Module 3 - Homework 3

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Problem 4.2-2

Signal III

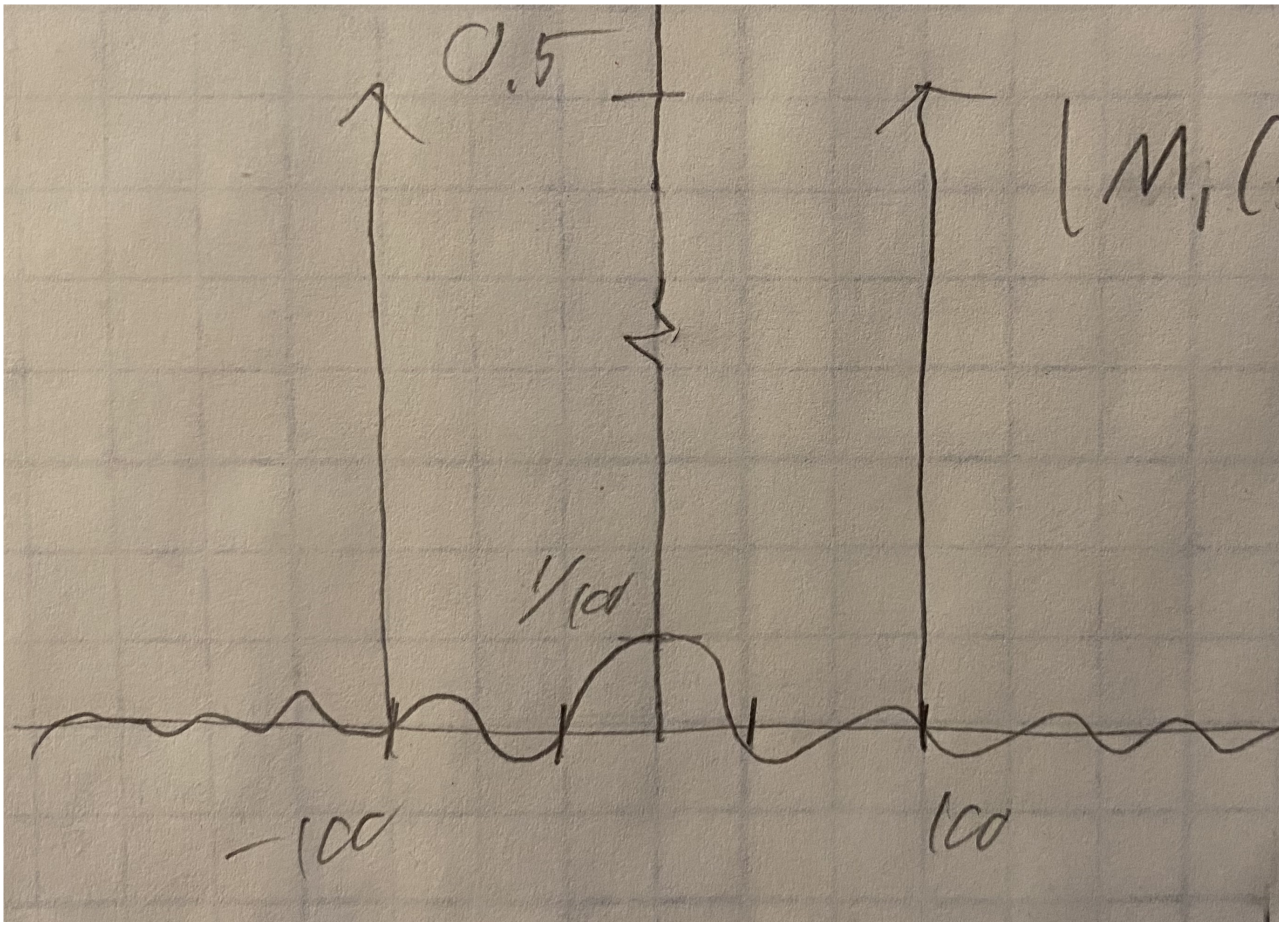
$$m_3(t)cos(200\pi t) + rect(100t)$$

(a) sketch the spectrum of m(t)
When we take the fourier transform of m(t) we get:

$$M_3(f) = 0.5[\delta(f+100) + \delta(f-100)] + \frac{1}{100}sinc(\frac{\pi f}{100})$$

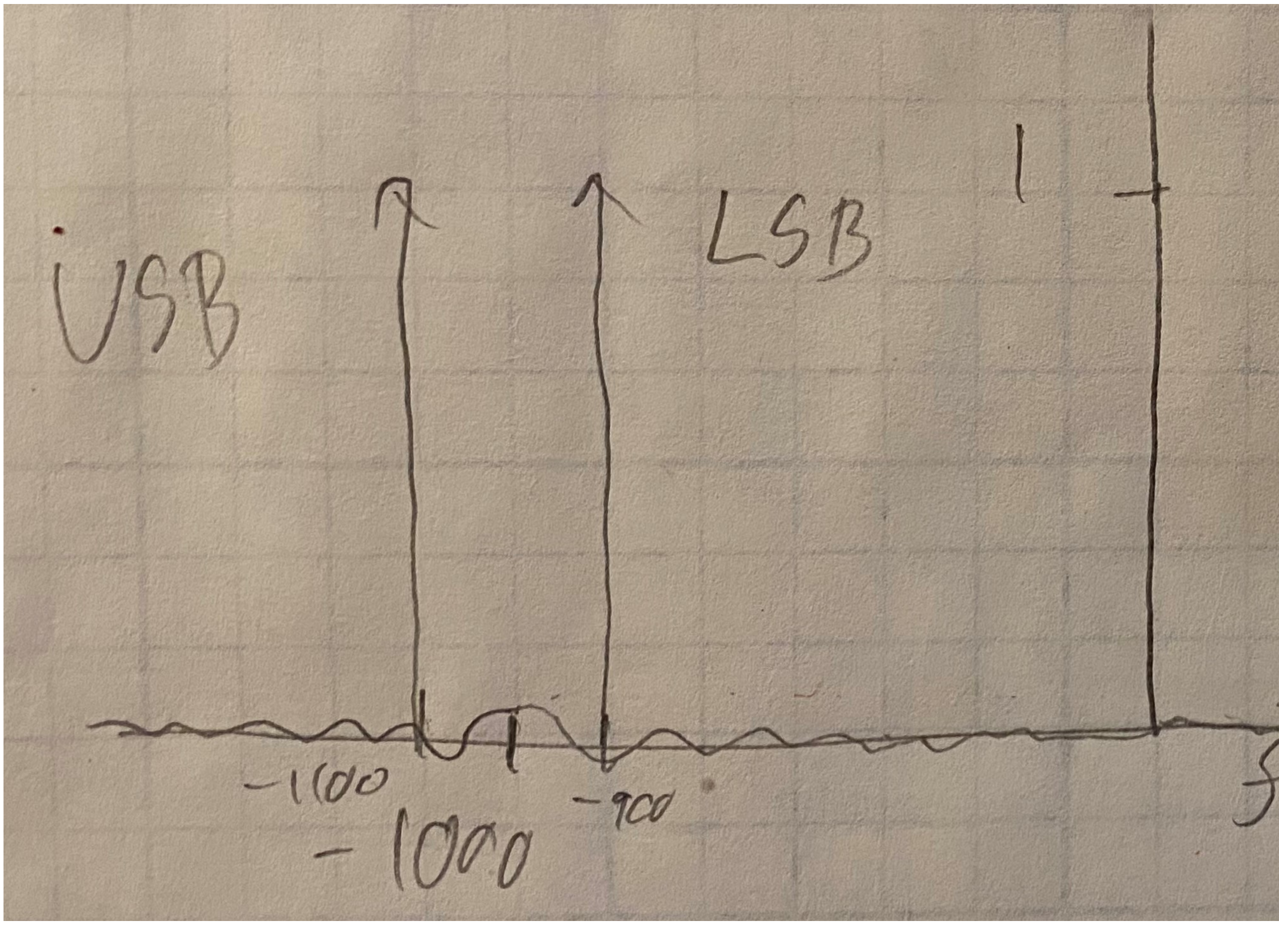
(b) sketch the spectrum of the DSB-SC (double sideband suppressed carrier modulation) signal $2m(t)cos(2000\pi t)$

We have $f_c = 1000$ for this signal, so we can sketch the spectrum as follows in figure


0.5
1/100
-100
100
|M₁(

(c) Identify the USB and the LSB spectra

The spectra are marked below. Think of the USB spectra being the outside halves and the LSB being the inside halves.



Signal IV

$$m_4(t) = 50exp(-100|t|) * sgn(t)$$

(a) sketch the spectrum of m(t)

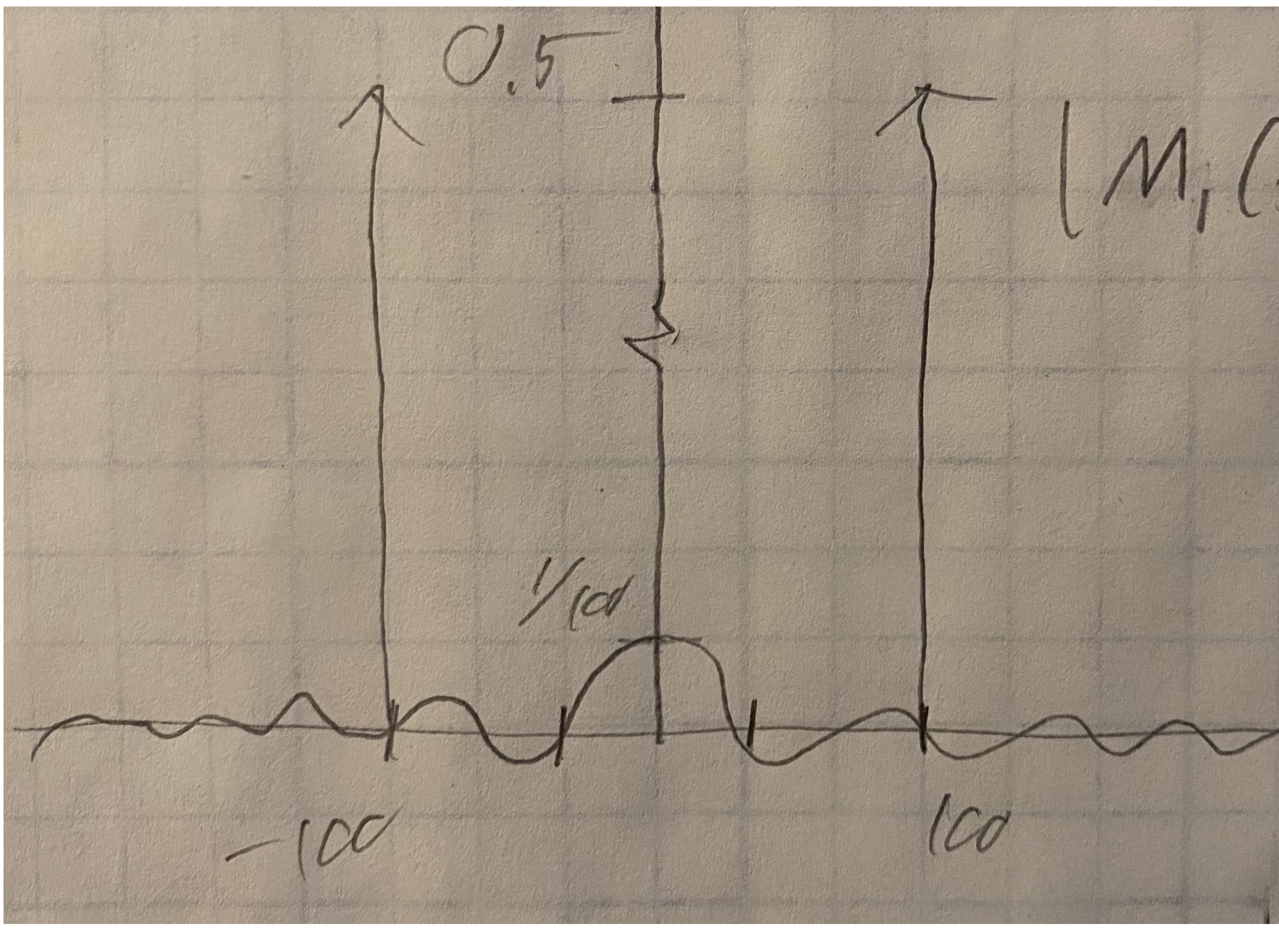
$$m_4(t) = \begin{cases} 50e^{100t} & t > 0 \\ -50e^{-100t} & t < 0 \end{cases}$$

$$m_4(t) = 50e^{100t}u(t) + -50e^{-100t}u(-t)$$

$$M_4(F) = \frac{50}{100 + j2\pi f} - \frac{50}{100 - j2\pi f}$$

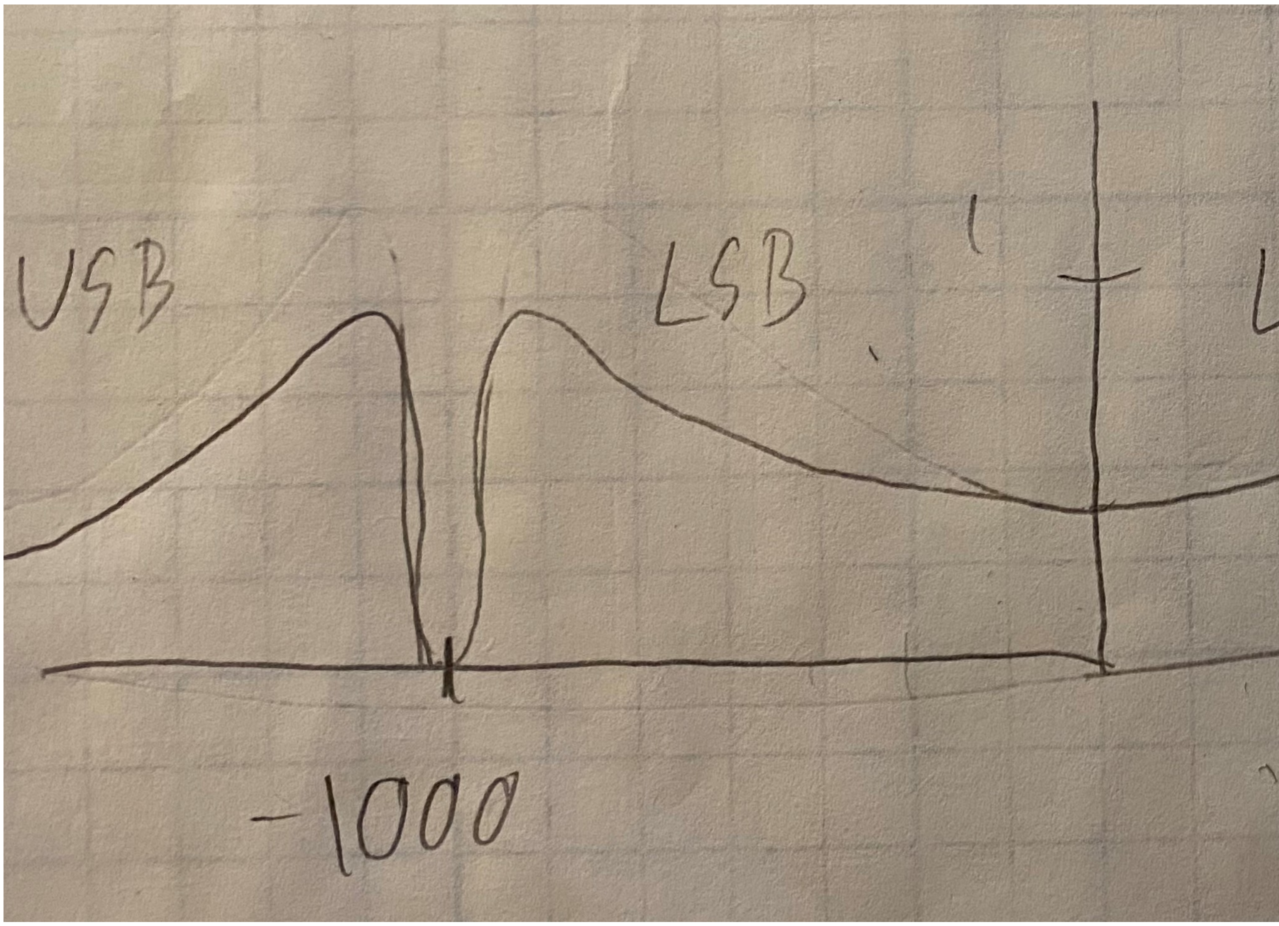
(b) sketch the spectrum of the DSB-SC (double sideband suppressed carrier modulation) signal $2m(t)cos(2000\pi t)$

We have $f_c = 1000$ for this signal, so we can sketch the spectrum as follows in figure


0.5
1/100
-100
100
|M₁(

(c) Identify the USB and the LSB spectra

The spectra are marked below. Think of the USB spectra being the outside halves and the LSB being the inside halves.

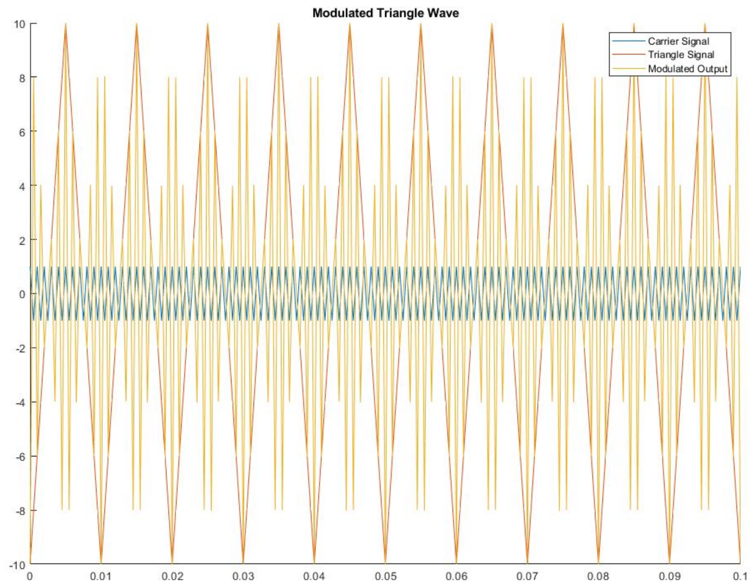


Problem 4.3-6

(a) - Sketch the time domain AM signal corresponding to the AM modulation in Problem 4.3-5

See figure for a Matlab plot. I tried sketching this by hand and wasn't convinced that my signal was right, so I verified it in Matlab. The carrier operates at 1000Hz.

(b) - If this modulated signal is applied at the input of an envelop detector,



show the output of the envelop detector is not m(t)

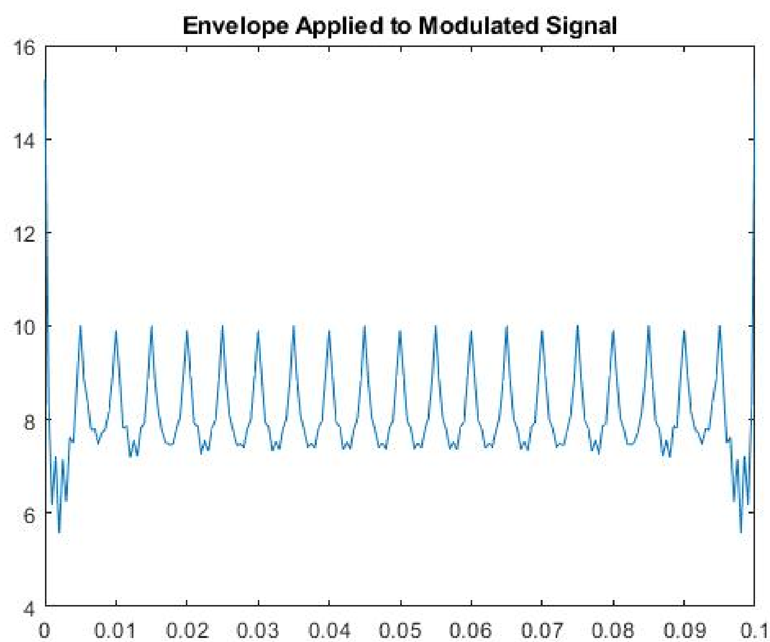
Matlab has a useful envelope function that I wanted to try as well. An envelope detector will follow the modulated signal, but notice how this one doesn't! This is because the signal that is being modulated has negative values. The peaks in figure are at amplitude 10 at the same frequency of the original signal. These detectors are implemented using an RC circuit that will store charge as the voltage oscillates, so you can see the "capacitor" decay in charge till another peak hits the circuit.

(c) - Show that, if an AM signal $A_c[A + m(t)]cos(\omega_c t)$ *is envelope-detected, the output is* $A_c|A + m(t)|$.

Figure 4.7 visually shows this, but when a signal is envelop detected when the following condition holds true:

$$A + m(t) \geq 0 \text{ for all t}$$

With this condition, , $A + m(t) = |A + m(t)|$. The envelop follows the peaks of the AM signal and produces output $A_c[A + m(t)] = A_c|A + m(t)|$.


Envelope Applied to Modulated Signal
16
14
12
10
8
6
4
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1