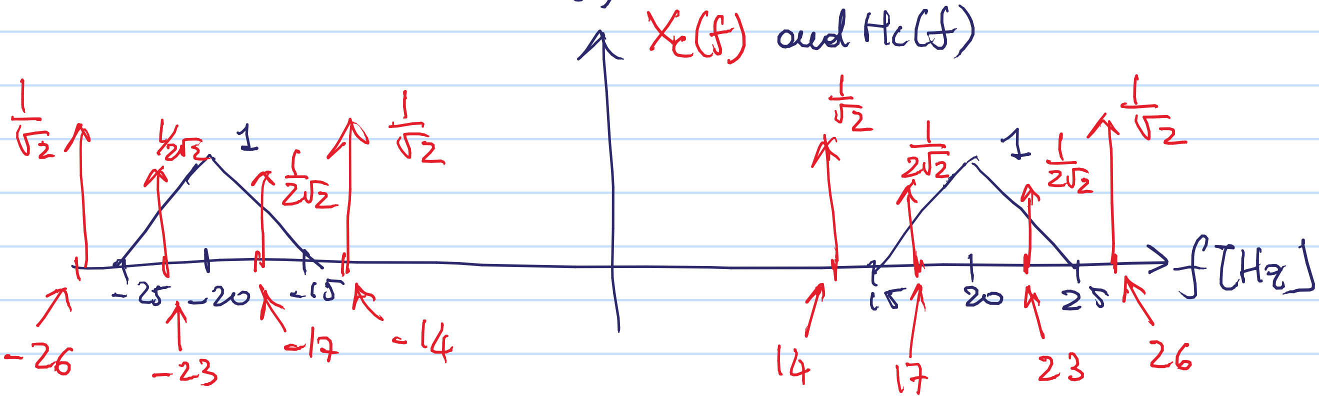
Baseband filter

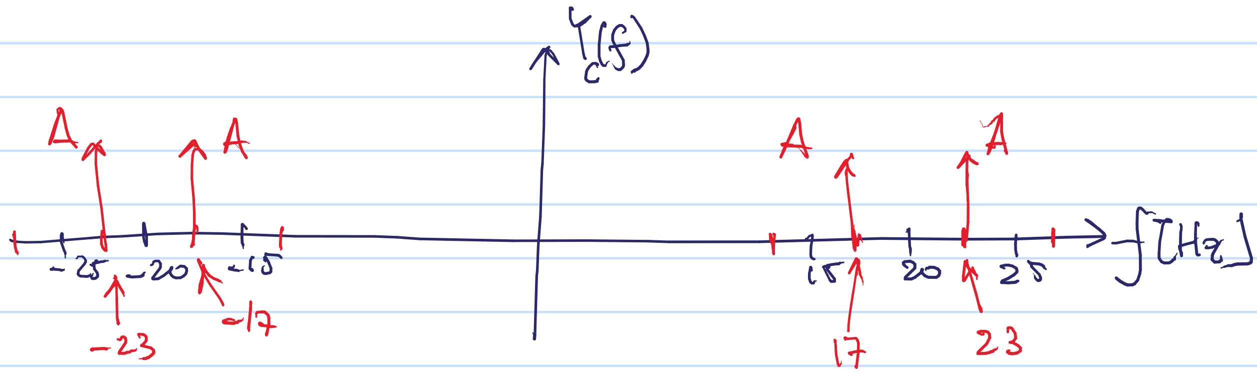
a. Bandpass filter:

$$H_e(f) = H_z(f-f_c) + H_z^*(-f-f_c)$$



c. $x_c(t) = \sqrt{2}\,\underbrace{\left(\cos(6\pi t) + 2\cos(12\pi t)\right)}_{x_2(t)}\cos(40\pi t)$





where $A = \frac{1}{2\sqrt{2}}H_c(23) = \frac{1}{2\sqrt{2}}H_c(A) = \frac{1}{2\sqrt{2}}\cdot\left(1-\frac{3}{5}\right) = \frac{1}{\cancel{2}\sqrt{2}}\,\frac{\cancel{2}}{5} = \frac{1}{5\sqrt{2}}$

$\Rightarrow y_c(t) = \sqrt{2}\left(\frac{2}{5}\cos(6\pi t)\right)\cos(40\pi t)$

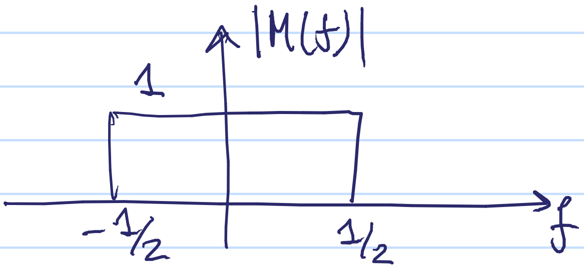
c. $y_z(t) = \frac{2}{5}\cos(6\pi t)$

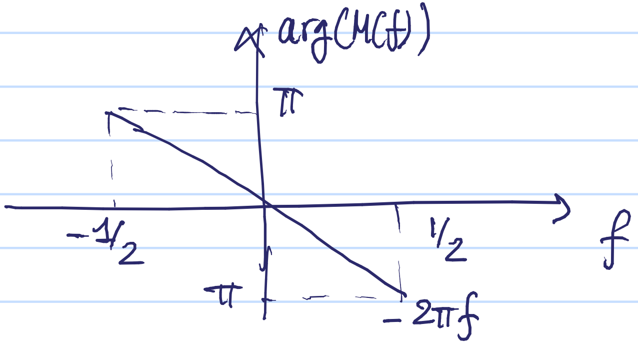
d. $P_{x_c} = \left(\frac{1}{\sqrt{2}}\right)^2 \times 4 + \left(\frac{1}{2\sqrt{2}}\right)^2 \times 4 = 2 + \frac{1}{2} = \frac{5}{2}$

$P_{y_c} = \left(\frac{1}{5\sqrt{2}}\right)^2 \times 4 = \frac{2}{25}$

2. $m(t) = \operatorname{sinc}(t-1)$

a. $M(f) = \begin{cases} e^{-j2\pi f} & \text{for } -\frac{1}{2} \leq f \leq \frac{1}{2} \\ 0 & \text{otherwise} \end{cases}$





b. $x_z(t) = e^{jm(t)} = e^{j\,\mathrm{sinc}(t-1)}$

$$x_c(t) = \sqrt{2}\cos\left(20\pi t + \mathrm{sinc}(t-1)\right)$$

c. $B_T = 2(D+1)W$

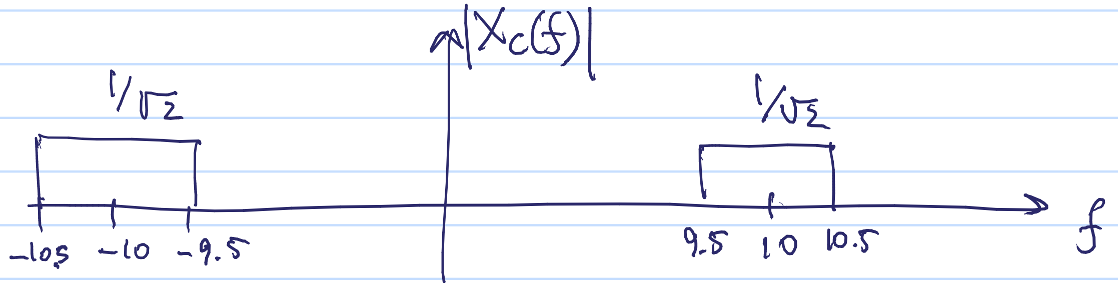
$W = 1/2$

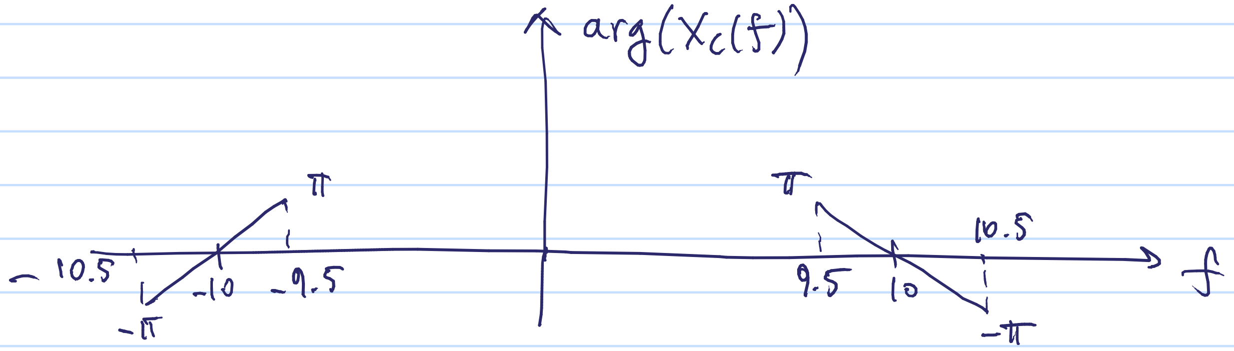
$$D = \frac{1}{2\pi W}\max_t |m(t)| = \frac{1}{\pi}$$

$$\Rightarrow B_T = \cancel{2}\left(\frac{1}{\pi}+1\right)\frac{1}{\cancel{2}} = 1.32\ \mathrm{Hz}$$

d. $x_z(t) = \mathrm{sinc}(t-1)$

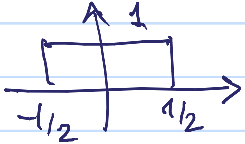
$$x_c(t) = \sqrt{2}\,\mathrm{sinc}(t-1)\cos(20\pi t)$$





e. We could use VSB-AM (see notes)

f. $R_m(\tau) = \mathcal{F}^{-1}\left\{ |M(f)|^2 \right\}$

$= \mathcal{F}^{-1}\left\{ \right.$  $\left. \right\}$

$= \text{sinc}(\tau)$