Signals and Systems

Lab – 4

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Submission Date: 01/04/2021

Figure 1

In this figure, we see the cosine wave with 100Hz frequency at the first graph, the cosine wave with 1kHz frequency at the second graph and multiplication of first and second graph from product modulator at the last graph. Last graph is the modulated graph that is used for carry the message which is DSB-SC AM.

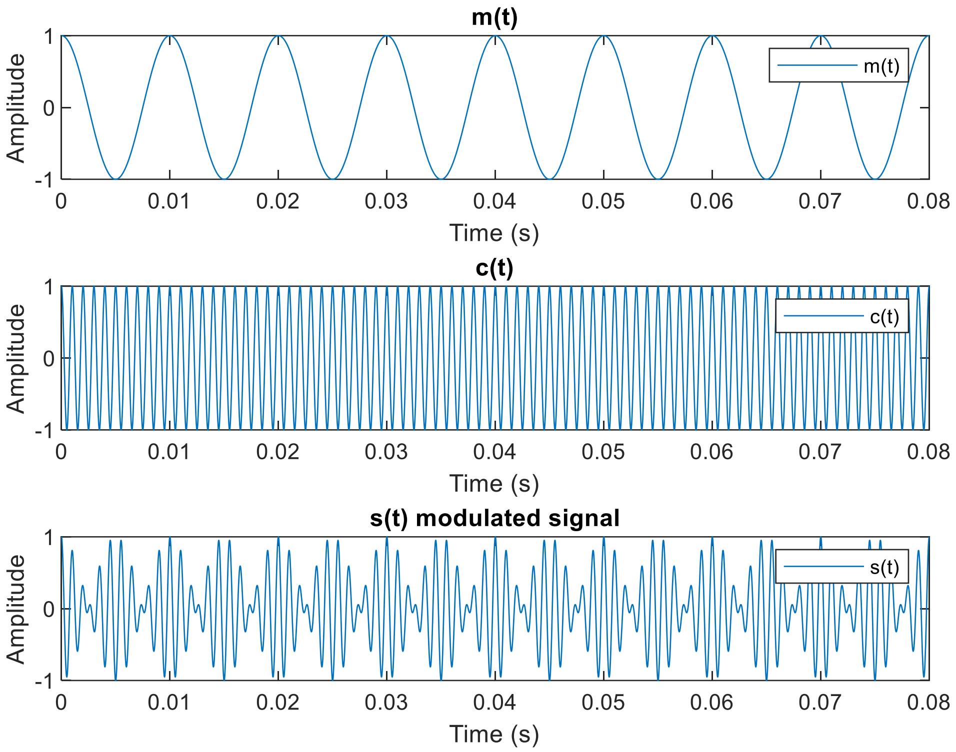


Figure 2

At the first graph, we see peaks at 100 and -100Hz because of the fourier transform of cosine which is 100Hz. $m(t) = \cos(2\pi 100t)\,.\,Fourier => \frac{1}{2}[\delta(-100) + \delta(100)]$

At the second graph, we see the fourier transform of modulated signal which is $m(t) * \cos(2\pi 1000t) = \frac{m(t-1000)}{2} + \frac{m(t+1000)}{2}$

$Fourier \gg 1/4[\delta(-1000 - 100) + \delta(-1000 + 100) + \delta(1000 - 100) + \delta(1000 + 100)]$

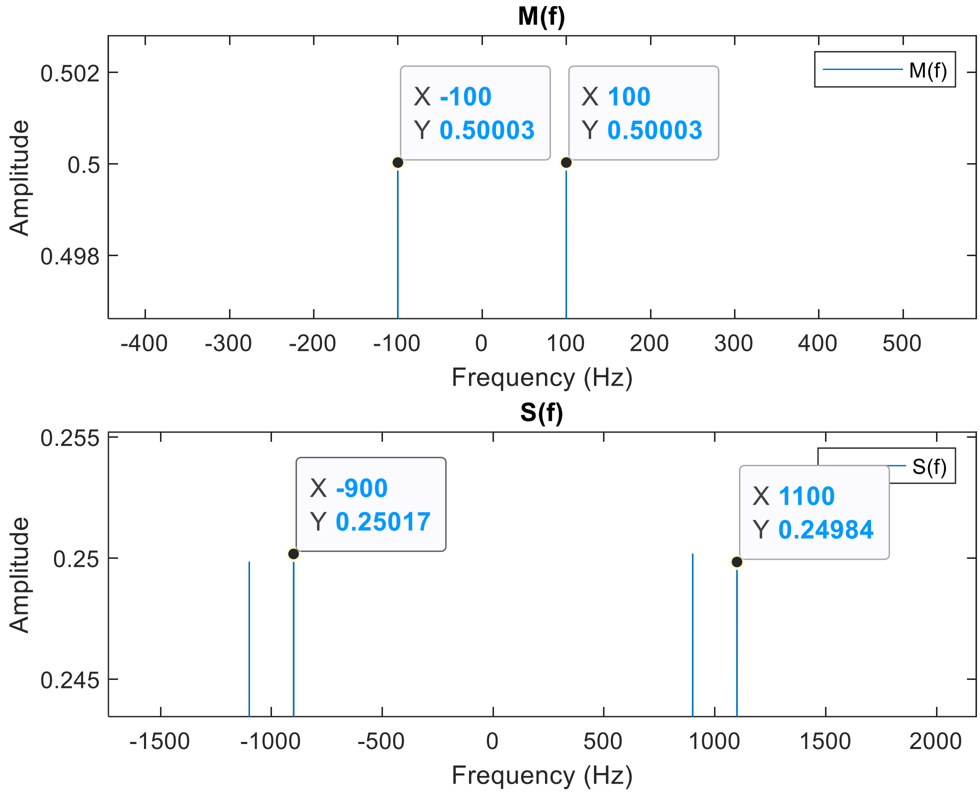


Figure 3

In this figure, we see the demodulated state of s(t) before filter. We multiplied s(t) with local oscillator

$$m(t) * \mathrm{Ac} * \cos(2\pi 1000t) * Ac' * \cos(2\pi 1000t + \varphi)$$
$$= \frac{A_c * A_c'}{2} m(t)[\cos(\varphi) + \cos(2\pi 2000t)]$$

I assumed that φ goes to 0, thus we obtain, $\frac{A_c * A_c'}{2} m(t)[1 + \cos(2\pi 2000t)]$ and the fourier transform of this equation is

$\frac{A_c * A_c'}{4} * [\delta(-100) + \delta(100) + \frac{1}{2}(\delta(-2000-100) + \delta(-2000+100) + \delta(2000-100) + \delta(2000+100))]$

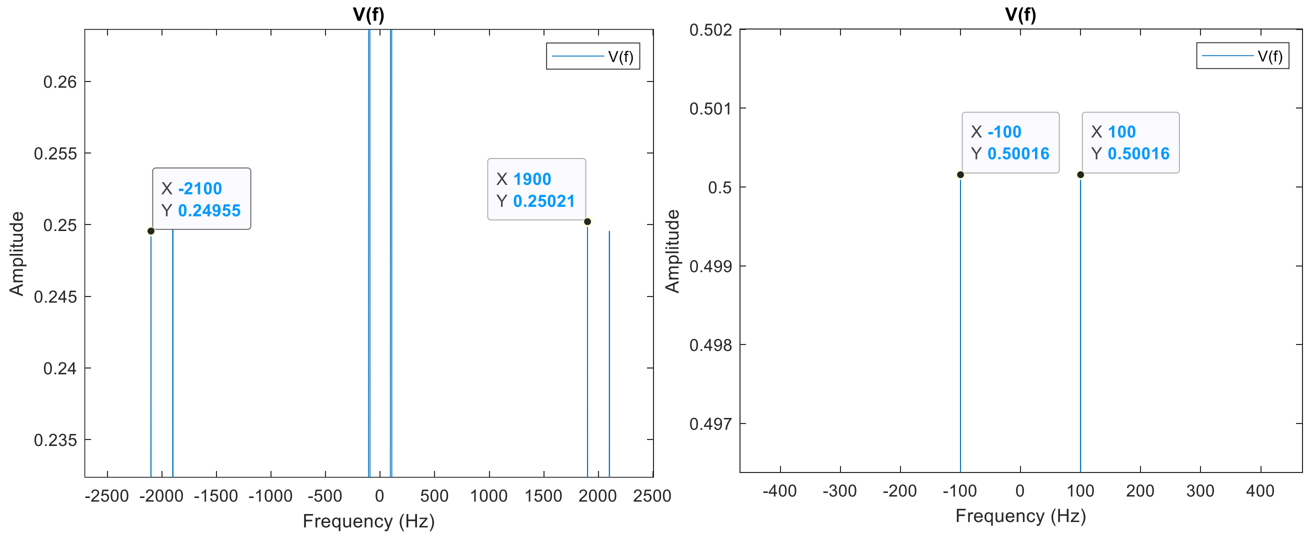
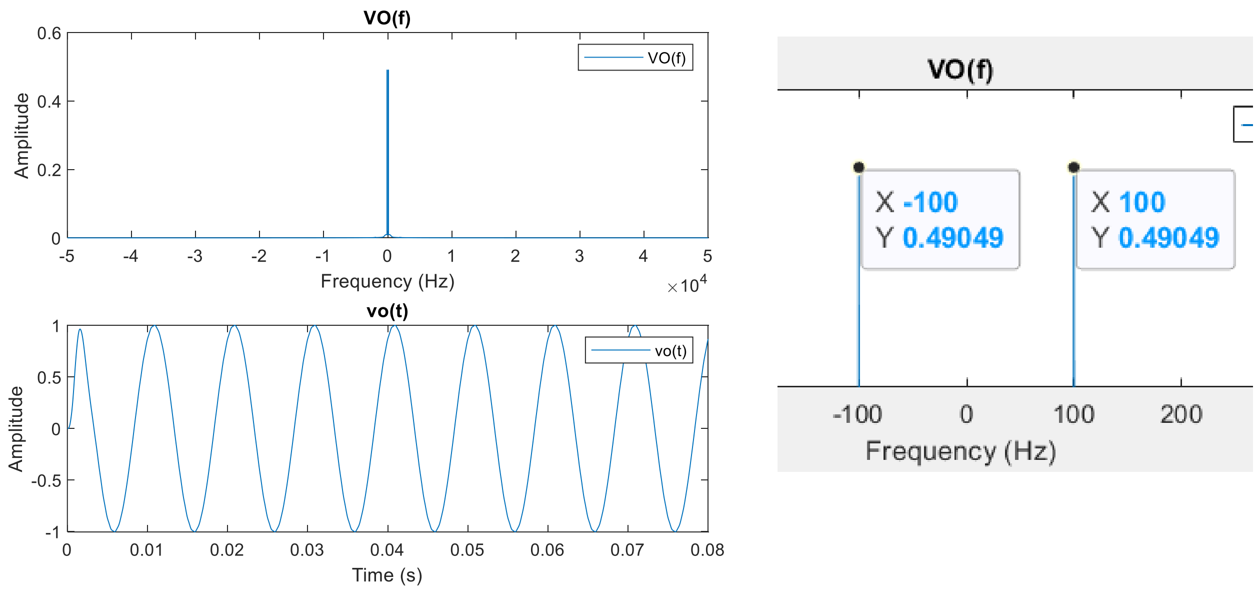


Figure 4

In the first graph, we see the filtered v(t) signal to obtain the message signal. Thus, we see the frequency response of m(t) which is $\frac{1}{2}[\delta(-100) + \delta(100)]$. We eliminated the $\cos(2\pi 2000t)$. In the second graph, we directly see $\cos(2\pi 100t)$.



Comments

2.1d

In the obtain signal, we see 4 impulses with 1/4 amplitude at -1100, -900, 900 and 1100. That represents the fourier transform of modulates signal.
s(t) = m(t)*Ac*cos(2pi1000t) = cos(2pi100t)*Ac*cos(2pi1000t)
S(f) = 1/4[δ(-1000-100)+δ(-1000+100)+δ(1000-100)+δ(1000+100)]

2.2b

We see 6 impulses which are at -2100,-1900,-100, 100, 1900 and 2100.
Because v(t) = ((Ac*Ac')/2)* m(t)*[cos(φ)+cos(2π2000t)]
V(f) = (Ac*Ac')/4*[δ(-100)+δ(100)+1/2(δ(-2100)+δ(-1900)+δ(1900)+δ(2100))]
Ac = 1, Ac' = 2, that’s why we see 1/2 amplitude at -100 and 100, 1/4 at -2100, -1900, 1900 and 2100.

2.2c

We want to eliminate the signal which is greater that 1900Hz and keep the signal which is less than 100Hz. Thus, our cutoff frequency of the filter is supposed to be between 100Hz and 1900Hz. Also, to obtain the least costly efficient filter design, we need to choose least order that we can. That is why, the order of my filter is 4 and cutoff is 500.

2.2d

Compare and comment on the frequency content and magnitude of the obtained signal. To obtain the same signal as m(t), I have chosen the Ac as 1 and Ac' as 2. We see the same frequency and the same amplitude. There is just a little phase shift at the demodulated signal because of lowpass filter.