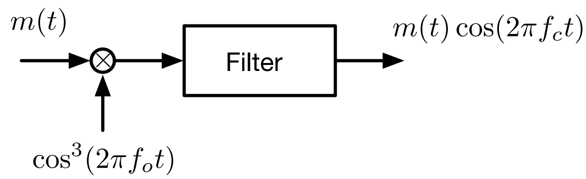
EE179 Fall 2021-22 Pauly
Introduction to Communications

Problem Set #2

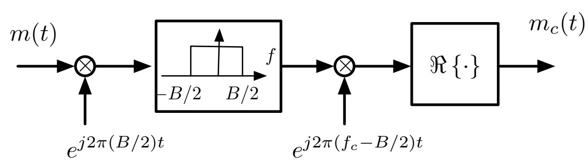
Due: Friday Oct 15, 2021 at 5 PM.

1. We have an input signal $m(t)$ that is band limited to $\pm B$ (its full bandwidth is 2B). We want to modulate it to a carrier frequency f_c with the following system

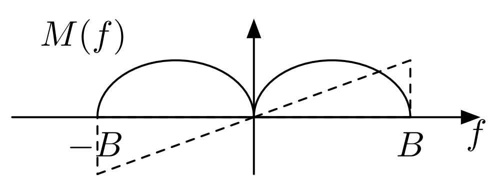


Design two different systems with different f_o's that will produce the desired output. Specify f_o and the filter for each. How large must f_c be for this to work (this is seldom a problem!).

2. Another method for generating SSB signals is shown below



   (a) Assume $m(t)$ has the spectrum



   Sketch the spectrum after the first modulator and the lowpass filter.

   (b) Sketch the spectrum after the second modulator.

   (c) Sketch the spectrum after the final block that takes the real part.

This approach is called the *Weaver Method*, and is frequently used in digital implementations. It is convenient in that only modulators and low pass filters are required. No Hilbert transform filter is needed.

3. The modulator described on slides 4 and 5 of Lecture 6 is called a *balanced mixer*. This exploits a non-linearity to modulate a signal to a carrier frequency. In class, we considered the case where there is a quadratic non-linearity. Assume that the nonlinearity also has a cubic term, so

$$y(t) = ax(t) + bx^2(t) + cx^3(t)$$

Again, assume the inputs are

$$\begin{aligned} x_1(t) &= \cos(2\pi f_c t) + x(t) \\ x_2(t) &= \cos(2\pi f_c t) - x(t) \end{aligned}$$

What is the output $y_1(t) - y_2(t)$ of the balanced mixer? Is this usable as a mixer? What output frequencies can we use it for?