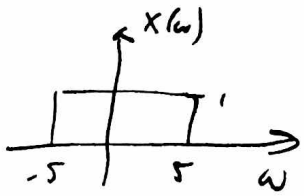
1. Determine the Nyquist rate for the following signals.
   (a) (2 points) $x(t) = \sum_{n=1}^{3} \cos(4nt)$
   (b) (1 point) $x(t) = \frac{\sin(5t)}{\pi t}$
   (c) (2 points) $s(t) = \frac{\sin(5t)}{\pi t} \cos(10t)$

a) The highest frequency cosine has the frequency 12 rad/sec

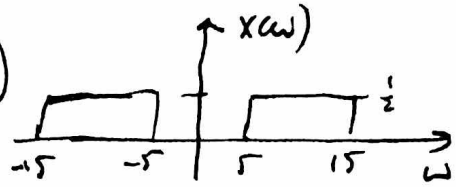
$\Rightarrow \underline{\omega_N = 24}$

b)



$\Rightarrow \underline{\omega_N = 10}$

c)



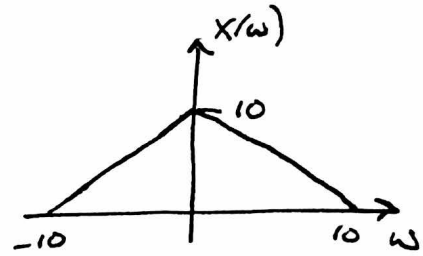
$\Rightarrow \underline{\omega_N = 30}$

2. For this question, you may need the CTFT pair

$$\sum_{n=-\infty}^{\infty} \delta(t - nT_s) \longleftrightarrow \frac{2\pi}{T_s} \sum_{n=-\infty}^{\infty} \delta(\omega - n\frac{2\pi}{T_s})$$

The spectrum of $x(t) = 2\pi \left(\frac{\sin(5t)}{\pi t}\right)^2$ is a triangular function

$$X(\omega) = \begin{cases} \omega + 10, & -10 < \omega < 0 \\ -\omega + 10, & 0 < \omega < 10 \\ 0, & \text{else} \end{cases}$$

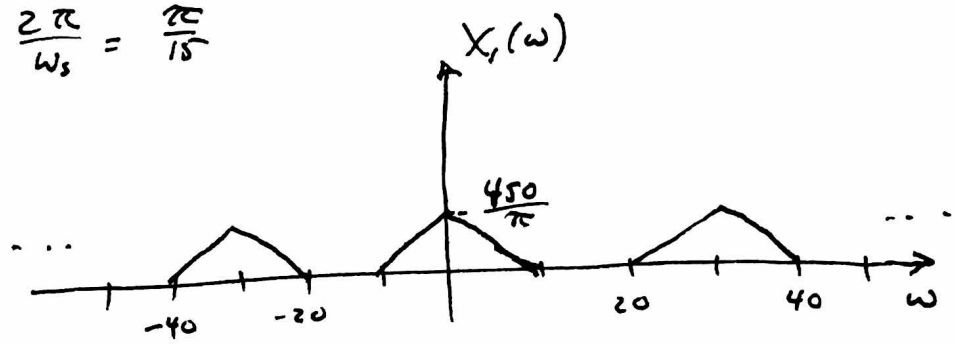


(a) (2 points) Plot the spectrum of $x_1(t) = x(t)\sum_{n=-\infty}^{\infty} \delta(t - nT_s)$ where $\omega_s = 30$.

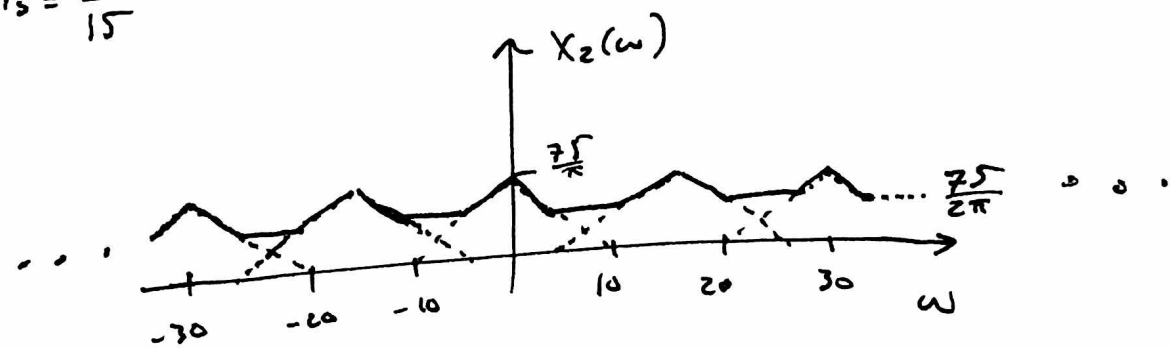
(b) (2 points) Plot the spectrum of $x_2(t) = x(t)\sum_{n=-\infty}^{\infty} \delta(t - nT_s)$ where $\omega_s = 15$.

(c) (1 point) Can you reconstruct $x(t)$ from $x_1(t)$ or $x_2(t)$? Explain your answer.

a) $T_s = \frac{2\pi}{\omega_s} = \frac{\pi}{15}$



b) $T_s = \frac{2\pi}{15}$



c) $x(t)$ can be reconstructed from $x_1(t)$, but not $x_2(t)$. There is aliasing in the spectrum of $x_2(t)$ caused by sampling under the Nyquist rate, $\omega_N = 20$.