Communication Systems

Lab – 6

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Submission Date: 22/04/2021

Figure 1

In this figure we observe differences when we have different frequency sensitivity factors k_f. Change in k_f, changes the frequency deviation of the modulated signals which are 10, 50 and 100 in order. Thus, it is expected to observe more obvious change in frequency at s3 because of the greatest frequency deviation value and least at the first graph because of the least frequency deviation value.

$$\Delta f = k_f A_m$$

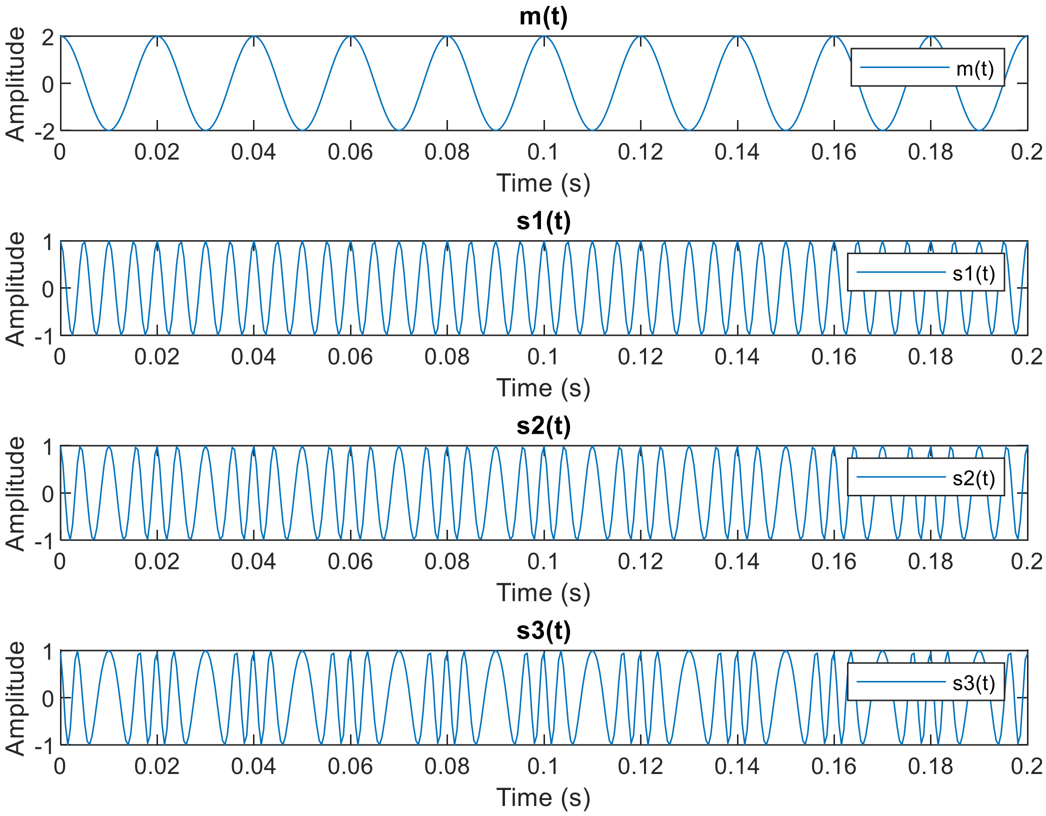

Figure 2

In this graph, we observe peaks at frequencies of m(t) and c(t). We obtain peaks at their frequencies with half of their amplitudes because of fourier transform of cosine function.

$$\mathrm{m(t)} = 2\cos(2\pi 50t)\ \ Fourier => [\delta(-50) + \delta(50)]$$

$$\mathrm{c(t)} = \cos(2\pi 200t)\ \ Fourier => \frac{1}{2}[\delta(-100) + \delta(100)]$$

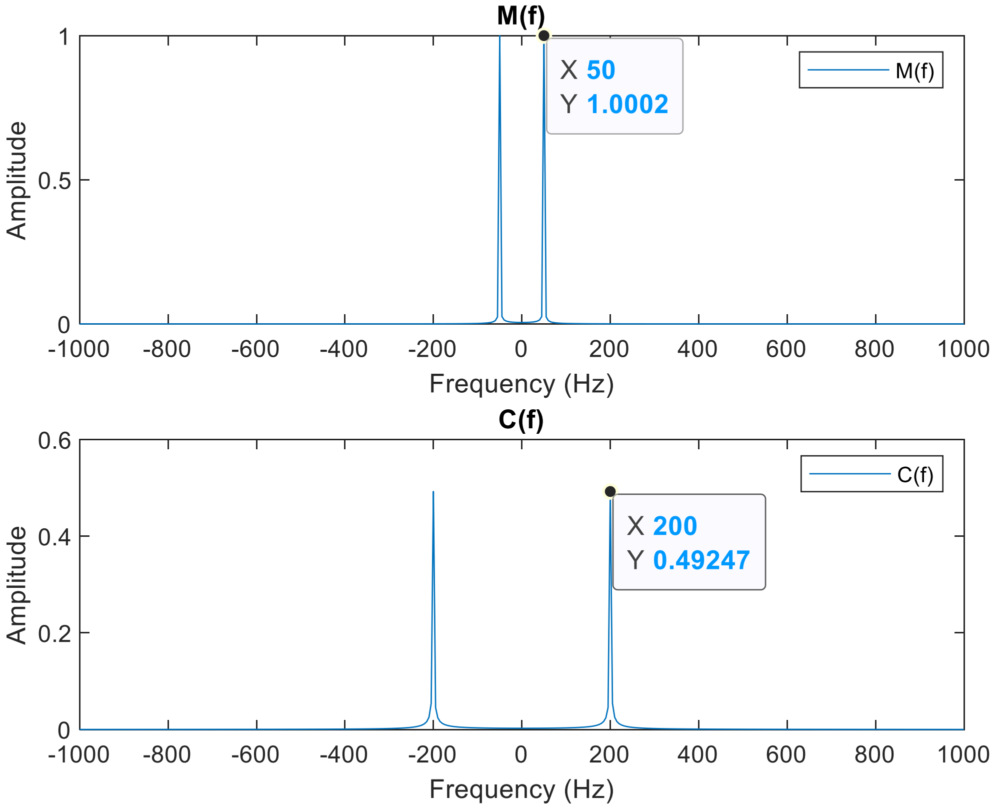

Figure 3

In this figure, different from figure 1, we observe effect of k_f at *frequency* domain. We see different graph because change at k_f changes the modulation index of the signal which is $\beta = \frac{k_f A_m}{f_m}$. The modulation index values are 0.2, 1 and 2. s1(t) is narrowband FM and s3(t) is wide band FM. To explain why we have peaks at that value, we observe peaks at the carrier frequency and around it with fm Hz distances. Also, their amplitudes are related to Ac/2 and Bessel function because of the formula

$$S(f) = \frac{A_c}{2} \sum_{n=-\infty}^{\infty} J_n(\beta)[\delta(f - f_c - nf_m) + \delta(f + f_c + nf_m)]$$

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$\beta = 0.2$	$\beta = 0.5$	$\beta = 1$	$\beta = 2$
0.990	0.938	0.765	0.224
0.100	0.242	0.440	0.577
0.005	0.031	0.115	0.353
		0.020	0.129
		0.002	0.034
			0.007
			0.001

According to Bessel function with different modulation index, our values are like the table. That is why, the amplitudes are decreasing while they are going far from the fc. Also, we can clearly see that increase in modulation index, increases the number of significant side frequencies. Because of that, we observe common frequency at 0Hz for S3(f).

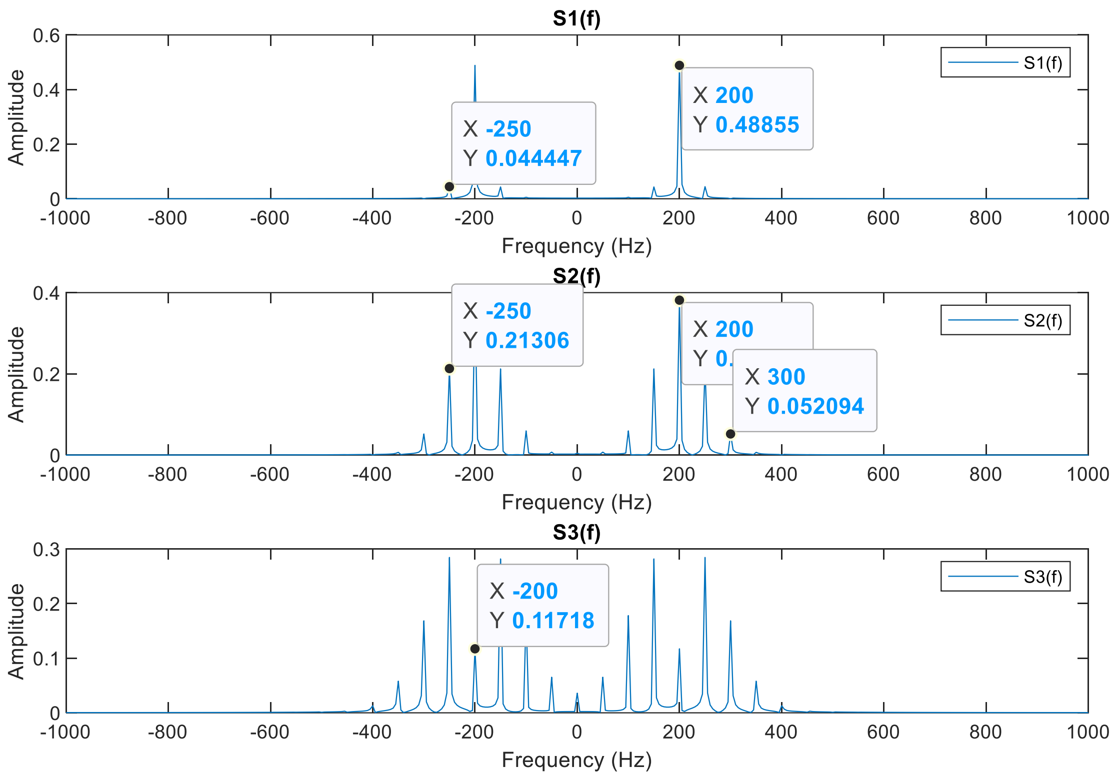

Figure 4

In this figure, we see that almost the same m(t) is obtained from the demodulation. The worst demodulation is s3(t) because it has the widest bandwidth overall from Carlson's Rule which is BT =2*(Δf + fm). Greater bandwidth results in intersection of side frequencies which makes signal to lose some data. This is valid for s2(t) but with less affect. Also, s1(t) is almost identical to the original m(t) which tells us that increase in frequency sensitivity factor results in distortion on the demodulated signal.