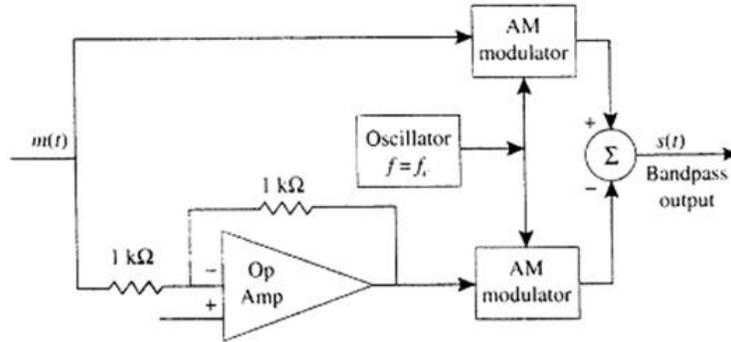


Problem Set 2

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 $A_c = 2$.
- Find $\hat{m}(t)$, the Hilbert transform of $m(t)$
 - Find the time-domain representation of the upper SSB signal
 - Find the average power in the SSB signal