BIRZEIT UNIVERSITY

Faculty of Engineering & Technology

Electrical & Computer Engineering Department

COMMUNICATIONS LAB

ENEE4113

Pre-lab

PM Experiment #5

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Section: 5

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1.Software Prelab for PM Experiment #5

The frequency modulated signal:

s(t)=cos(2π×20k×t+πcos(1000π×t))

1.1. Extract the message signal m(t) from s(t).

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$s(t) = \cos(2\pi(20k)t + \pi\cos(1000\pi t))$

* The general form

$s(t) = A_c\cos(2\pi f_c t)[1+m(t)]$

$= A_c\cos(2\pi f_c t) + A_c\cos(2\pi f_c t)m(t)$

$A_c = 1$, $f_c = 20k$ Hz

So

$s(t) = \cos(2\pi 20kt)(1+\pi\cos(1000\pi t))$

$m(t) = \pi\cos(1000\pi t)$

$k_p = \pi$ since $\theta = k_p A_m$ and suppose $A_m = 1$

Figure 1.Extract the message signal m(t) from s(t) by hand

General parameters:

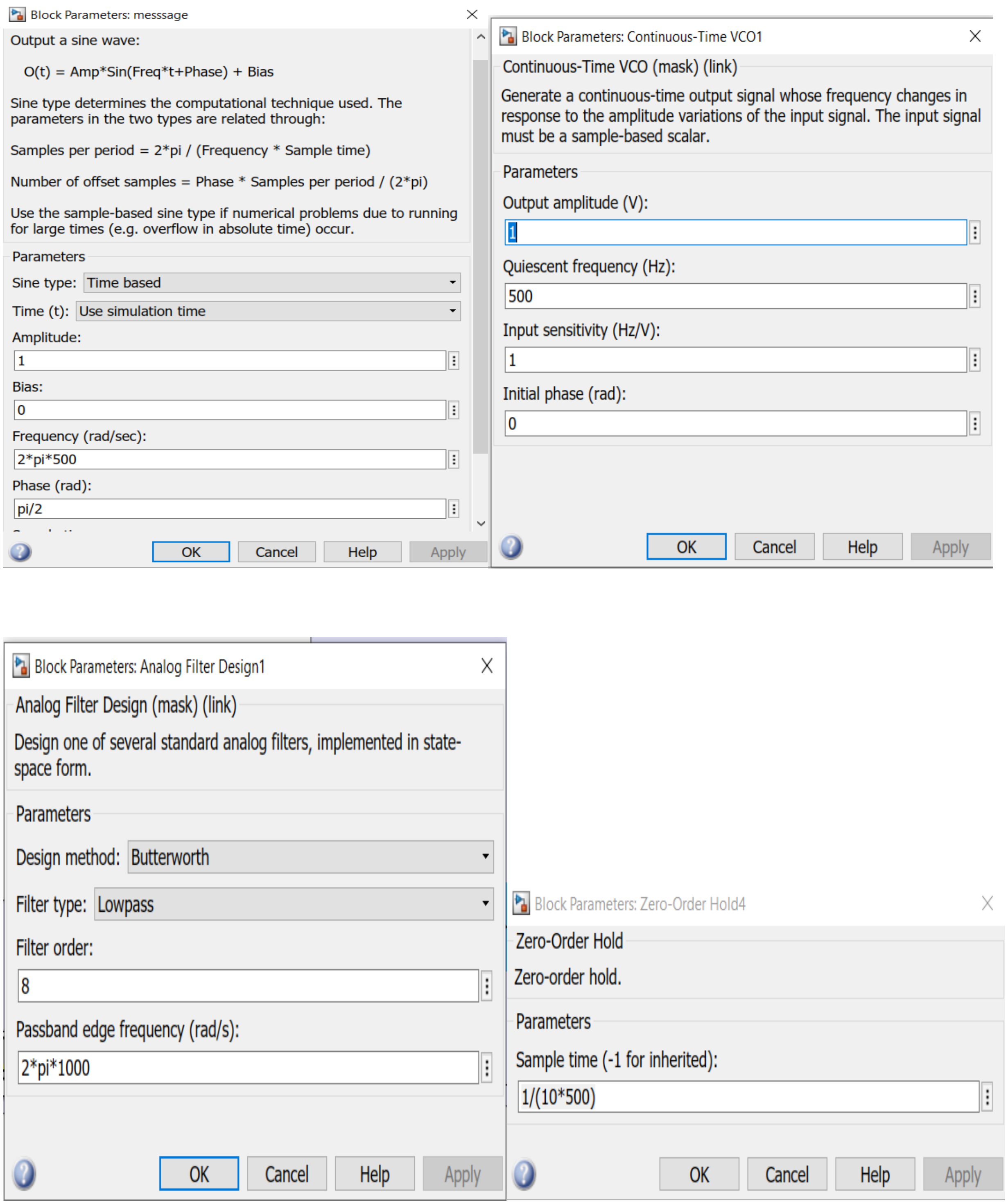

Figure 2.general parameters

1.2.Plot 5 cycle from message signal m(t) and s(t) versus t.

1.2.1.Block diagram for Modulation of pm:

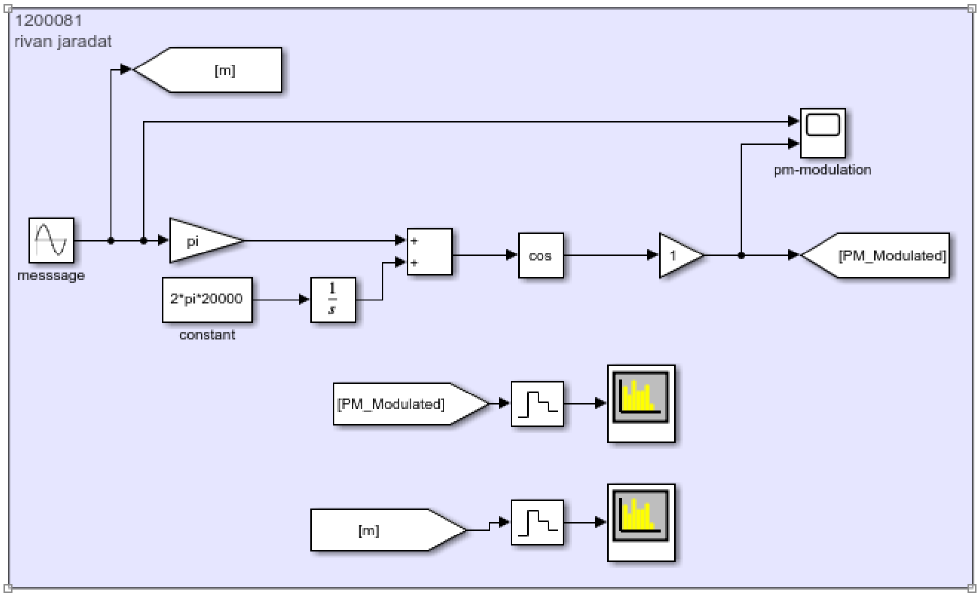

Figure 3.Modulation of PM

1.2.2.Time domain:

M(t):

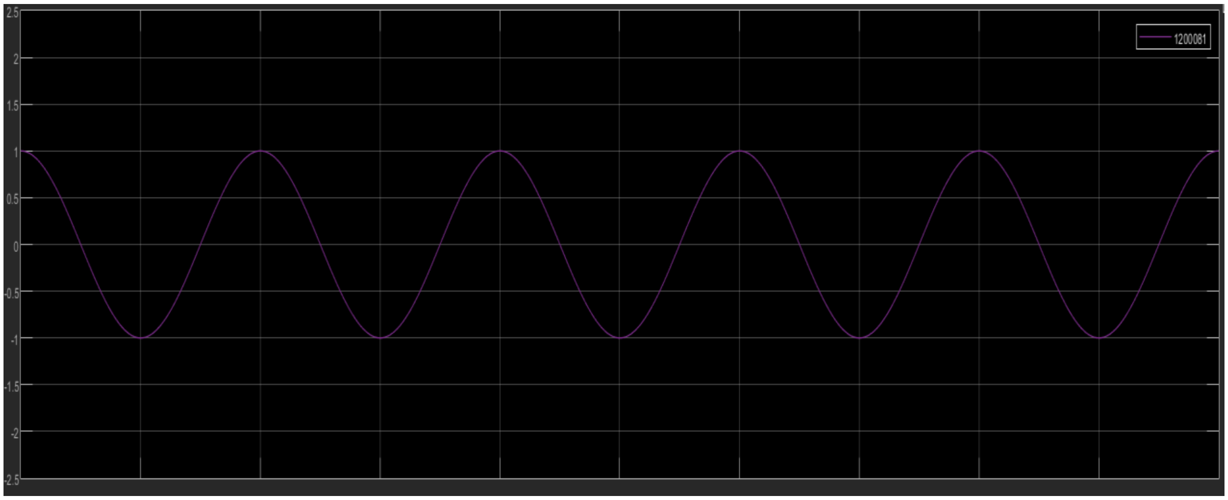

Figure 4.m(t) in time domain

After Plot 5 cycle from message signal m(t) we noticed that the amplitude of message signal =1 , and it same as we get it from the hand solution

modulated signal

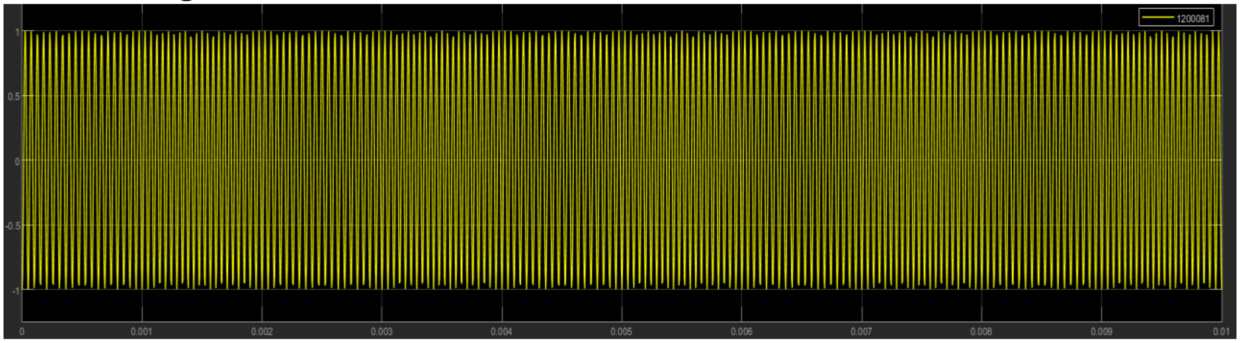

Figure 5.modulated signal in time domain

1.2.3.Frequency domain:

M(t)

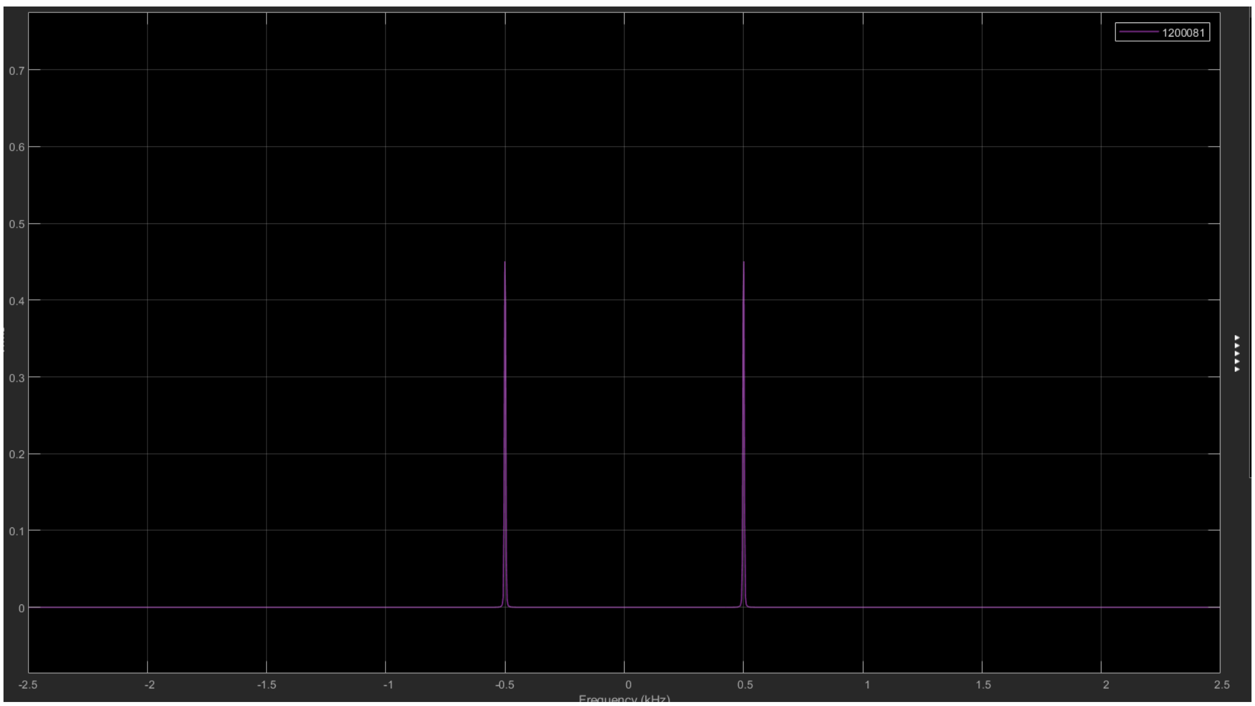

Figure 6.m(t) in frequency domain

m(t)=cos(2π×1000×t)

Spectrum of m(t)= 1/2 δ(f−500)+ 1/2 δ(f+500)

the frequency spectrum of m(t) consists of two impulses centered at 500 Hz and −500 Hz, each with an amplitude of almost 1/2

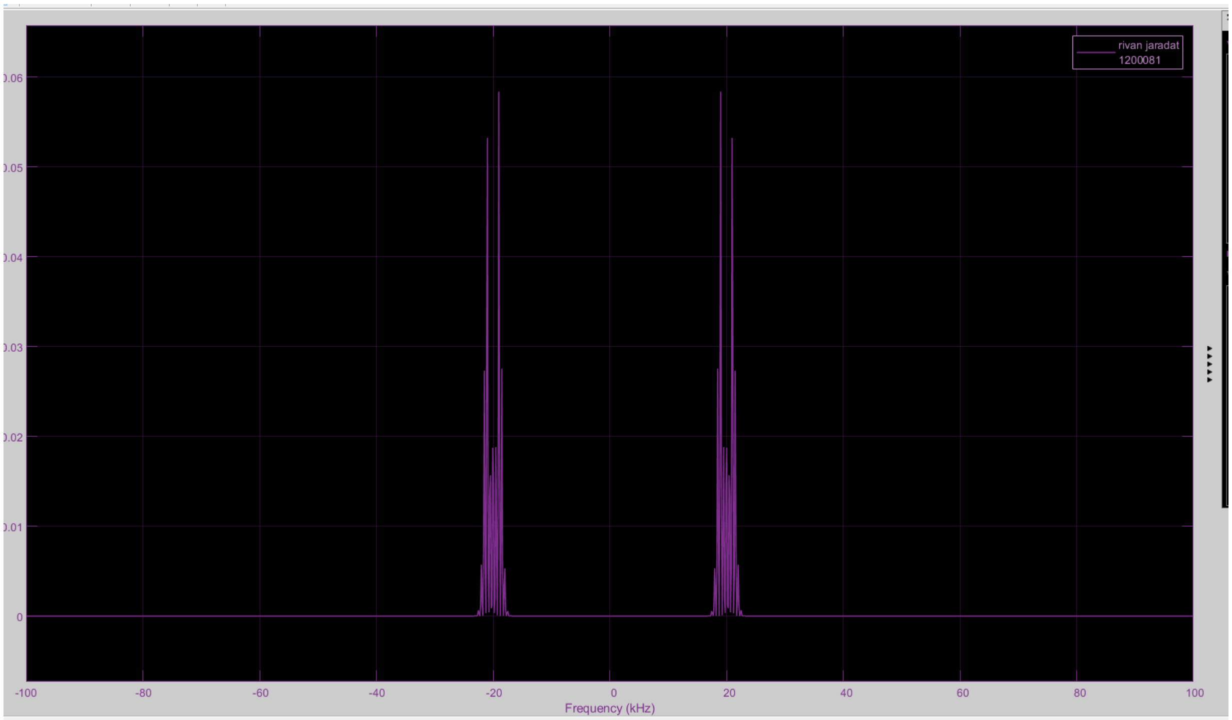

Figure 7.modulated signal in frequency domain

1.3.Differentiate s(t) with respect to t and plot ds(t)/dt. Notice how this operation transforms
an PM waveform into an AM waveform.
1.3.1. Differentiate s(t)

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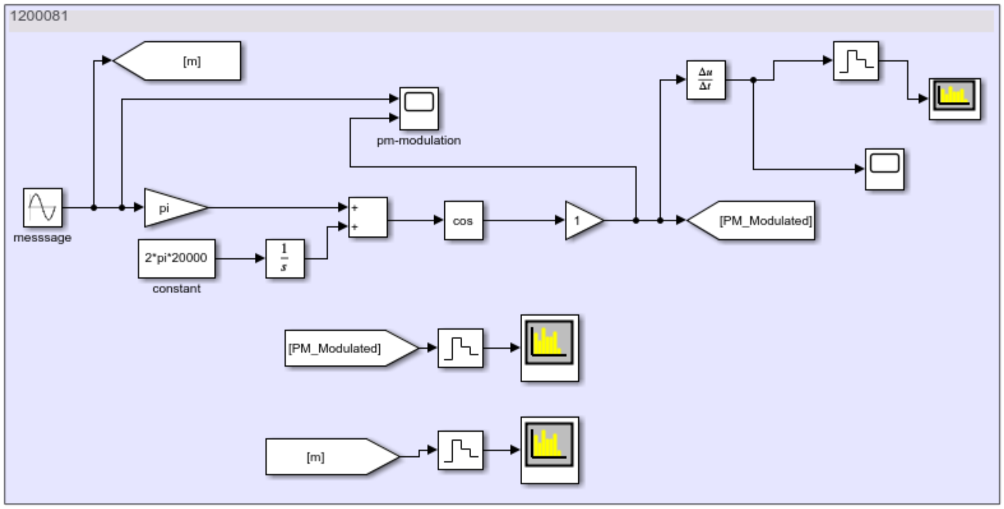
$$\frac{d\,s(t)}{dt} = \left(2\pi \times 20k - 1000\,\pi^2 \sin(1000\,\pi t)\right)$$
$$\times -\sin\left(2\pi \times 20k\, t + \pi \cos(1000\,\pi t)\right)$$

Figure 8.Differentiate s(t) by hand

1.3.2.block diagram:



1.3.3.Time domain:

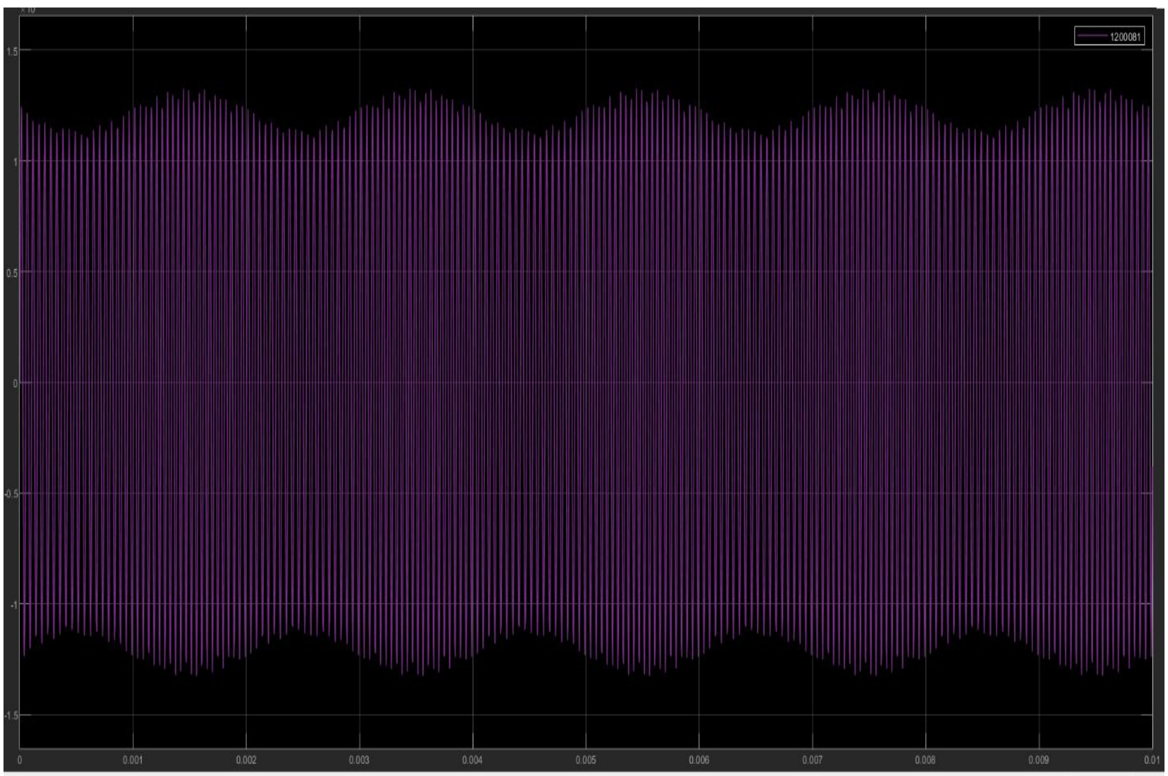
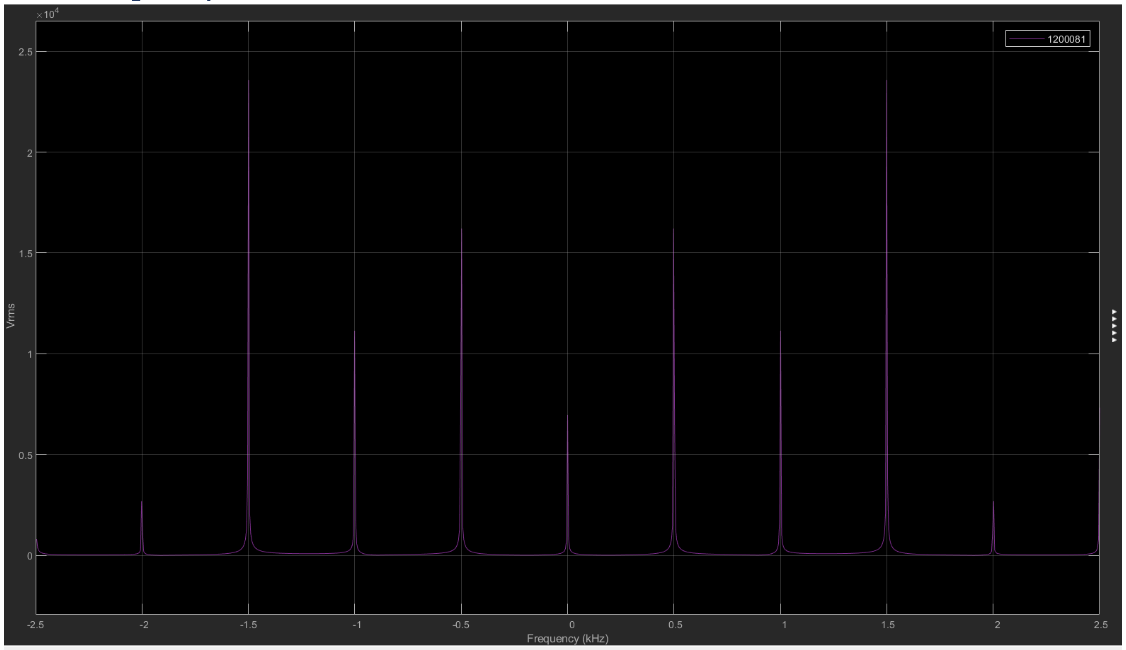


Figure 9.Differentiate s(t) in time domain

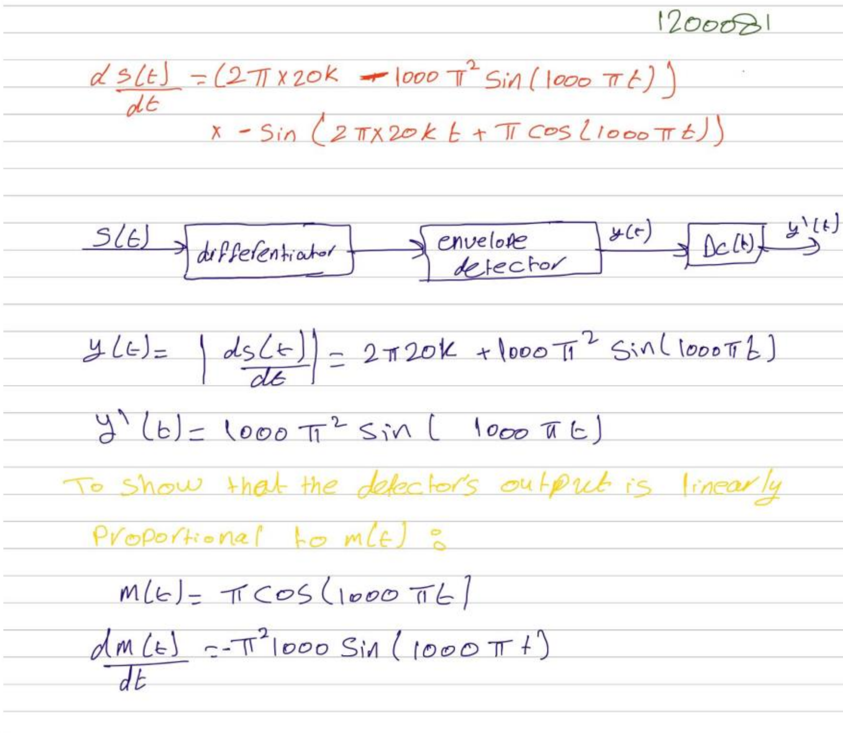
From this image we find that the waveform in the ds/dt time domain resembles a typical amplitude modulation (AM) waveform.

1.3.4.Frequency domain:



1.4.Apply ds(t)/dt to an ideal envelope detector, subtract the dc term and show that the detector's output is linearly proportional to m(t).

1.4.1.hand solution:



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$$\frac{d\,s(t)}{dt} = (2\pi \times 20k - 1000\,\pi^2 \sin(1000\,\pi t))$$
$$\times - \sin(2\pi \times 20k\, t + \pi \cos(1000\,\pi t))$$

$s(t) \rightarrow$ differentiator $\rightarrow$ envelope detector $\xrightarrow{y(t)}$ Dc(t) $\rightarrow y'(t)$

$$y(t) = \left| \frac{ds(t)}{dt} \right| = 2\pi 20k + 1000\,\pi^2 \sin(1000\,\pi t)$$

$$y'(t) = 1000\,\pi^2 \sin(1000\,\pi t)$$

To show that the detector's output is linearly proportional to m(t) :

$$m(t) = \pi \cos(1000\,\pi t)$$

$$\frac{dm(t)}{dt} = -\pi^2 1000 \sin(1000\,\pi t)$$

Figure 10.by hand solution

1.4.2.block diagram:

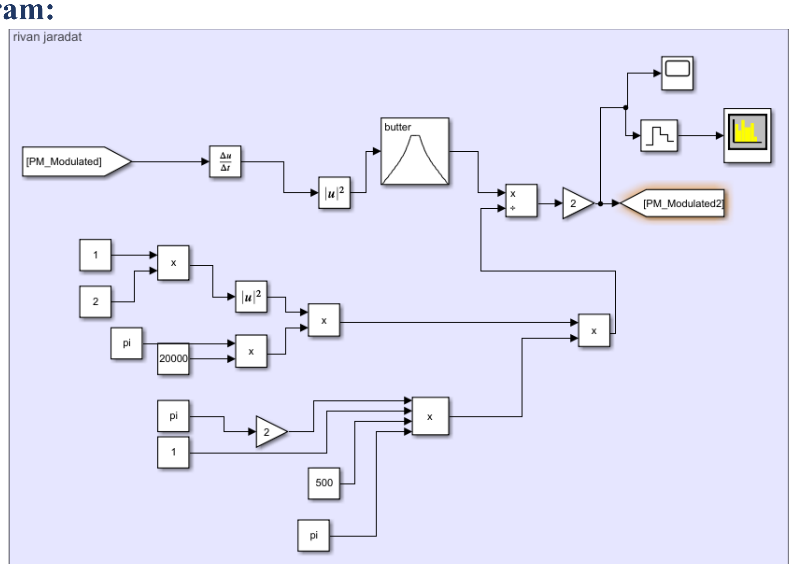

Figure 11.block diagram for PM Demodulation by envelop detector

1.4.3.time domain:

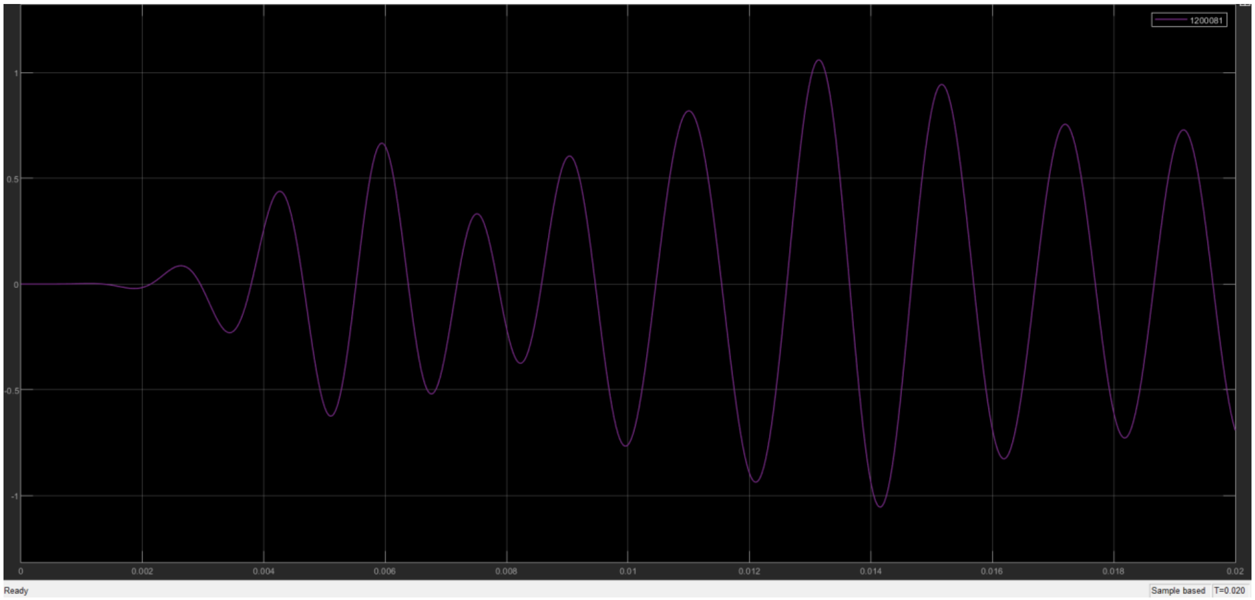

Figure 12.PM Demodulation in time domain

1.4.4.Frequency domain:

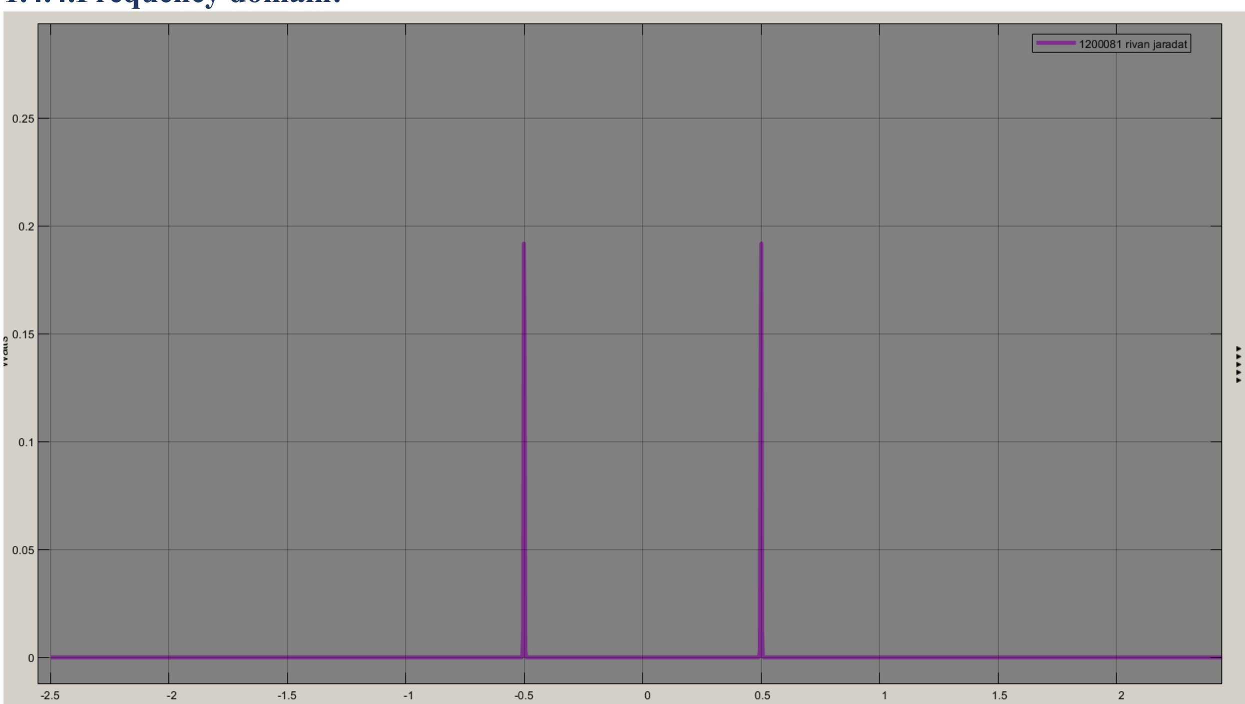

Figure 13.PM Demodulation in frequency domain

Here we get the same value in frequency of m(t)

1.5.Extract message signal by using phase-locked loop (PLL) and by envelop detector.

1.5.1.block diagram:

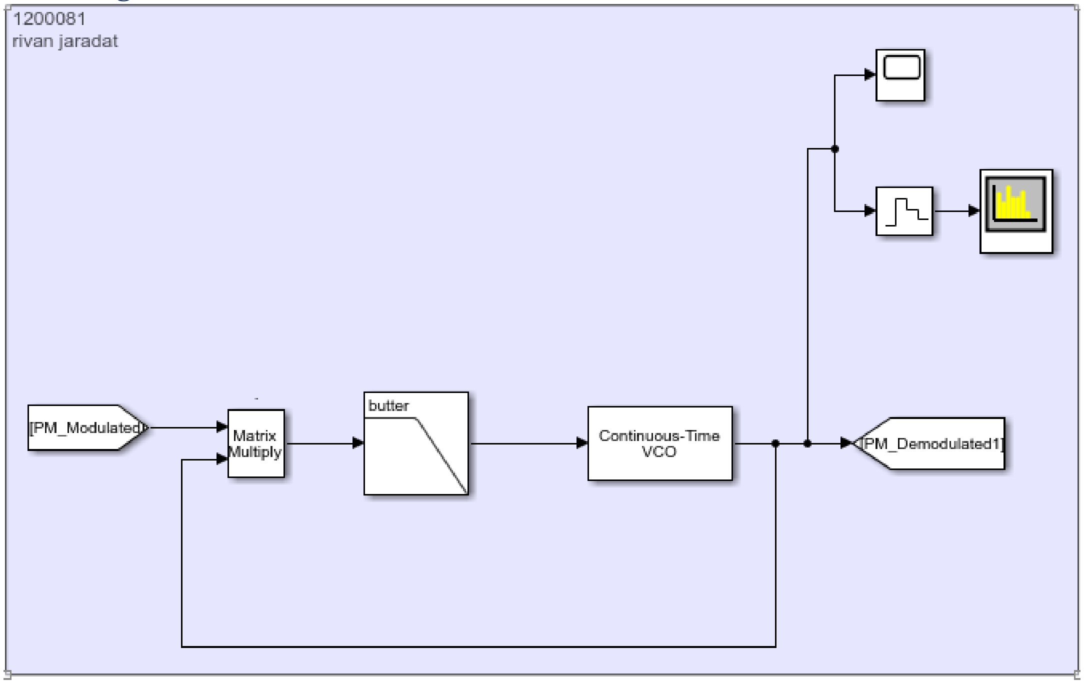

Figure 14.block diagram

1.5.2.Frequency domain :

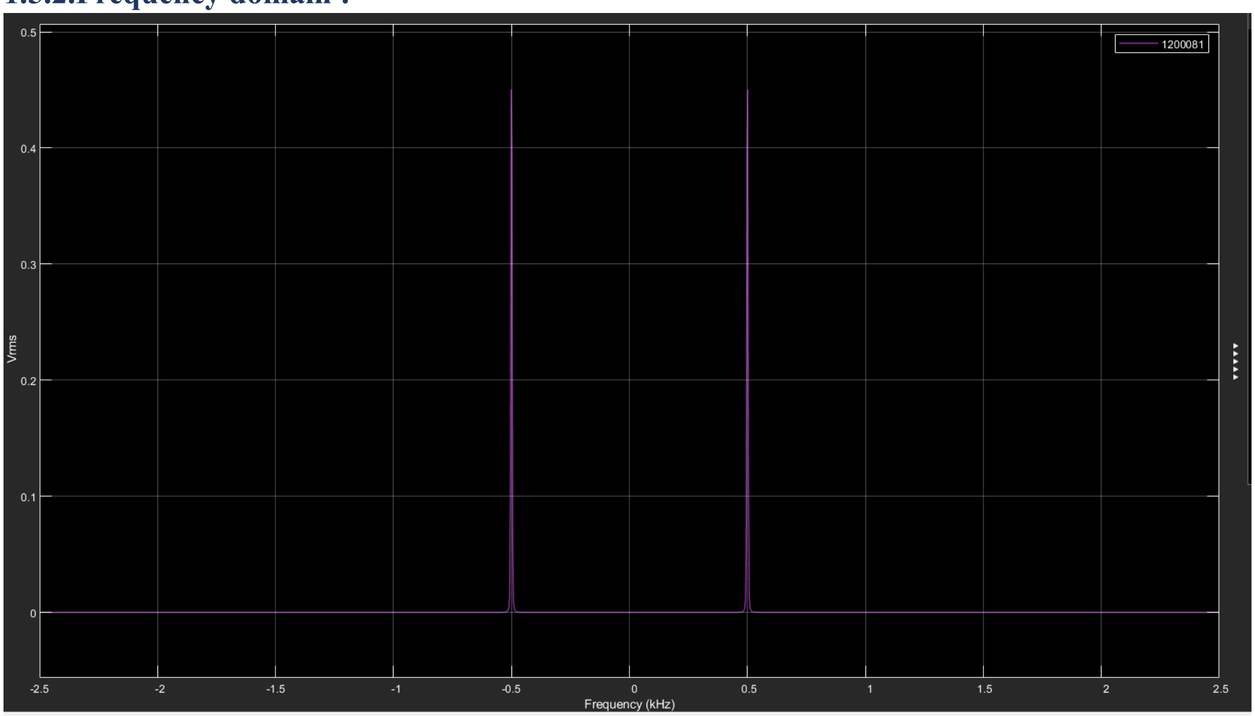

Figure 15.Extract m(t) by using (PLL) and by envelop detector in frequency domain

Here, in the recovered signal, the frequency spectrum m(t) consists of two pulses centered at 500 Hz and -500 Hz, each with an amplitude of approximately 1/2, as is the case in the original signal. This means that the recovery process has succeeded.

1.5.3.time domain:

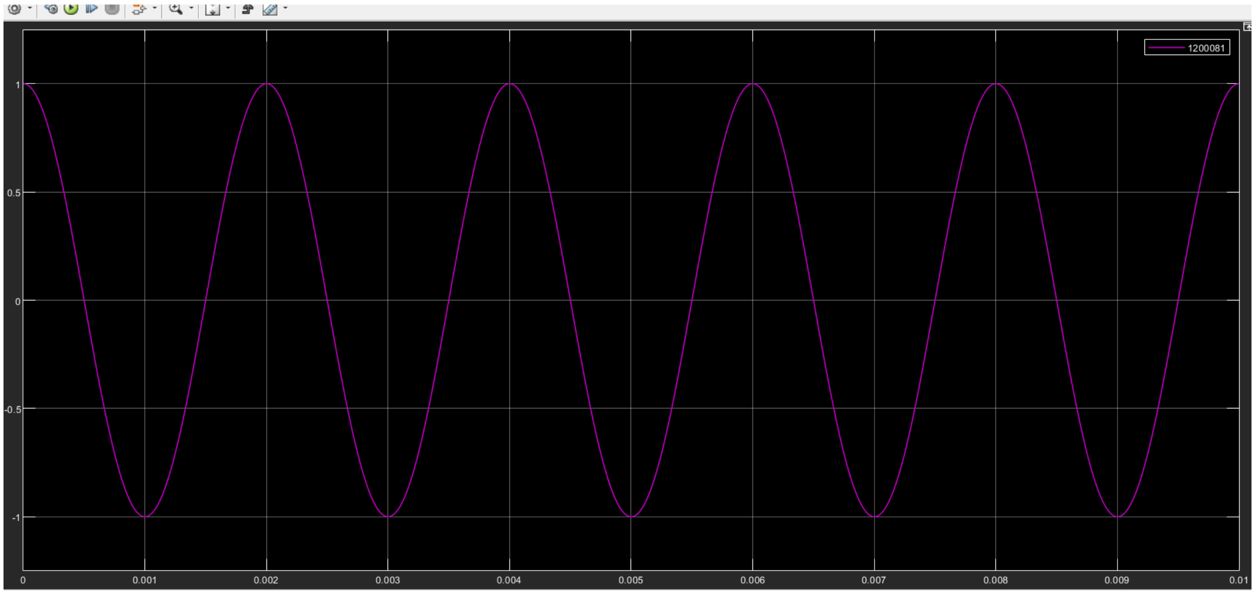

Figure 16.Extract m(t)by using (PLL) and by envelop detector in time domain

We notice here in this way that we have obtained the signal of the original message and we have measured the amplitude = 1