Sharif University of Technology

FACULTY Computer Engineering

Signals & Systems

Computer Assignment 4

Modulation

Student Name	**Student ID**
AmirHossein Bagheri	98105612

Instructor:

Prof. Hossein Sameti

Contents

1 Part one

I)

$$x1(t) = cos(10\pi t)$$

$$x1[n] = \sum_{k=-\infty}^{\infty} cos(\frac{10\pi k}{fs})\delta(n)$$

II)

$$x2(t) = cos(30\pi t)$$

$$x2[n] = \sum_{k=-\infty}^{\infty} cos(\frac{30\pi k}{fs})\delta(n)$$

$$fs = 20 \implies$$

$$x1[n] = \sum_{k=-\infty}^{\infty} cos(\frac{\pi k}{2})\delta(n) = \begin{cases} cos(\frac{n\pi}{2}) & n \ even \\ 0 \ \ n \, odd \end{cases}$$

$$x2[n] = \sum_{k=-\infty}^{\infty} cos(\frac{3\pi k}{2})\delta(n) = \sum_{k=-\infty}^{\infty} cos(\frac{\pi k}{2}) + \pi k)\delta(n) = \begin{cases} cos(\frac{n\pi}{2}) & n \ even \\ 0 \ \ n \, odd \end{cases}$$

so with fs = 20 these two signals become identical

1.1 a time domain

Here is plot of main function:

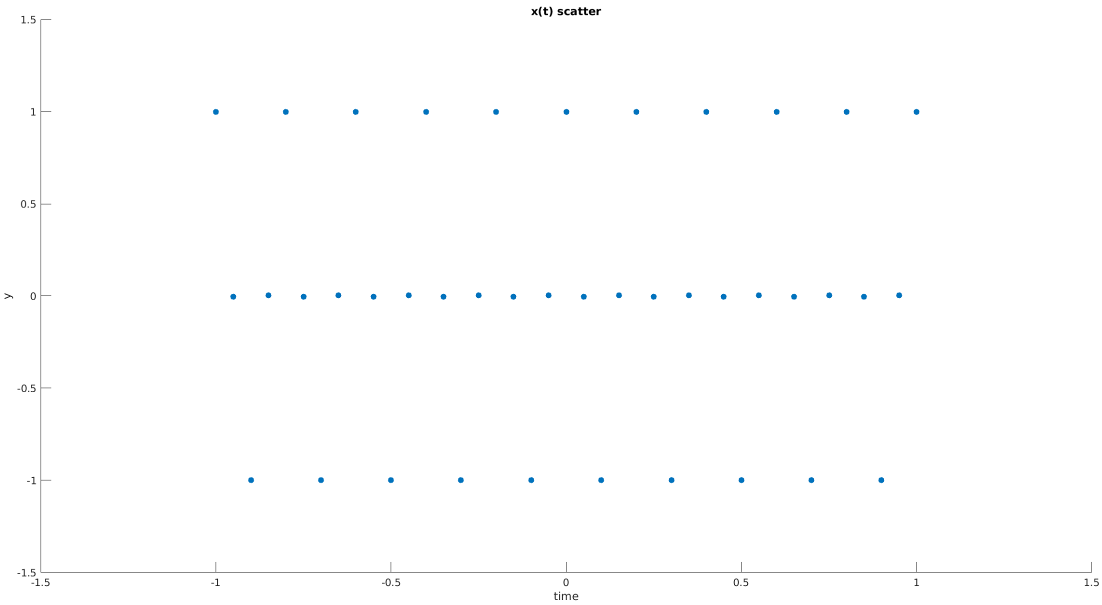

Figure 1: scatter plot

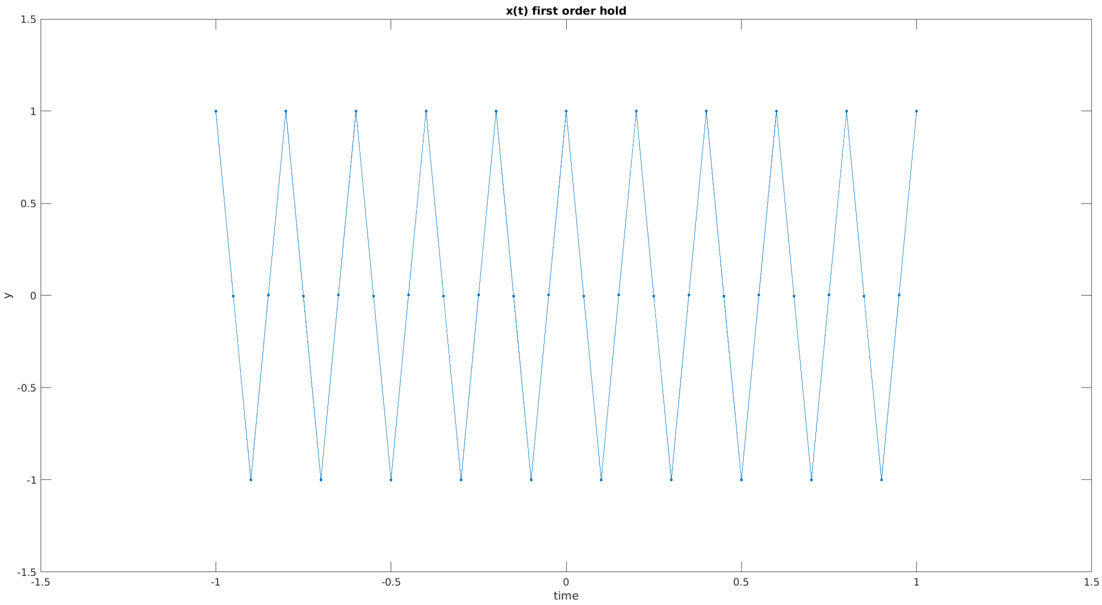

Figure 2: first hold plot

1.2 b frequency domain

$$x1[n] = \sum_{k=-\infty}^{\infty} cos(\frac{\pi k}{2} + 0.001\pi)\delta(n)$$

$$X[e^{jw}] = \sum_{k=-\infty}^{\infty} \pi \times e^{0.001\pi j}\delta(w + \frac{\pi k}{2}) + \pi \times e^{-0.001\pi j}\delta(w - \frac{\pi k}{2})$$

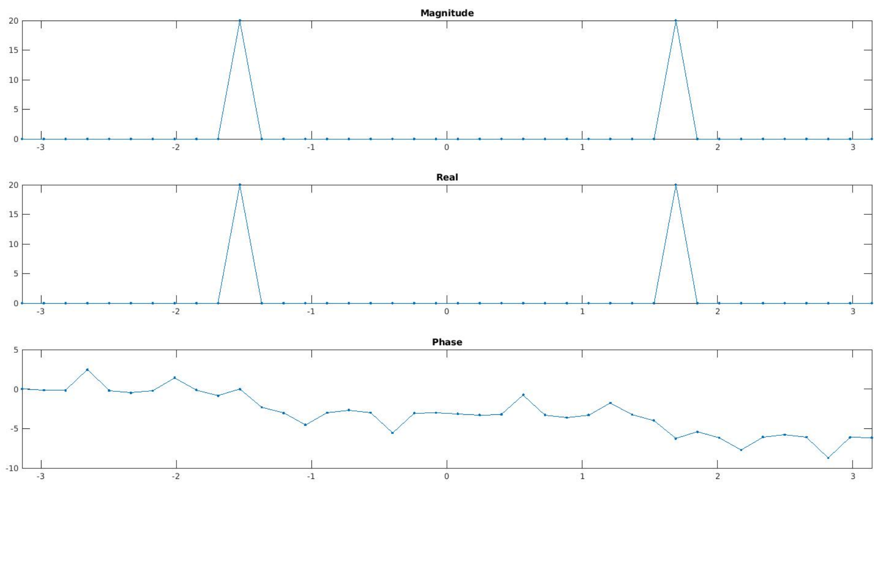

Figure 3: freq domain

1.3 c Filter

1.3.1 Matlab provided

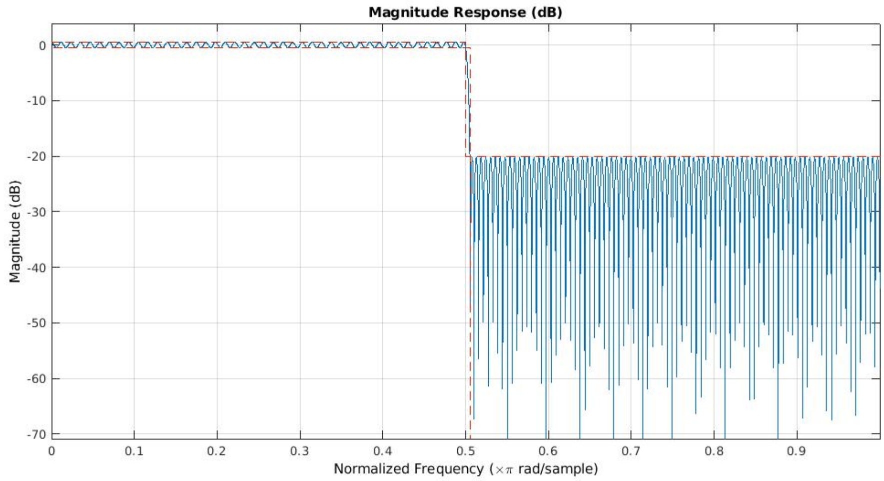

Figure 4: Filter Magnitude

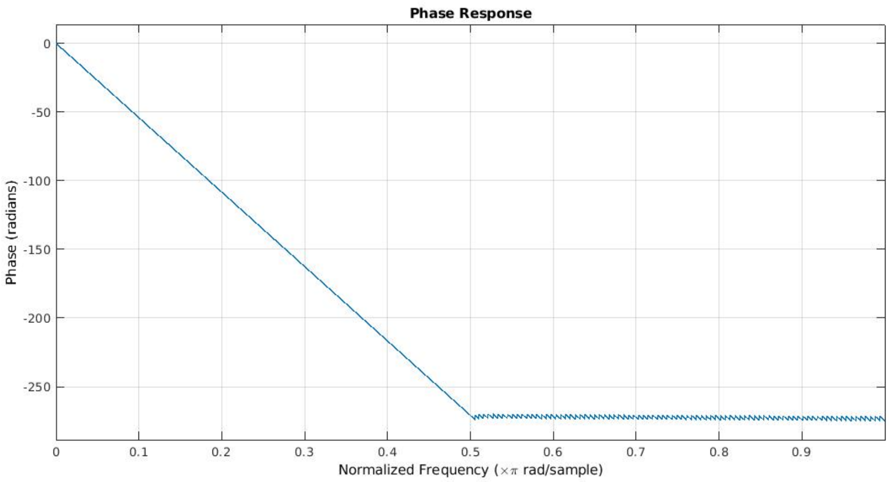

Figure 5: Filter Phase

Filtered signal frequency domain

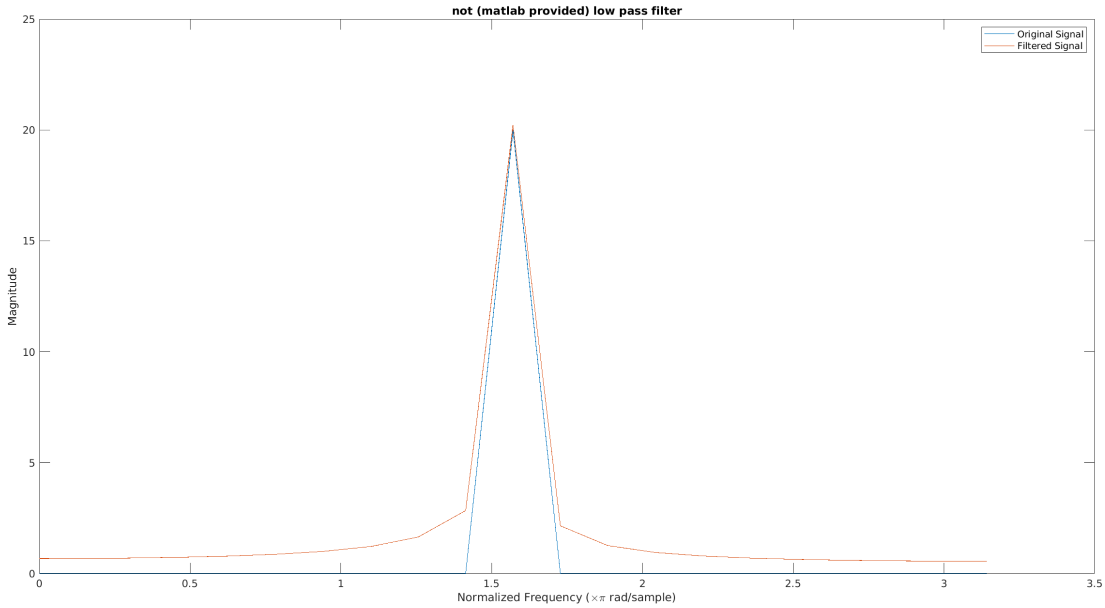

Figure 6: Filtered signal freq domain

Filtered signal time domain

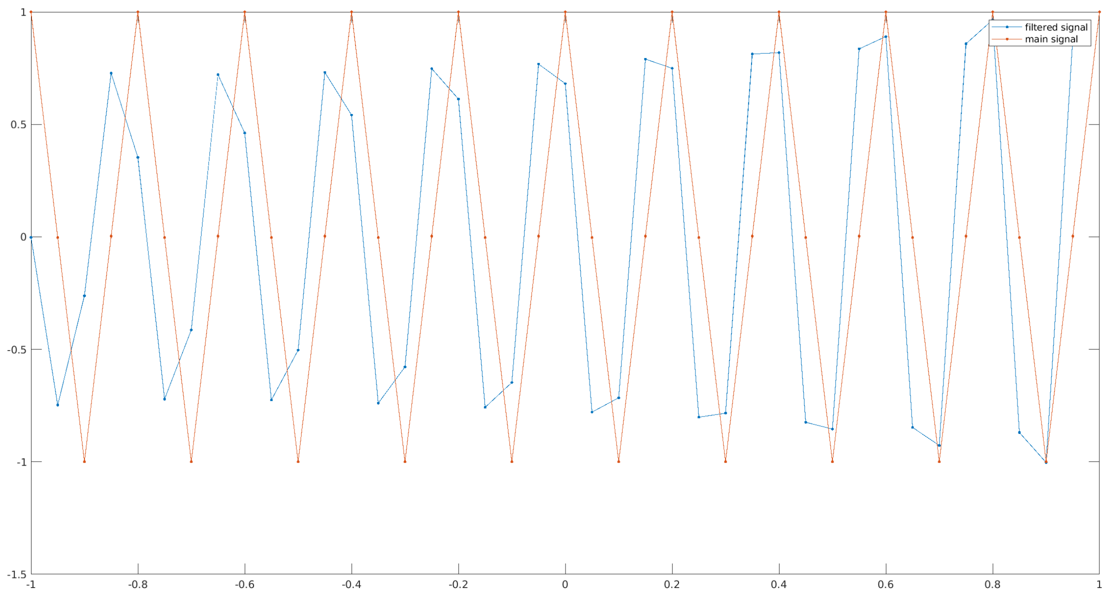

Figure 7: Filtered signal time domain

1.3.2 Manual Ideal

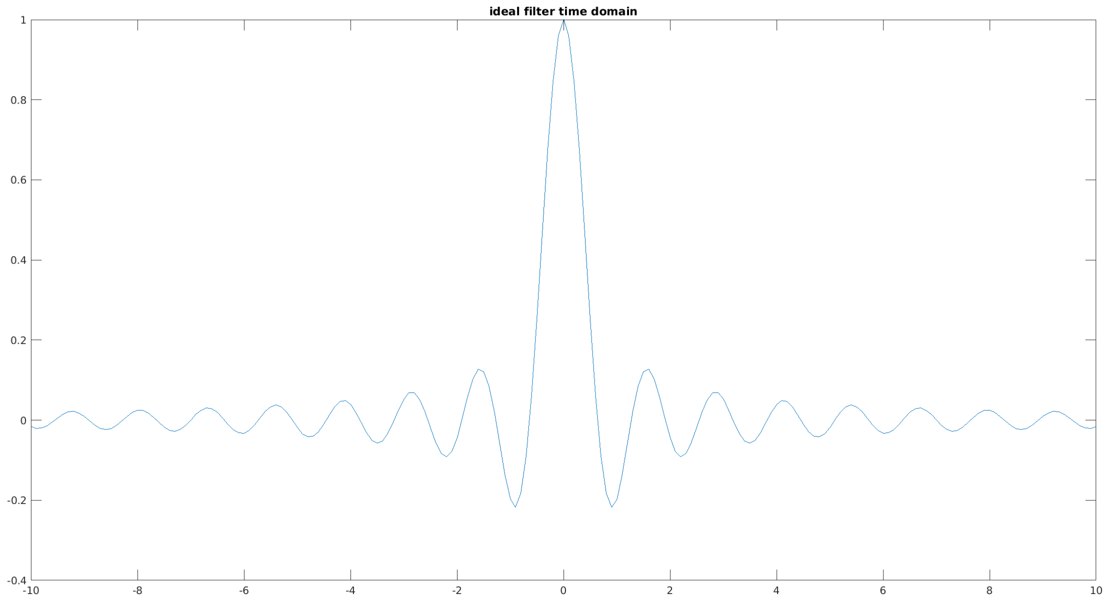

Figure 8: Filter time

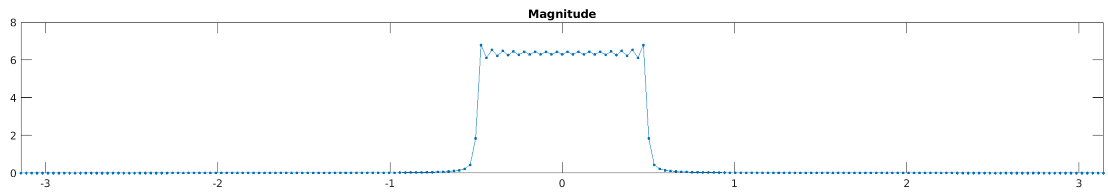

Figure 9: Filter Magnitude

Filtered signal frequency domain

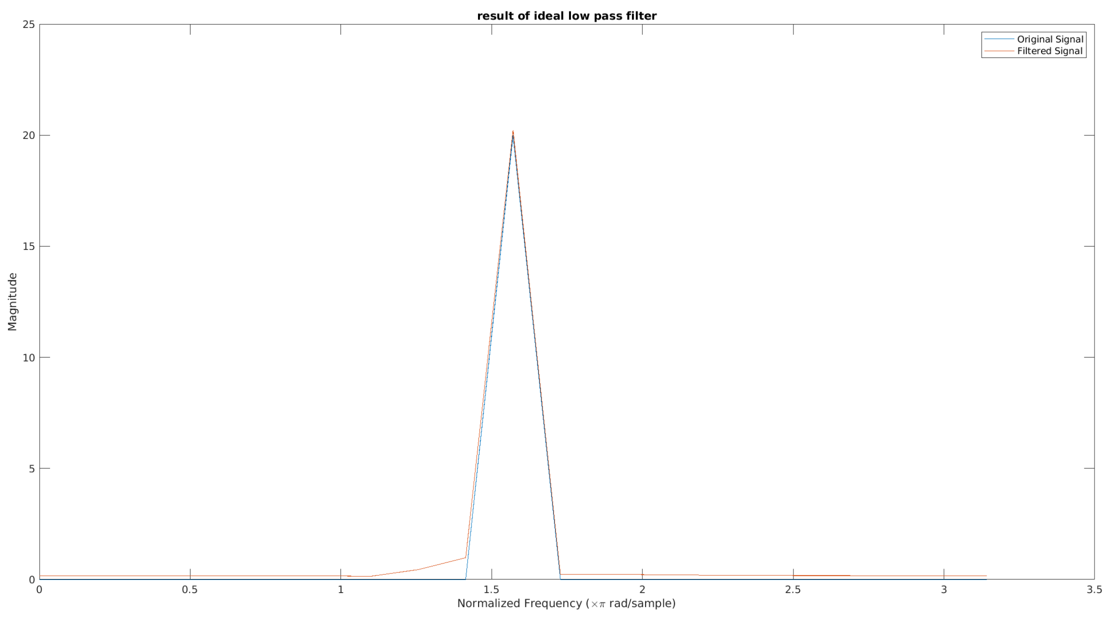

Figure 10: Filtered signal freq domain

Filtered signal time domain

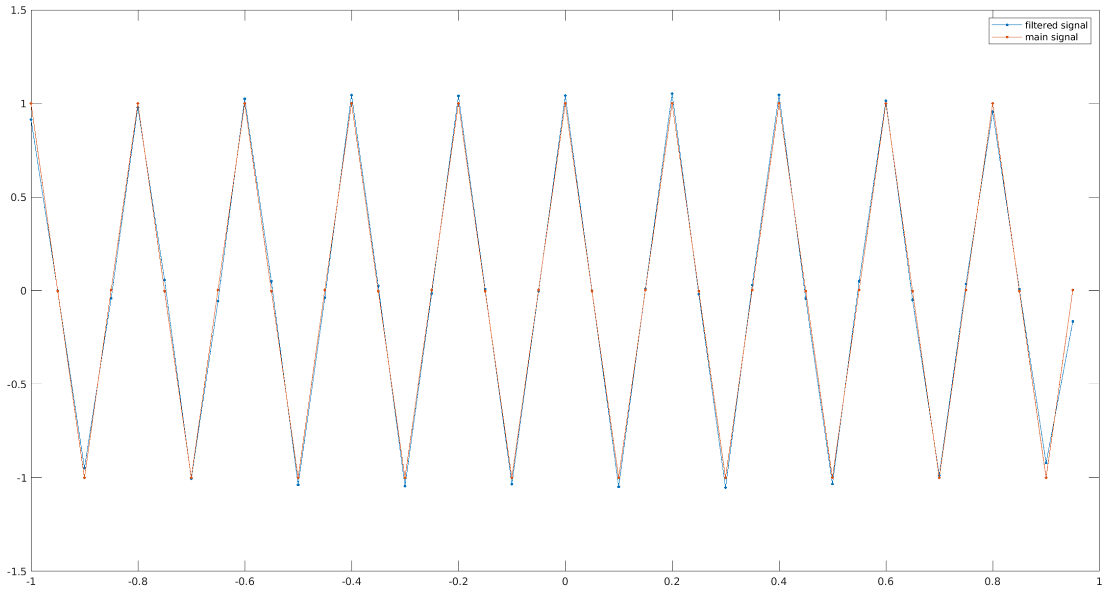

Figure 11: Filtered signal time domain

1.4 d

as we saw in part one both signals are similar to each other and we expect same result

1.4.1 a time domain

Here is plot of main function:

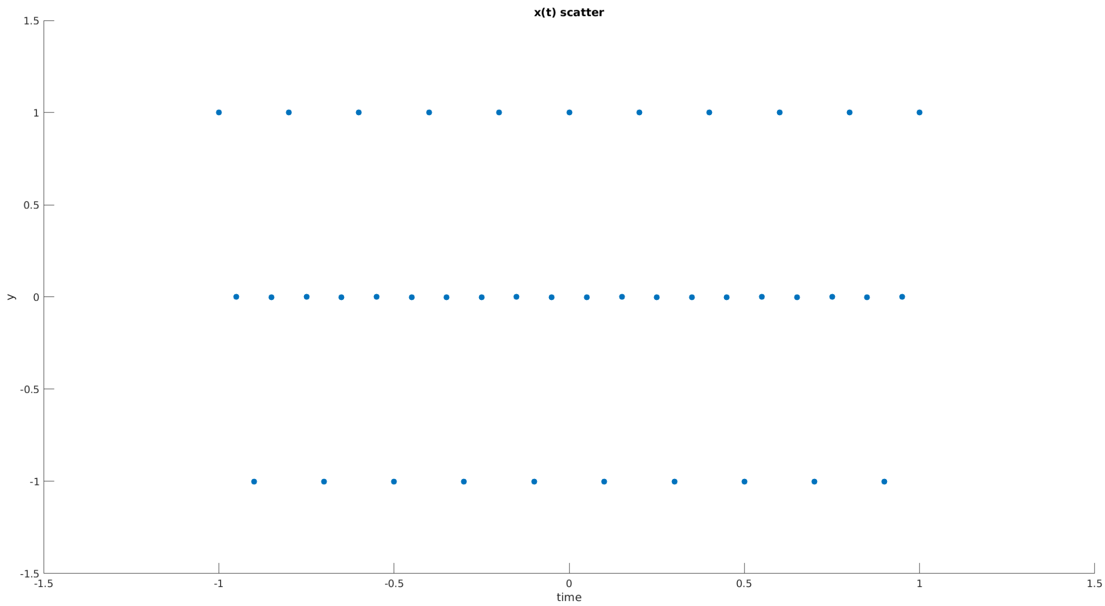

Figure 12: scatter plot

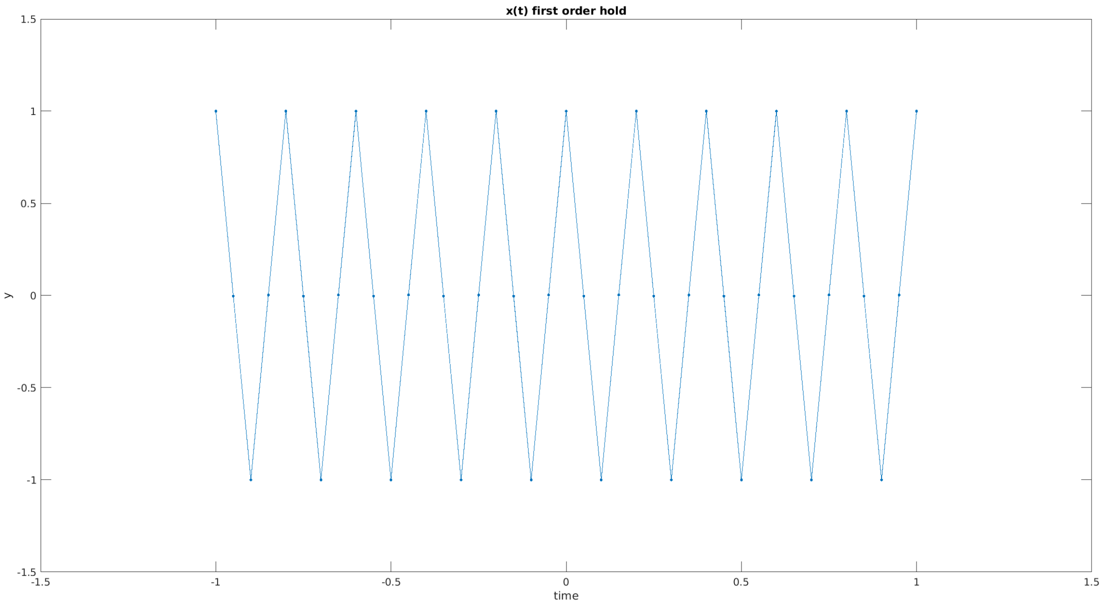

Figure 13: first hold plot

1.4.2 b frequency domain

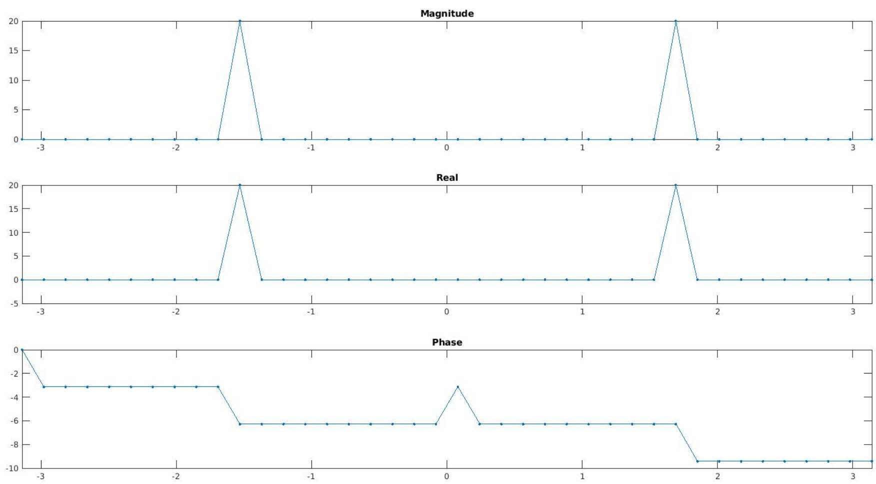

Figure 14: freq domain

1.4.3 c Filter

Matlab provided **Filtered signal frequency domain**

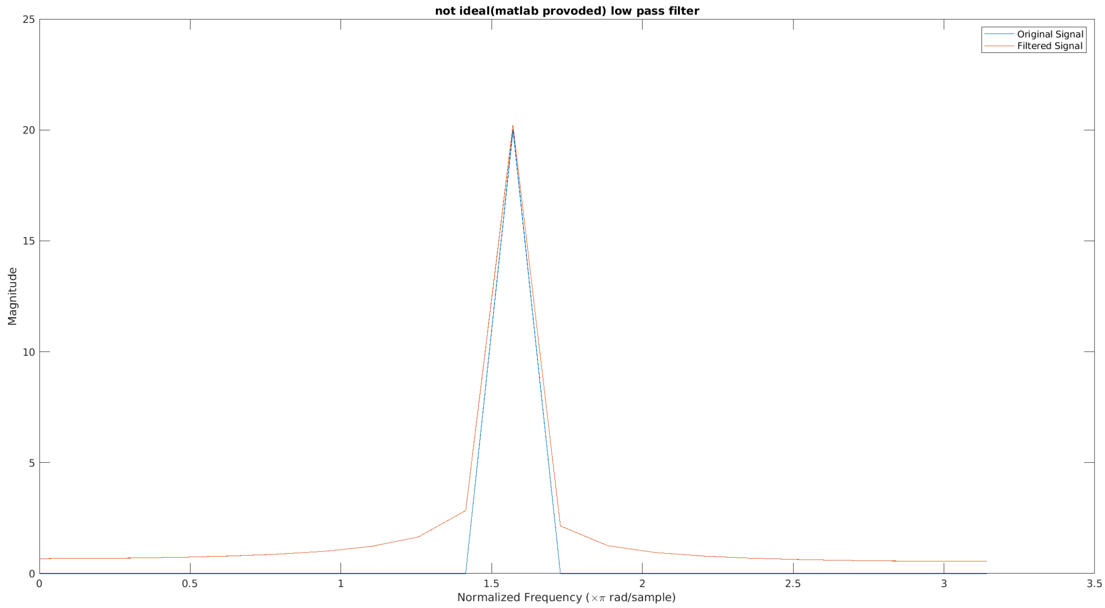

Figure 15: Filtered signal freq domain

Filtered signal time domain

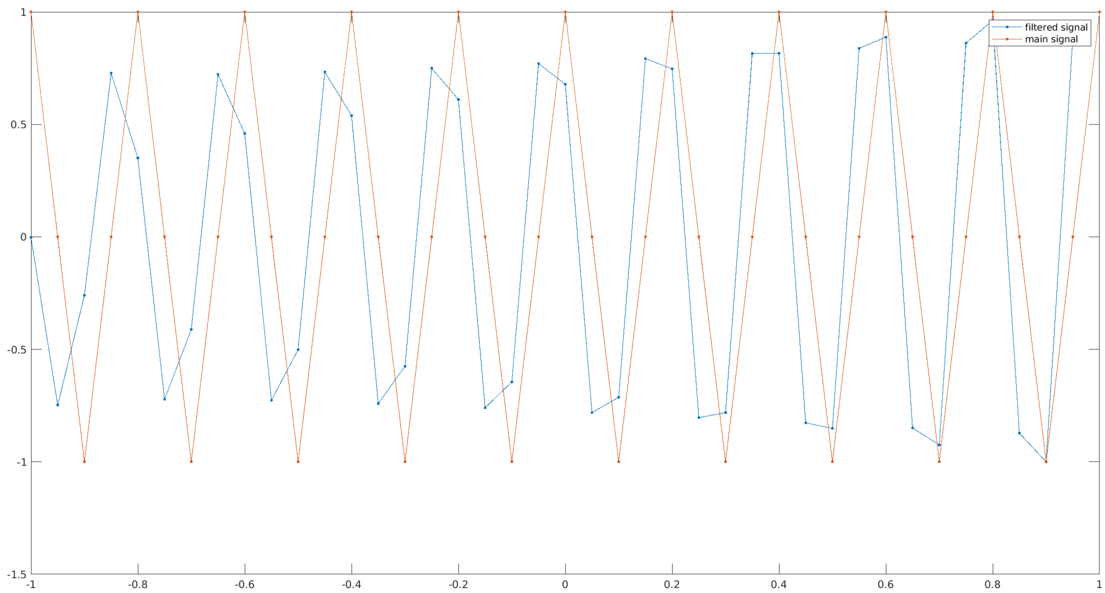

Figure 16: Filtered signal time domain

Manual Ideal **Filtered signal frequency domain**

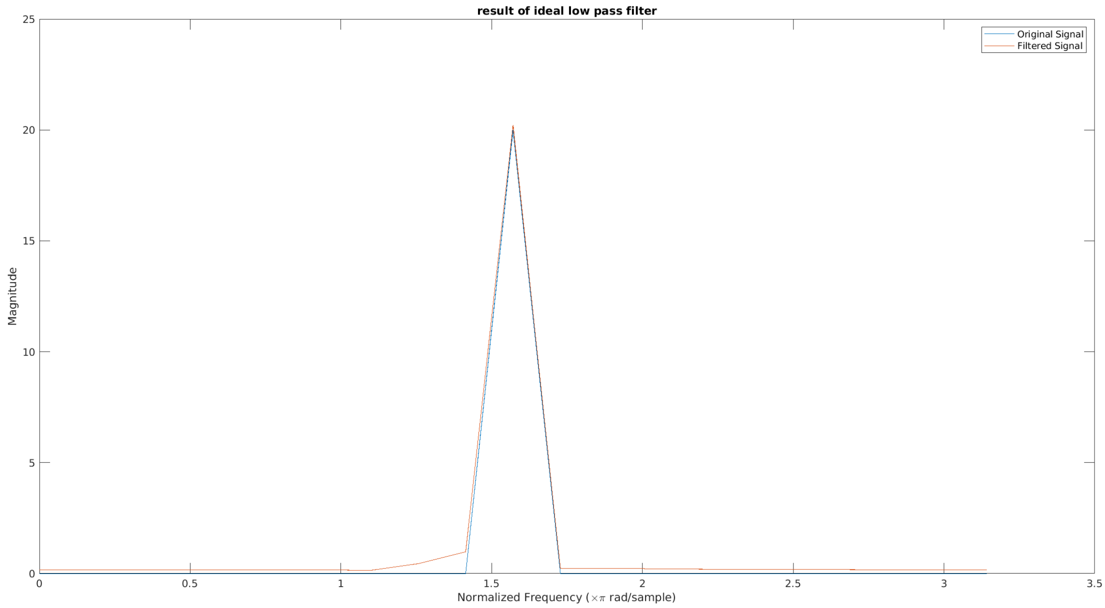

Figure 17: Filtered signal freq domain

Filtered signal time domain

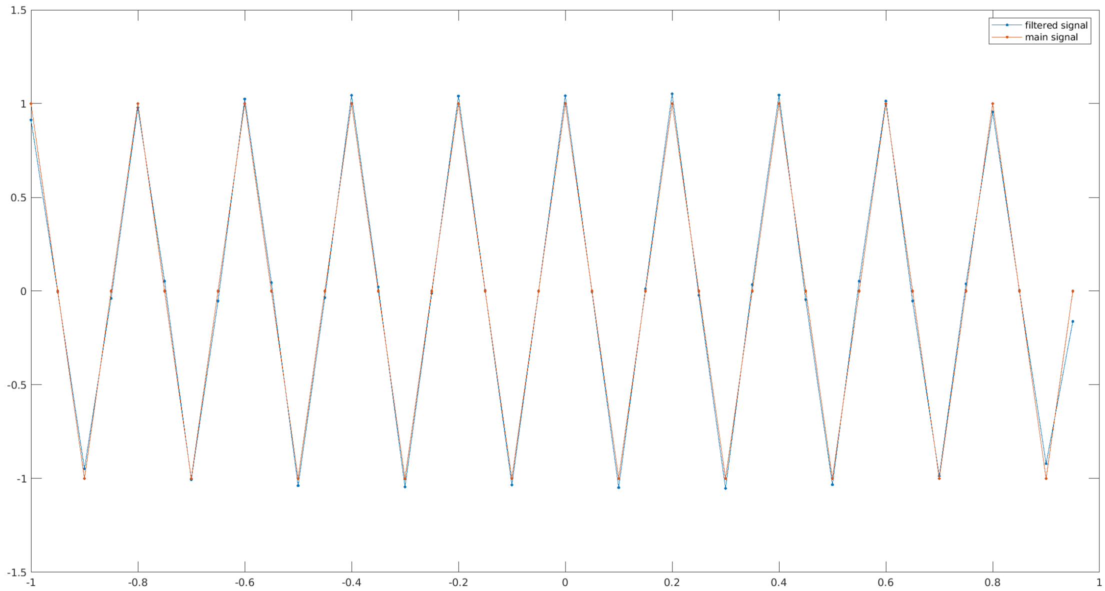

Figure 18: Filtered signal time domain

2 part Two

I mapped w axis to $[-\pi,\pi]$ so we can have better representation.

$$M(jw) = rect$$
$$C(jw) = \pi(\delta(\omega + \omega_0) + \delta(\omega - \omega_0))$$
$$u1(t) = m(t) \times c(t) \implies U1(jw) = \frac{1}{2}(rect(\omega + \omega_0) + rect(\omega - \omega_0))$$
$$u(t) = (1 + \alpha m(t)) \times c(t) \implies$$
$$U(jw) = \frac{\alpha}{2}(rect(\omega + \omega_0) + rect(\omega - \omega_0)) + \pi(\delta(\omega + \omega_0) + \delta(\omega - \omega_0))$$

2.1 a

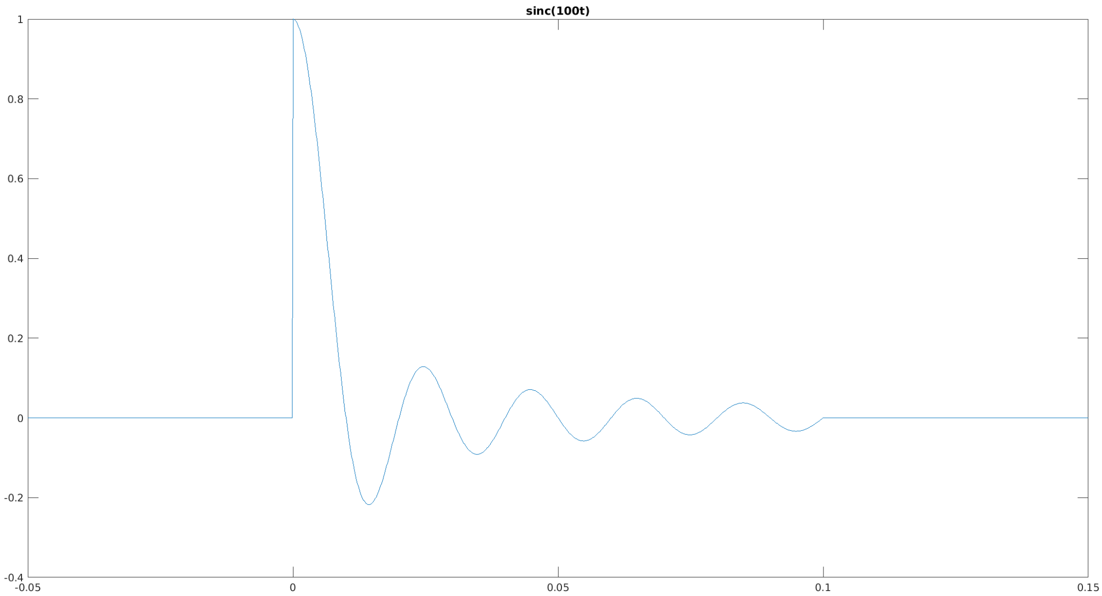

Figure 19: m(t)

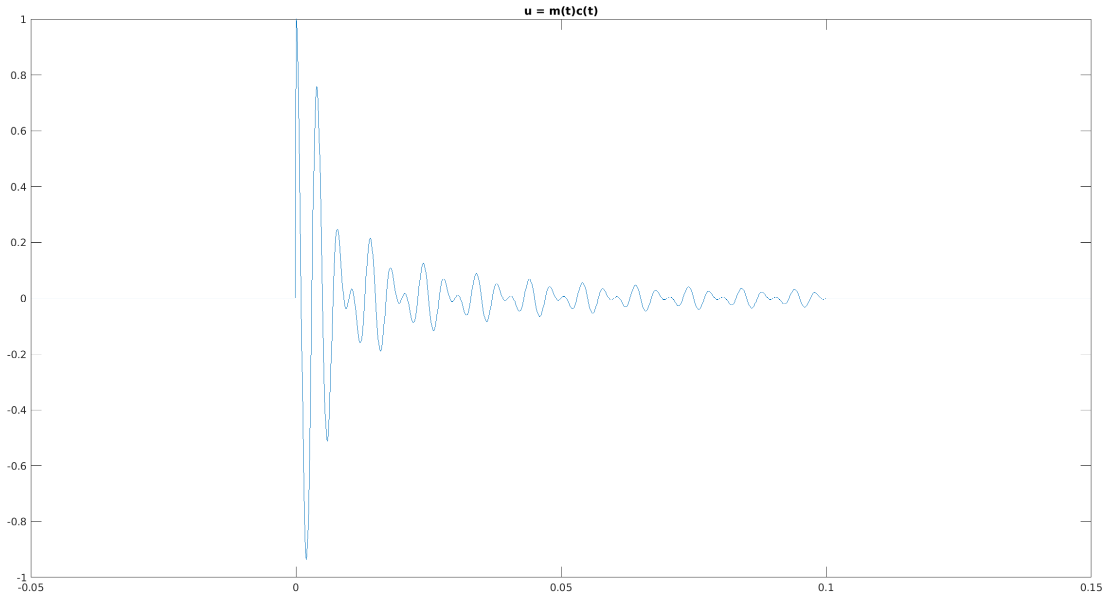

Figure 20: u(t) = m(t) c(t)

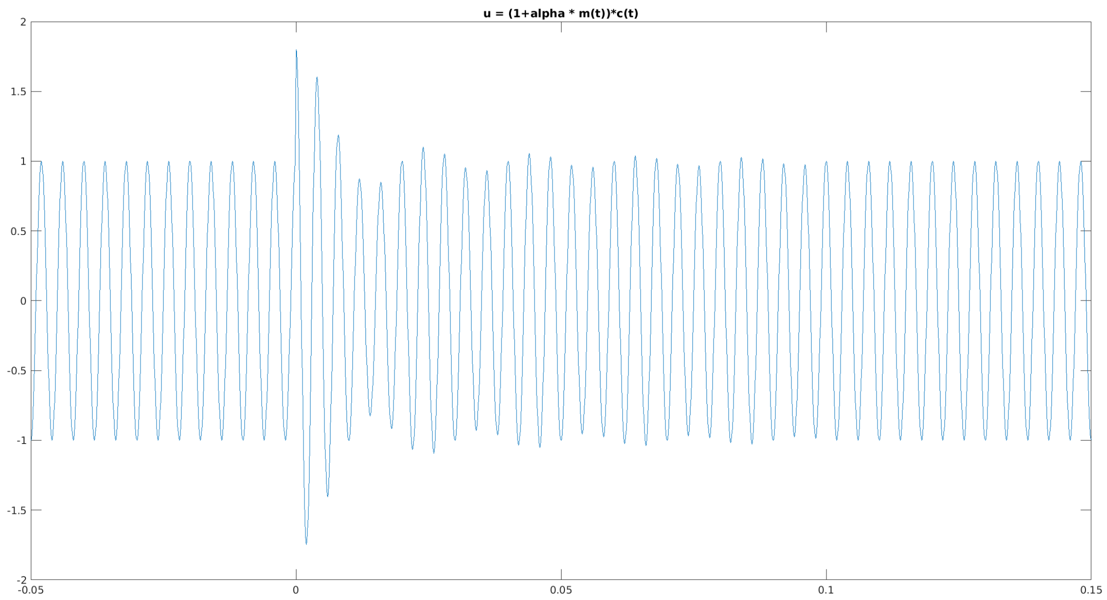

Figure 21: u(t) = (1+alpha m(t)) c(t)

2.2 b

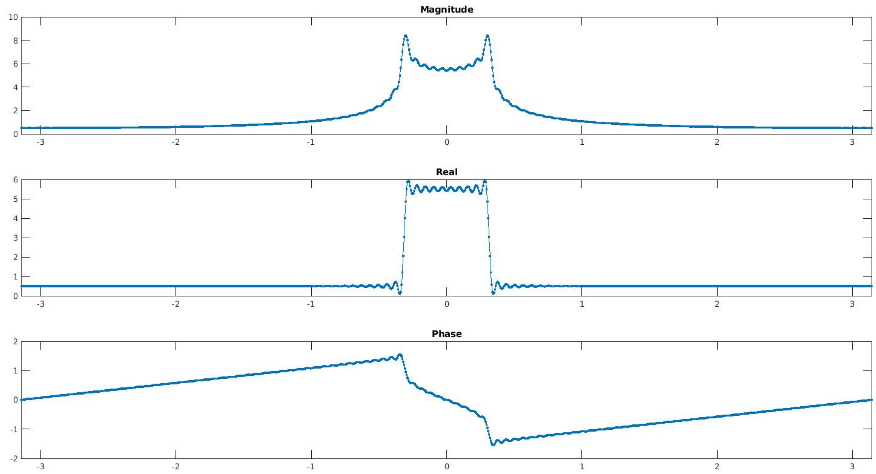

Figure 22: freq domain for m(t)

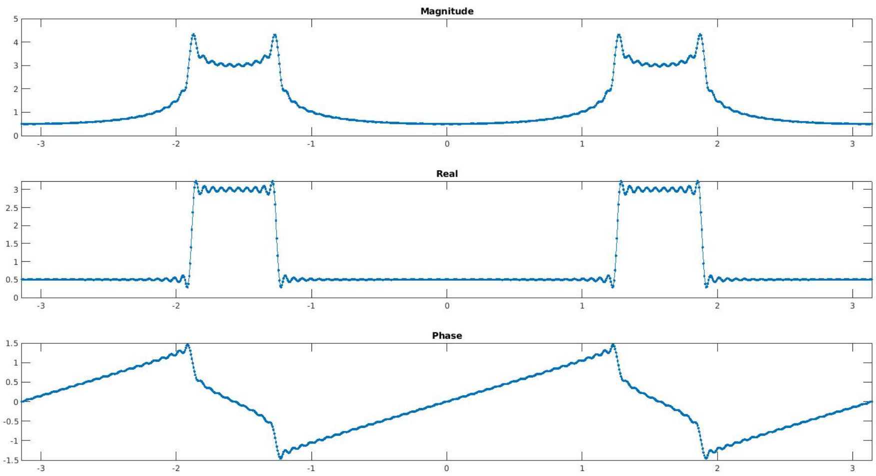

Figure 23: freq domain for u(t) without applying alpha

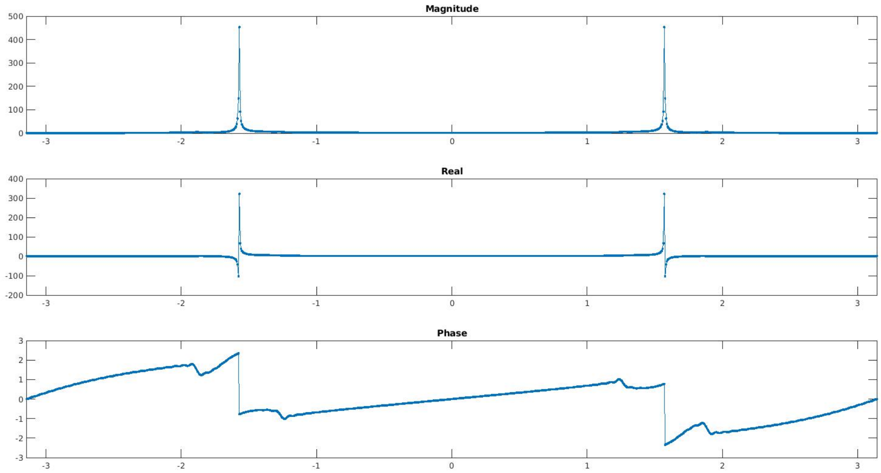

Figure 24: freq domain for u(t) applying alpha

2.3 c

2.3.1 a

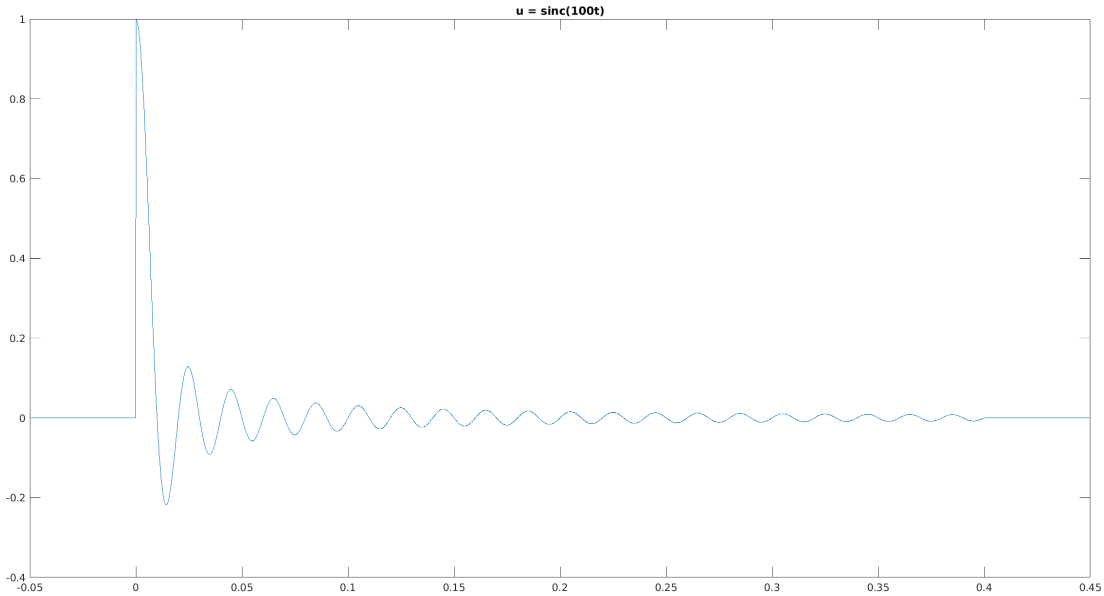

Figure 25: m(t)

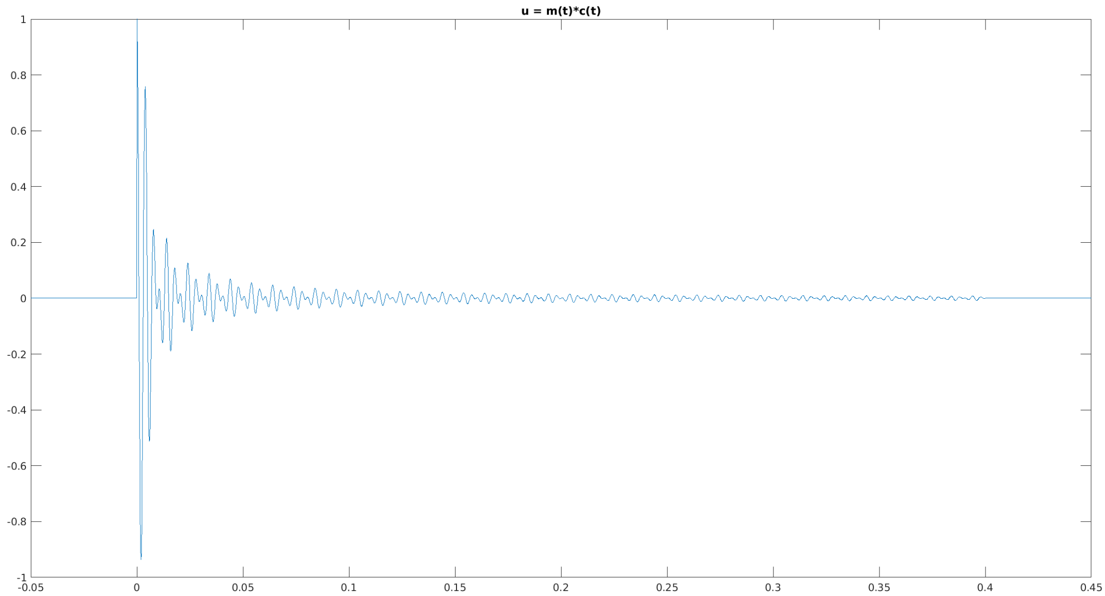

Figure 26: u(t) = m(t) c(t)

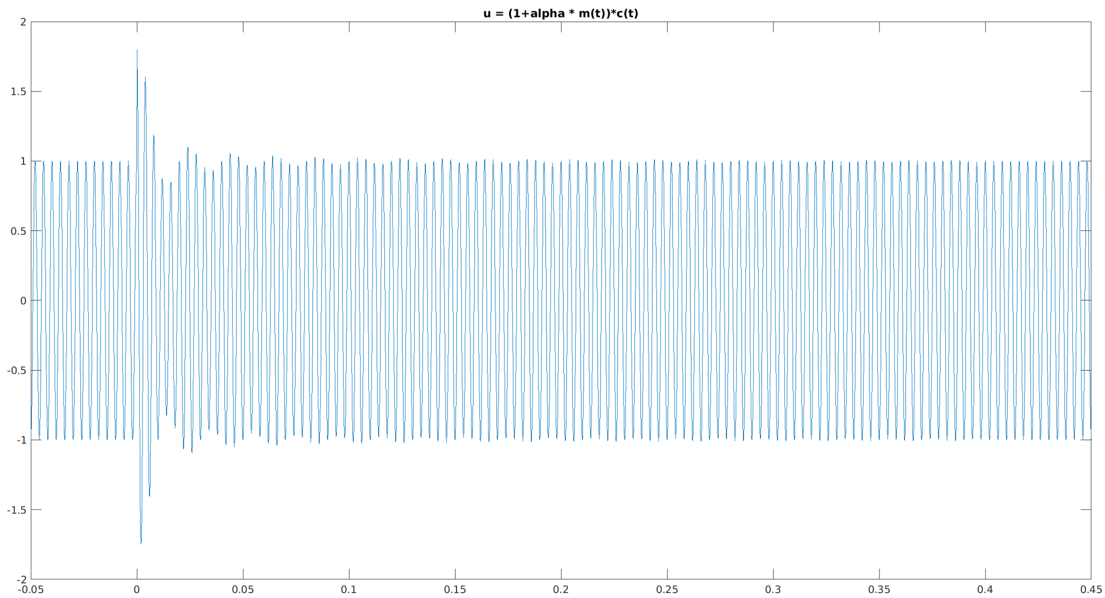

Figure 27: u(t) = (1+alpha m(t)) c(t)

2.3.2 b

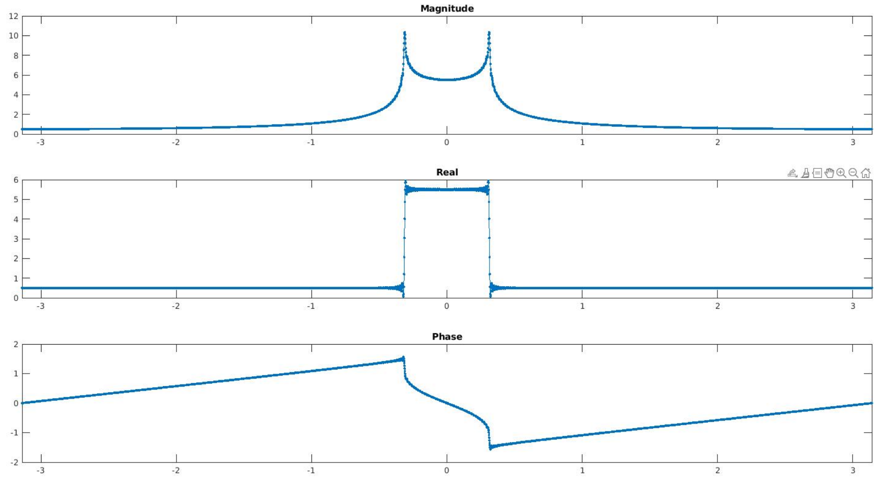

Figure 28: freq domain for m(t)

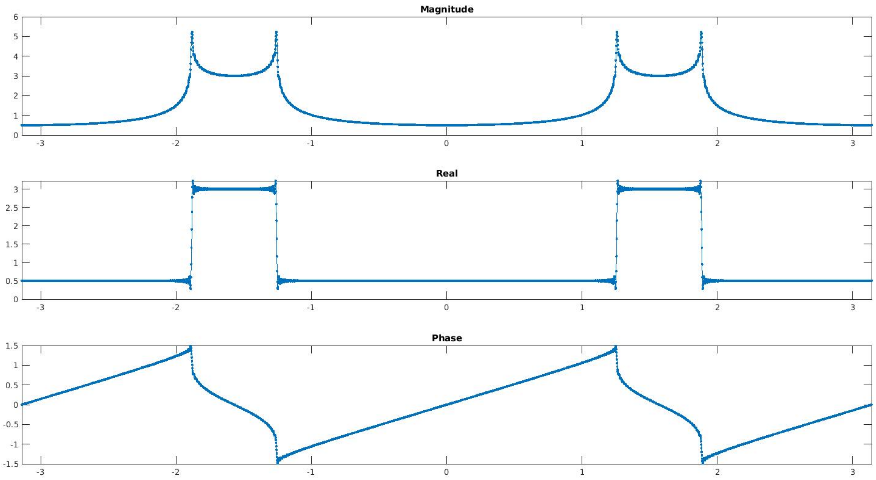

Figure 29: freq domain for u(t) without applying alpha

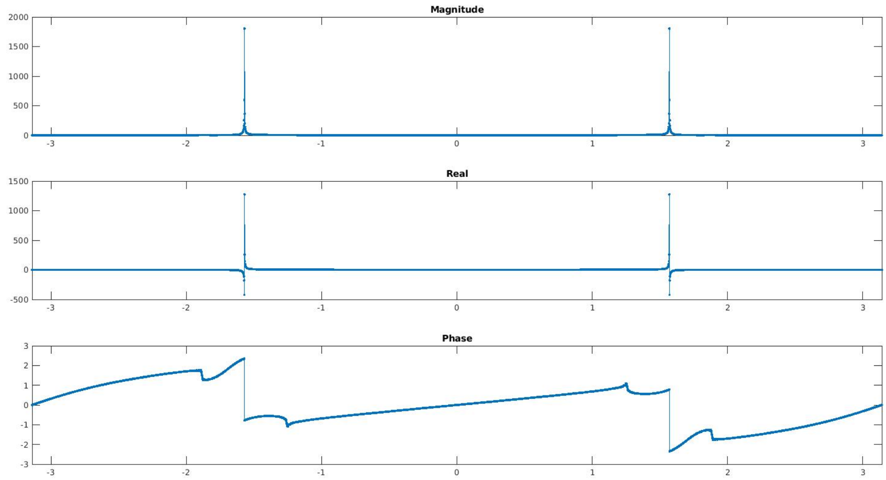

Figure 30: freq domain for u(t) applying alpha

2.4 conclusion

As we increase t0 our result for freq without applying alpha become smoother and better because we are getting more detail of signal and more energy either.