EE160 - Fall 2023 **San José State University**
Homework # 4 **Due: Fri. 10/13/23 11:59 PM**

1. Consider the signal $x(t) = \text{sinc}\,(100t)$.
   (a) Determine the minimum Nyquist sampling frequency $f_{s,\min}$.
   (b) Sketch carefully the ideal sampled spectrum $X_\delta(f)$ with a guardband of 50 Hz, in the frequency range $|f| \leq 400$ Hz. (We use δ in $X_\delta(f)$ to denote *ideal* sampling.)
   (c) Repeat part (b), for the *practically* sampled (or switched) spectrum $X_s(f)$ using a periodic train of rectangular pulses of duty cycle 50%.

2. Consider again the signal $x(t)$ in problem 1.
   (a) Specify the transfer function $H(f)$ of an ideal lowpass filter (LPF) that will allow $x(t)$ to be recovered from its samples $x(nTs)$ via $x_\delta(t)$.
   (b) Suppose that the sampling frequency is set incorrectly to $f_s = 75$ Hz. You are asked to find an expression of the LPF output signal $y(t)$ and to sketch it carefully.

3. Consider the DSB-SC AM signal $u(t) = 5\cos(20\pi t)\cos(200\pi t)$.
   (a) Sketch $u(t)$ over the interval $|t| \leq 0.125$ sec.
   (b) Sketch carefully the amplitude spectrum $|U(f)|$ in the range $-120 \leq f \leq 120$ Hz.

4. Let $u(t) = \text{sinc}(20t)\cos(200\pi t)$ be a DSB-SC AM signal.
   (a) Sketch carefully $u(t)$ over the range $-0.15 \leq t \leq 0.15$.
   (b) Sketch carefully the amplitude spectrum $|U(f)|$.
   (c) Find an expression of the lower-sideband signal $u_\ell(t)$, having a spectral density composed of the lower sidebands of $U(f)$, and sketch it carefully.
   (d) Find an expression of the upper-sideband signal $u_u(t)$, having a spectral density composed of the upper sidebands of $U(f)$, and sketch it carefully.
   (e) Using a computer, plot both $u(t)$ and $\tilde{u}(t) = u_\ell(t) + u_u(t)$ in the same graph to verify that $u(t) = \tilde{u}(t)$.