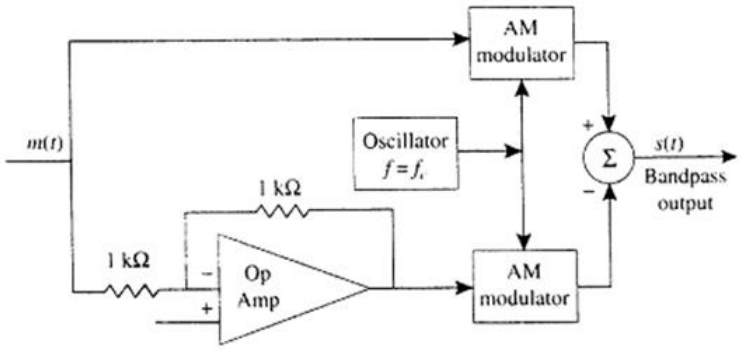
Problem Set 2

Amplitude Modulation Systems

1. Let the modulating signal $m(t)$ be a square wave that switches periodically between $+1$ and -1. Sketch the modulated signal $s(t)$ when
   a. $s(t)$ is AM modulated with a modulation index $\mu = 0.5$
   b. $s(t)$ is AM modulated with a modulation index $\mu = 1$
   c. $s(t)$ is a DSB-SC signal.
2. If $m(t) = \cos(200\pi t)$,
   a. find the bandwidth and transmitted power for an AM signal assuming $A_c = 10$ and a modulation index $\mu = 0.6$
   b. Repeat for DSB transmission
3. The signal $m(t) = \text{sinc}^2(40t)$is to be transmitted using AM with $\mu < 0.6$. Sketch the spectrum of $s(t)$ and the transmission bandwidth.
4. The multi-tone modulating signal $m(t) = 3k(\cos(8\,\pi t) + 2\cos(20\pi t))$ is input to an AM modulator with $\mu = 1$ and $f_c = 1000$ Hz,
   a. Find k so that $m(t)$ is properly normalized
   b. Draw the spectrum of the modulated signal
   c. Find the power efficiency defined as the power in the sidebands divided by the total transmitted power.
5. The signal $m(t) = 4\cos(80\,\pi t)$ is transmitted using DSB. What range of carrier frequencies can be used?
6. The signal $m(t) = 3(\cos(8\,\pi t) + 2\cos(20\pi t)$ is transmitted using DSB with $f_c = 100$ Hz
   a. Sketch the spectrum of the modulated signal.
   b. Find the average transmitted power
   c. Find the transmission bandwidth
7. The signal $m(t) = 2\cos(200\,\pi t) + 2\cos(300\pi t) + 2\cos(400\pi t)$ is transmitted using upper SSB with $f_c = 1000$ and $A_c = 5$
   a. Sketch the spectrum of the modulated signal.

b. Find the transmission bandwidth

8. The signal $m(t) = 2\cos(4\pi t)$ is transmitted using DSB with $f_c = 100$ and $A_c = 2$. Sketch the output signal if envelope detection is used for demodulation.
9. Prove that a DSB-SC can be generated from two AM signals as shown in Fig. 1.



10. Show that the impulse response of a -90° phase shift network (i.e., Hilbert Transform) is

$$h(t) = 1/(\pi t)$$

Hint, make use of the Fourier transform pair $sgn(t) \Leftrightarrow \frac{1}{j\pi f}$

11. An upper SSB transmitter is modulated with a sinusoidal signal $m(t) = 2\cos(200\,\pi t)$ and $A_c = 2$.
    a. Find $\hat{m}(t)$, the Hilbet transform of $m(t)$
    b. Find the time-domain representation of the upper SSB signal
    c. Find the average power in the SSB signal