EE160 - Fall 2023 **San José State University**
Homework # 7 **Due: TUE 11/21/23 11:59 PM**

1. Problem 2 of Midterm exam 2

   A sinusoidal signal $x(t) = 10\cos(10000\pi t)$ is sampled using a periodic train of rectangular pulses of duty cycle 50%. The sampling frequency is $f_s = 7000$ Hz.

   (a) Sketch the spectrum $X_s(f)$ of the sampled signal over $-10000 \leq f \leq 10000$ Hz.

   (b) Sketch the spectrum $Y(f)$ of the output of an ideal 3-kHz reconstruction filter (LPF). You may assume that the filter has unit gain.

   (c) Give the expression of the reconstructed signal $y(t)$. (Hint: Downconversion by sampling.)

2. Let $u(t)$ be a sinusoidal modulated DSB-SC signal of carrier amplitude $A_c = 2$ and modulating amplitude $A_m = 2$. Assume that $f_c \gg f_m$.

   (a) Sketch the power spectral density $S_u(f)$ of $u(t)$

   (b) Use $S_u(f)$ to compute the average power content P_u

   (c) Verify the result of part (b) by computing directly the average power as

   $$P_u = \frac{1}{T_m}\int_{-T_m/2}^{T_m/2} u^2(t)\,dt.$$

3. Consider a heterodyne receiver using two amplifiers: (1) a low-noise channel amplifier (LNA) with a 5 dB gain and noise figure $\text{NF}_1 = 10\log_{10}(F_1) = 1$ dB; and (2) an IF amplifier with a gain of 20 dB and noise figure $\text{NF}_2 = 3$ dB.

   (a) Determine the overall noise figure NF in dB

   (b) The noise power spectral density (noise floor) at the input of the receiver LNA is $P_N = -95$ dBm. Determine the noise floor N_{IF} at the output of the IF amplifier

   (c) The signal-to-noise ratio (SNR) at the input of the receiver is 30 dB. What is the SNR value in dB at the output of the IF amplifier?