Communication Systems: Homework #6

Due on Azar 26, 1396 at 4:30pm

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Problem 1

Weavers SSB modulator is illustrated in Figure 1. By taking the input signal as $m(t) = cos2f_m t$, where $f_m < W$, demonstrate that by proper choice of f_1 and f_2 the output is a SSB signal.

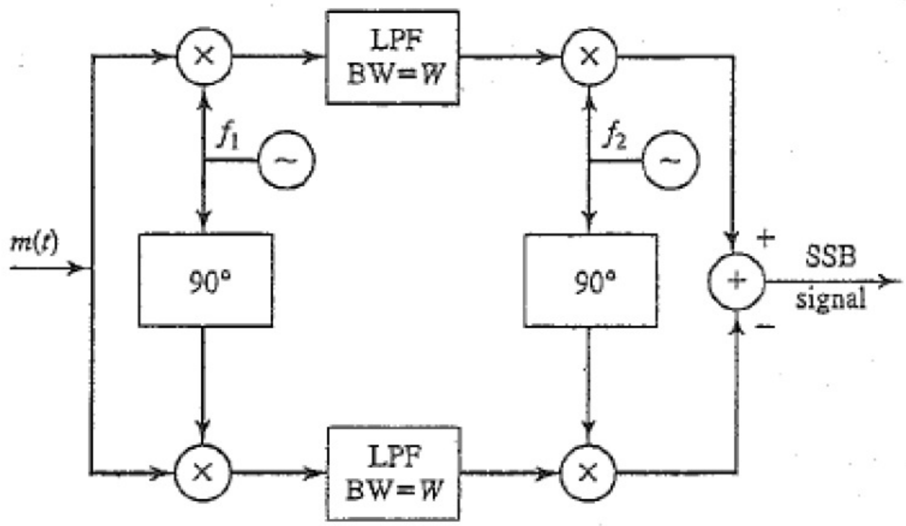

Figure 1: Weaver Modulator

Problem 2

The message signal is given by $m(t) = Acos(\omega_1 t) + Bcos(\omega_2 t)$. This message signal is modulated using an FM modulator to generate $x_c(t) = A_c cos(\omega_c t + \beta_1 sin(\omega_1 t) + \beta_2 sin(\omega_2 t))$ where $\beta_1 = \frac{Af_\Delta}{f_1}$ and $\beta_2 = \frac{Bf_\Delta}{f_2}$. Obtain an expression for the spectrum of $x_c(t)$ (Use the same method which was used for a single tone message signal and express the results in terms of $J_n(\beta)$

Problem 3

The message signal m(t) whose spectrum is shown in Figure 2 is passed through the system shown in the same figure. The bandpass filter has a bandwidth of 2W centered at f_0 and the lowpass filter has a bandwidth of W. Plot the spectra of the signals $x(t)$, $y_1(t)$, $y_2(t)$, $y_3(t)$ and $y_4(t)$. what are the bandwidths of these signals?

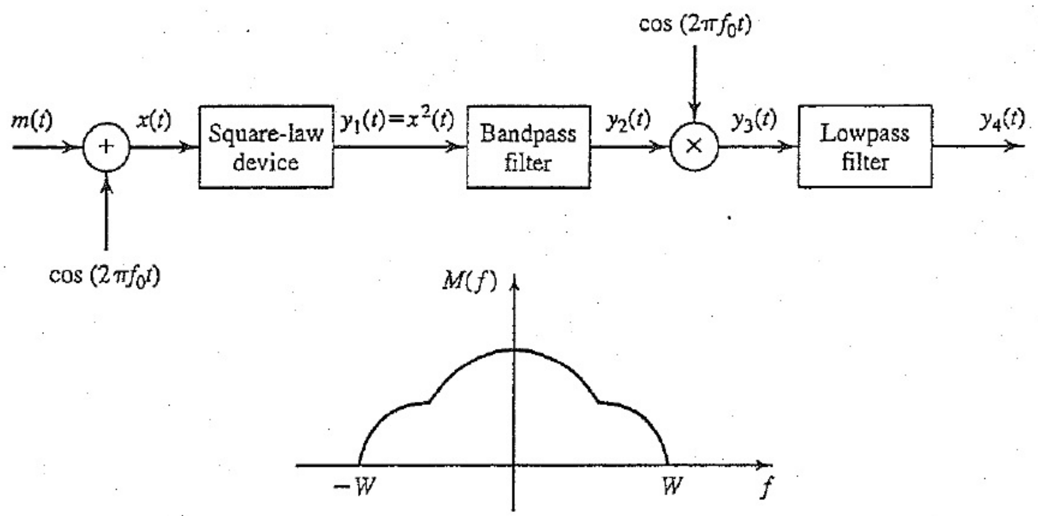

Figure 2: Problem 3

Problem 4

The carrier $c(t) = Acos(2\pi 10^6 t)$ is FM modulated by the sinusoid signal $m(t) = 2cos(2000\pi t)$ with a modulation index factor $k_f = 3000Hz/V$

(a) Determine the amplitude and frequency of all signal components that have a power level of at least 10% of the power of unmodulated carrier wave and plot the spectrum of the signal (include only these components)

(b) Determine the bandwidth using Carsons rule

(c) Answer parts (a) and (b) if the amplitude of m(t) is decreased by a factor of two.

(d) Answer parts (a) and (b) if the frequency of m(t) is increased by a factor of two.

Problem 5

An FM demodulator is shown in Figure 3. The envelope detector is assumed to be ideal and has an infinite input impedance. Select the value of L and C to demodulate an FM signal at carrier 80 MHz and a peak frequency deviation of 6 MHz (If the center frequency of the transfer function $H(f)$ of the LC circuit is f_0 you can assume that the slope of $H(f)$ is almost linear from $0.1f_0$ to $0.9f_0$)

Problem 6

Figure 4 shows an FM modulator. If the message has a bandwidth of 15 kHz and the output frequency from the oscillator is 100 kHz,

Problem 6 continued on next page...

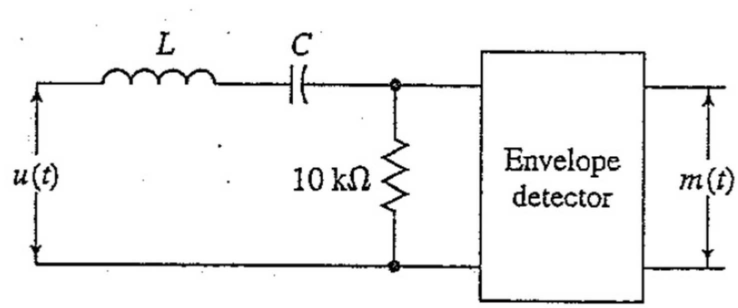

Figure 3: Problem 5

(a) Determine the frequency multiplication that is necessary to generate an FM signal at a carrier frequency of $f_c = 104MHz$ and a frequency deviation of $f = 75kHz$.

(b) If the carrier frequency for the wideband FM signal is to be within 2 Hz determine the maximum allowable drift of the 100 kHz oscillator

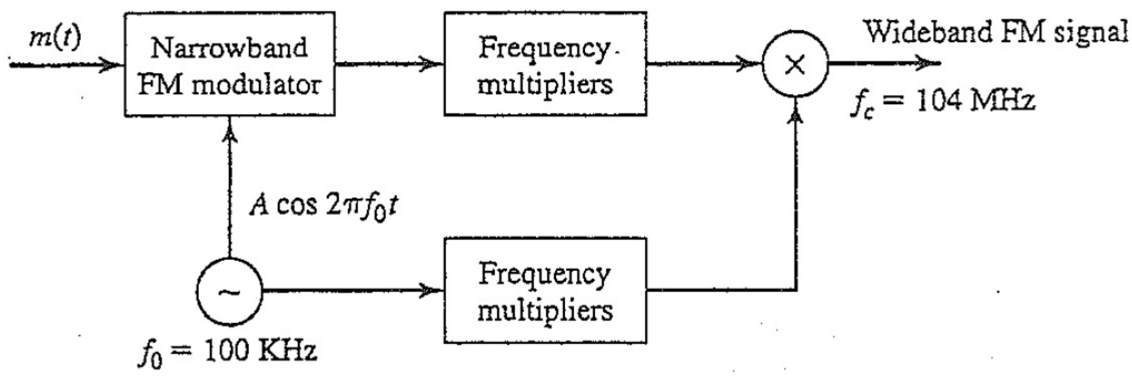

Figure 4: Problem 6

Problem 7

An audio signal has a bandwidth of 15 kHz and a maximum peak amplitude of 5V. This signal frequency modulates a carrier. Estimate the peak deviation and the bandwidth of the modulator output, assuming that the deviation constant of the modulator is a) 20 Hz/V b) 2 kHz/V and c) 20kHz/V

Problem 8

(Computer Assignment) For a two-tone message signal given in the question 2, a carrier frequency $f_c = 120MHz$ do the following:

1. Calculate the FM bandwidth using Carsons rule assuming $A = B = 3,\ f_1 = 2kHz,\ f_2 = 5kHz$ and $f_\Delta = 10kHz/V$
2. Write a MATLAB program to generate the FM signal. Determine the bandwidth by considering only those side frequencies whose amplitudes exceed 1 percent of the un-modulated carrier amplitude.
3. Repeat part b with the same assumptions with $f_1 = 3kHz$ and compare the obtained results with Carsons rule
4. Repeat part c with the same assumptions with $f_1 = 10kHz$ and compare the obtained results with Carsons rule