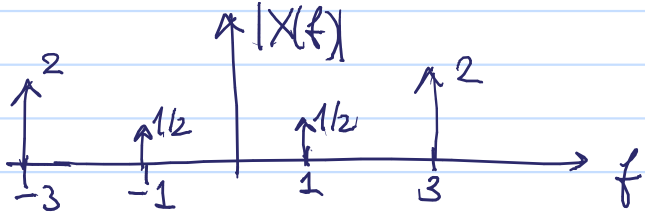
1. $x(t) = 4\cos(6\pi t) + \sin(2\pi t)$

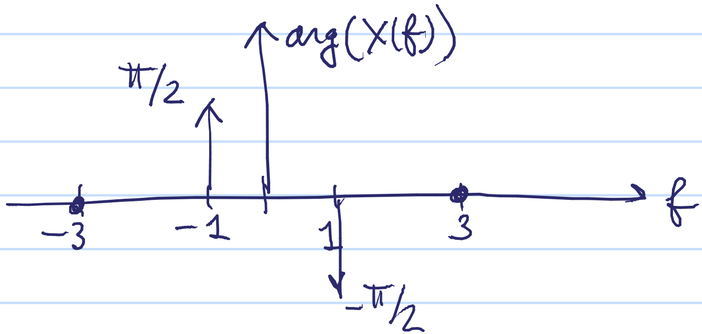
a. $X(f) = 2\delta(f-3) + 2\delta(f+3) + \frac{1}{2j}\delta(f-1) - \frac{1}{2j}\delta(f+1)$

b. $X_1 = \frac{1}{2j}$, $X_{-1} = -\frac{1}{2j}$, $X_3 = 2$, $X_{-3} = 2$, $X_n = 0$ elsewhere

c.



d.

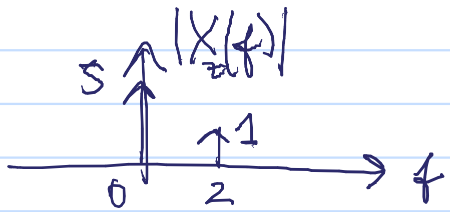


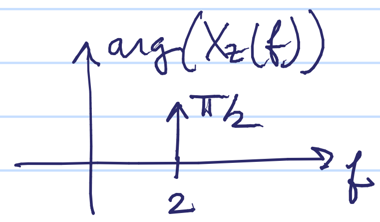
2. $x_z(t) = 5 + je^{j4\pi t} = 5 - \sin(4\pi t) + j\cos(4\pi t)$

a. $x_I(t) = 5 - \sin(4\pi t)$

$x_Q(t) = \cos(4\pi t)$

b. $X_z(f) = 5\delta(f) + j\delta(f-2)$





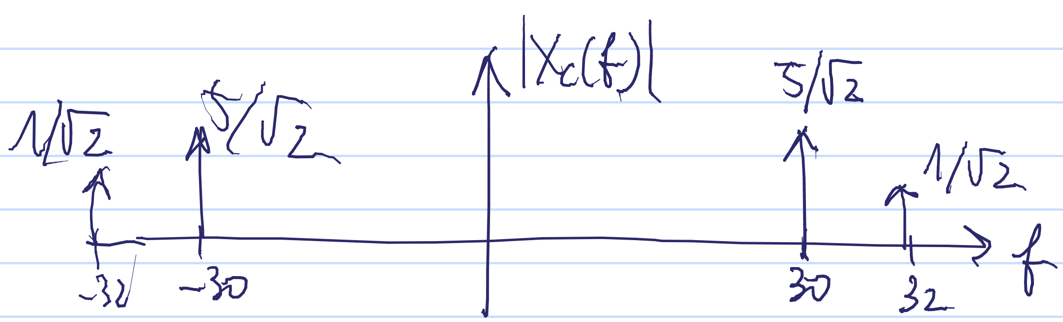
It does not satisfy Hermitian symmetry because the signal $x_z(t)$ is complex.

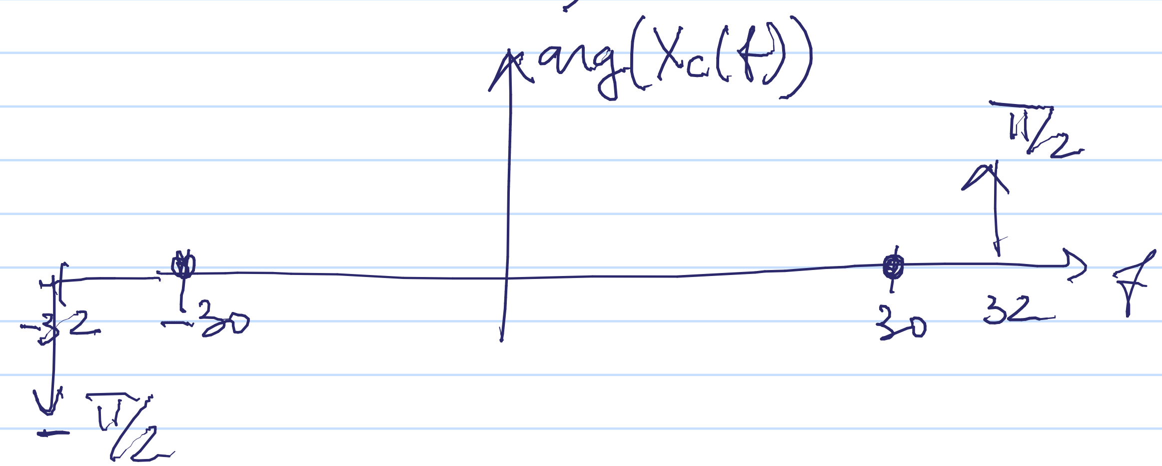
c. $x_c(t) = \sqrt{2}\,\mathrm{Re}\{(5 + je^{j4\pi t})e^{j60\pi t}\}$

$$= 5\sqrt{2}\cos(60\pi t) + \sqrt{2}\cos(64\pi t + \pi/2)$$

$$= \sqrt{2}\underbrace{(5 - \sin(4\pi t))}_{x_I(t)}\cos(60\pi t) - \sqrt{2}\underbrace{\cos(4\pi t)}_{x_Q(t)}\sin(60\pi t)$$

d. $X_c(f) = \frac{1}{\sqrt{2}}\left(5\delta(f-30) + j\delta(f-32) + 5\delta(f+30) - j\delta(f+32)\right)$





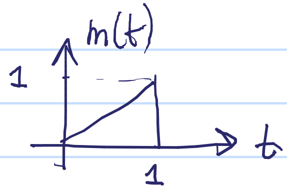
It does satisfy Hermitian symmetry since $x_c(t)$ is real.

3. $1/T_s = $ [illegible]$0 \times 2 \times \left(\underbrace{10 + \frac{1}{8}}_{\text{approximate largest frequency}} \right) = 4$[illegible]$.5$

multiplicative oversampling factor for better display

from Shannon-Nyquist theorem

4.



a. $x_p(t) = 2m(t)$

$$x_c(t) = \begin{cases} \sqrt{2}\cos(40\pi t + 2t) & \text{for } 0 \le t \le 1 \\ \sqrt{2}\cos(40\pi t) & \text{elsewhere} \end{cases}$$

b. Using Carson's formula: $B_T \simeq 2W(1+D)$

$W \simeq 5$ Hz

$$D = \frac{2}{2\pi W} \max\left|\frac{dm(t)}{dt}\right| = \frac{1}{5\pi} \simeq 0.063$$

$$\Rightarrow B \simeq 10(1+0.063) = 10.63 \text{ Hz}$$

c. $x_p(t) = 2\int_0^t m(t)\,dt = \cancel{2}\frac{t^2}{\cancel{2}}$ for $0 \le t \le 1$

$$x_c(t) = \begin{cases} \sqrt{2}\cos(40\pi t + t^2) & \text{for } 0 \le t \le 1 \\ \sqrt{2}\cos(40\pi t + 1) & \text{elsewhere} \end{cases}$$

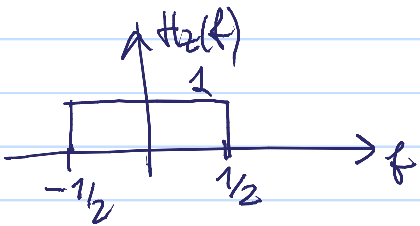
d. $D = \frac{2}{2\pi W} \max_t |m(t)| = 0.063 \Rightarrow B_T \simeq 10.63$ Hz

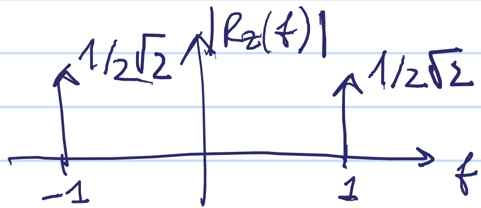
5. a. $r_c(t) = \sin\left(2\pi(t-0.2)\right)\cos\left(20\pi(t-0.2)\right)$

$$r_c(t) = \sqrt{2}\,\mathrm{Re}\left\{\frac{1}{\sqrt{2}}\sin\left(2\pi(t-0.2)\right) e^{j20\pi(t-0.2)}\right\}$$

$$= \sqrt{2}\,\mathrm{Re}\left\{\underbrace{\frac{1}{\sqrt{2}}\sin\left(2\pi(t-0.2)\right) e^{-j4\pi}}_{r_z(t)}\; e^{j20\pi t}\right\}$$

b.





$\Rightarrow$ the output signal is zero.