ELEG 4603/5173L Lab # 6
Sampling Theorem

1. Consider an analog signal $x_a(t) = 20\text{sinc}(20t)$ with Fourier transform

$$X_a(\omega) = \begin{cases} 1, & |\omega| < 20\pi, \\ 0, & \text{otherwise} \end{cases} \tag{1}$$

A discrete-time signal can be obtained as $x(n) = x_a(nT)$. In the questions below, use `n = [-1000:1000]` to approximate $(-\infty, \infty)$.

   (a) If the sampling frequency is 40 Hz, calculate with Matlab the DTFT of $x(n)$, and plot the DTFT in $[-3\pi, 3\pi]$.

   (b) If the sampling frequency is 20 Hz, calculate with Matlab the DTFT of $x(n)$, and plot the DTFT in $[-3\pi, 3\pi]$.

   (c) If the sampling frequency is 12 Hz, calculate with Matlab the DTFT of $x(n)$, and plot the DTFT in $[-3\pi, 3\pi]$.

   (d) What is the minimum sampling frequency to avoid aliasing?

2. The analog signal can be reconstructed from the discrete-time signal as

$$x_a(t) = \sum_{n=-\infty}^{\infty} x(n)\text{sinc}\left(\frac{t - nT_s}{T_s}\right)$$

where T_s is the sampline period. Consider the signal from the previous question.

   (a) If the sampling frequency is 20 Hz, reconstruct the analog signal from the discrete-time samples and plot it in the same figure as the original signal.

   (b) If the sampling frequency is 10 Hz, reconstruct the analog signal from the discrete-time samples and plot it in the same figure as the original signal.