EECS 361
Homework #11

1. Section 5.5 Participation Activities
   5.5.1: Modulation terminology.
   5.5.2: AM and DSB Spectra, with envelope detection.
   5.5.3: DSB and AM.
   5.5.4: FDM total bandwidth.
   5.5.5: AM radio station bandwidth.

2. Plot the magnitude spectrum and find the average transmitter power in the following cases where $f_m =$ 1000 and f_c=100kHz

a. Double sideband suppressed carrier (DSC-SC)

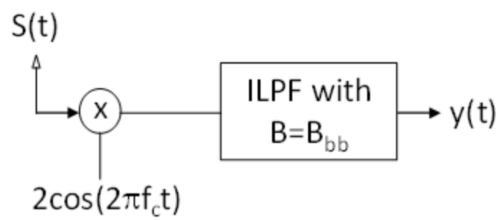
$$x_{\mathrm{DSB-SC}}(t) = 10\cos(2\pi f_m t)\cos(2\pi f_c t)$$

b. Double sideband large carrier (DSC-LC)

$$x_{\mathrm{DSB-SC}}(t) = (10+10\cos(2\pi f_m t))\cos(2\pi f_c t)$$

a.

3. Let $s(t) = x(t)\cos(2\pi f_c t) + z(t)\sin(2\pi f_c t)$, x(t) and z(t) are lowpass signals with a bandwidth of B_{bb}. The signal s(t) is processed by the receiver shown below. The bandwidth of the ILPF is B_{bb}. Assume $f_0 >> B_{bb}$.



a. Find the signal at the input to the ILPF in the time and frequency domains.
b. Assuming the ILPF has a bandwidth B find y(t).

4. Section 5.6 Participation Activities
   5.6.1: Nyquist sampling rate.
   5.6.2: Sampling theory.
   5.6.4: Sampling terminology.
   5.6.5: Sampling rates.

5. Challenge activity
   5.6.1: Sampling theorem

6. Find the Nyquist sampling rate for:

$$y(t) = x(t)g(t) \text{ where } x(t)=\frac{30}{\pi}\mathrm{sinc}(30t) \text{ and } g(t)=\frac{40}{\pi}\mathrm{sinc}(40t).$$

7. Let $x(t) = 4\mathrm{sinc}(12\pi t)(1+2\cos(12\pi t)$

a. Plot x(t).

b. Plot X(f) (do the plot in f-Hz).

c. What is the highest frequency in Hz present in x(t)?

d. Sample x(t) at the Nyquist rate and plot the spectrum of the sampled signal.

e. What is the inverse Fourier Transform of the spectrum of the sampled signal?

f. The discrete time sampled signal $x_s(n\Delta t)=x[n]$ where $\Delta t = \frac{1}{\text{Nyquist rate}}$. Note the first sample is at t=0. What are the values of the first 5 samples, i,e, x[n] for n=0...4.

8. Exercise 5.6.4

9. A signal $x(t) = 100\text{sinc}^2(2\pi 50t)$ is sampled at a rate of 120 samples/sec. What portion of the spectrum can be recovered from the samples? What is the Nyquist rate for x(t)? Hint[$2\,B\text{sinc}^2(2\,\pi\,B\,t) \longleftrightarrow \text{tri}\left(\frac{f}{2*B}\right)$]

10. An audio signal has a bandwidth of about 15kHz.

a. What is the Nyquist sampling rate for this signal.

b. Assume the energy spectral density of the high fidelity audio signal is $|X(f)|^2 = e^{\frac{-|f|}{15000}}$. The reconstruction filter is a RC LPF with a response $|H(f)|^2 = \frac{1}{1+\left(\frac{f}{80000}\right)^2}$. Using the Nyquist sampling rate, plot the energy spectrum at the output of the reconstruction filter.

c. Using an oversampling ratio of 10, plot the energy spectrum at the output of the reconstruction filter.

d. Plot the difference between the energy spectral density of the high fidelity audio signal and the energy spectrum at the output of the reconstruction filter. Comment of the use of oversampling.