EECS 562
Homework #2

1. A message signal is m(t)=4cos(20πt) volts and the carrier wave is c(t) = 200cos(1000πt) volts, the percent modulation (sometimes called modulation index or modulation factor) is 90%
   a. Find the amplitude sensitivity, k_a.
   b. Plot the RF signal in the time domain to scale.
   c. What is the total RF transmitted power assume a 100 ohm load.
   d. What is the power in the carrier wave assume a 100 ohm load.
   e. What is the RF bandwidth?
   f. Plot the power spectral density of the RF signal.

2. For a sequence of information bits b_i {1,0,1,1,1,0}; i=1..6, the message signal is formed as

$$m(t) = \sum_{i=1}^{6} b_i rect[t - i - 0.5)]$$

   a. Plot *m(t)*
   b. For 50% AM percent modulation plot the RF time-domain signal (use f_c=10Hz)
   c. For 100% AM percent modulation plot the RF time-domain signal (use f_c=10Hz)

3. 3.28

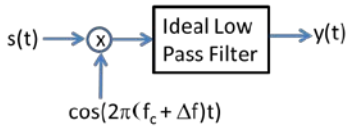
4. Consider a sequence of information bits b_i {….0,1,0,1,0,1,0,1….}, That is, alternating 0's and 1's. A baseband analog message signal *m(t)* is formed as where d_i=-2 if b_i = 0 and d_i=+2 if b_i = 1

$$m(t) = \sum_{k=-\infty}^{\infty} d_i rect[\frac{t-\frac{(2k+1)\tau}{2}}{\tau}])]$$

   a) With τ=1ms, plot *m(t)* for *k*=-3…3.
   b) What is the DC (or average value) of *m(t)*?
   c) Find the Fourier Series of *m(t)* and plot its amplitude spectrum.
   d) DSB-SC modulation is used to transmit *m(t)* with a carrier wave of carrier wave is c(t) = 10cos(2πf_c t) with f_c = 100kHz. Plot the RF amplitude spectrum. [Hint: from the Fourier Series of *m(t)* apply the modulation theorem.]
   e) With τ=1ms find the average energy per bit. This form of digital modulation is called Phase Shift Keying (PSK) or binary PSK (BPSK).

5. Repeat problem 4 d) and e) using DSB-SC with d_i=0 if b_i = 0 and d_i=+2 if b_i = 1. This form of digital modulation is called On-Off Keying (OOK).

6. Let s(t) be an DSB-SC signal, s(t)= m(t)cos(2πf_ct) with f_c=200kHz and m(t)=cos(2000πt). There is a frequency error in the coherent detector of Δf=10Hz.
   Find the output of the coherent detector, y(t) and plot y(t).



7. Let s(t) be an DSB-LC (AM) signal. The unmodulated transmitted power is 100 KW. The message signal is m(t) = cos(2πf_mt). The modulated transmitted power is 150 KW.
   a. Find the corresponding A_c and k_a in equation 3.2.
   b. What is the modulation factor?
   c. What is the power efficiency?
   d. What is the RF bandwidth?

8. Given a baseband bandwidth of 180 kHz for signals $x_1(t)$, $x_2(t)$, $x_3(t)$…. $x_N(t)$, i.e., B_i=180 kHz for each signal x_i i=1…N. These signals are modulated using DSB-SC modulation. The modulated DSB-SC signals are combined using FDM with assigned RF spectrum of 60 MHz.
    a. Assuming no guard band find N.
    b. Assuming a 10 KHz guard band find N.

9. An DSB-LC RF signal is plotted in the time domain below. What is the modulation index (modulation factor)?