**CMPE 323: Signals and Systems**

**Dr. LaBerge**

**Lab 08 Report**

**Using the Fast Fourier Transform**

Sabbir Ahmed

1. **Introduction**

This lab explores the use of the Fast Fourier Transform (FFT) to do spectrum analysis of sampled data systems. The FFT is an extremely efficient algorithm for computing the Discrete Fourier Transform (DFT).

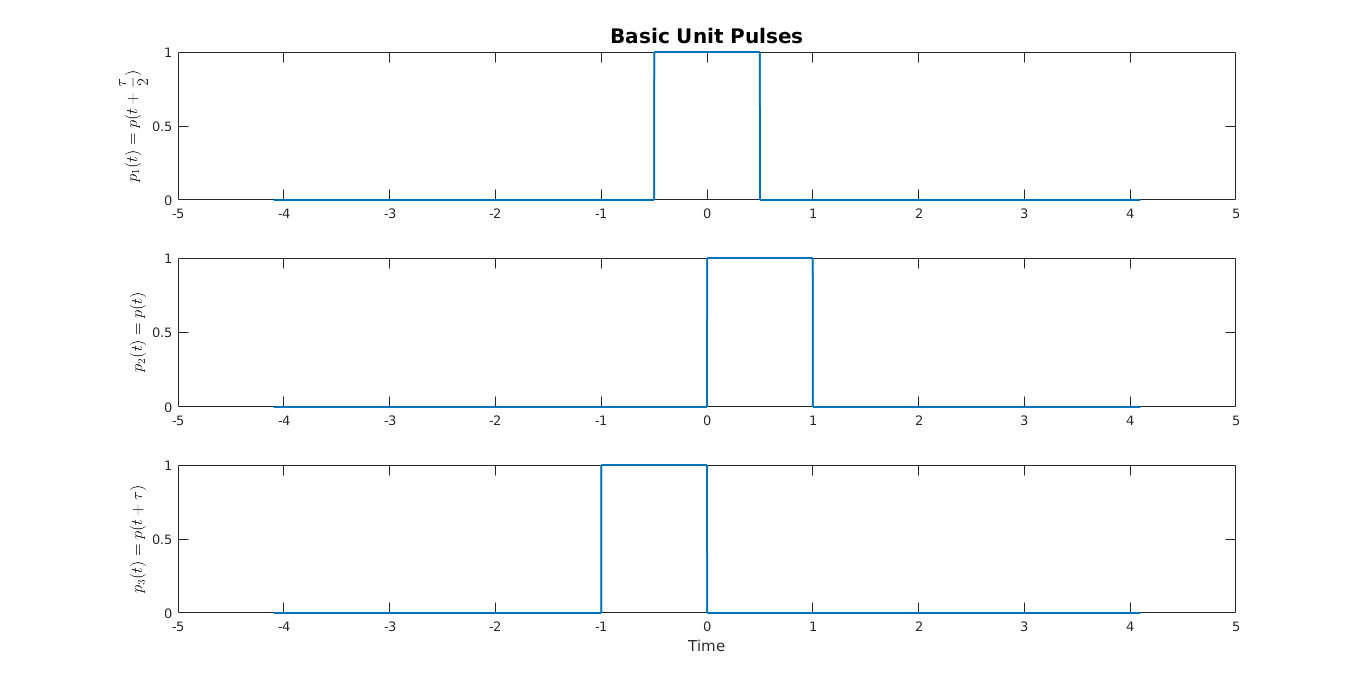
1. **Equipment**

A computer with MATLAB installed.

1. **Procedure**

## Computing the Fourier Transform of the basic pulse

Using a time array from [-4096: 0.001: 4095], the basic anonymous pulse function was used to compute the for  = 1. Pulses shifted by  and were also computed and plotted

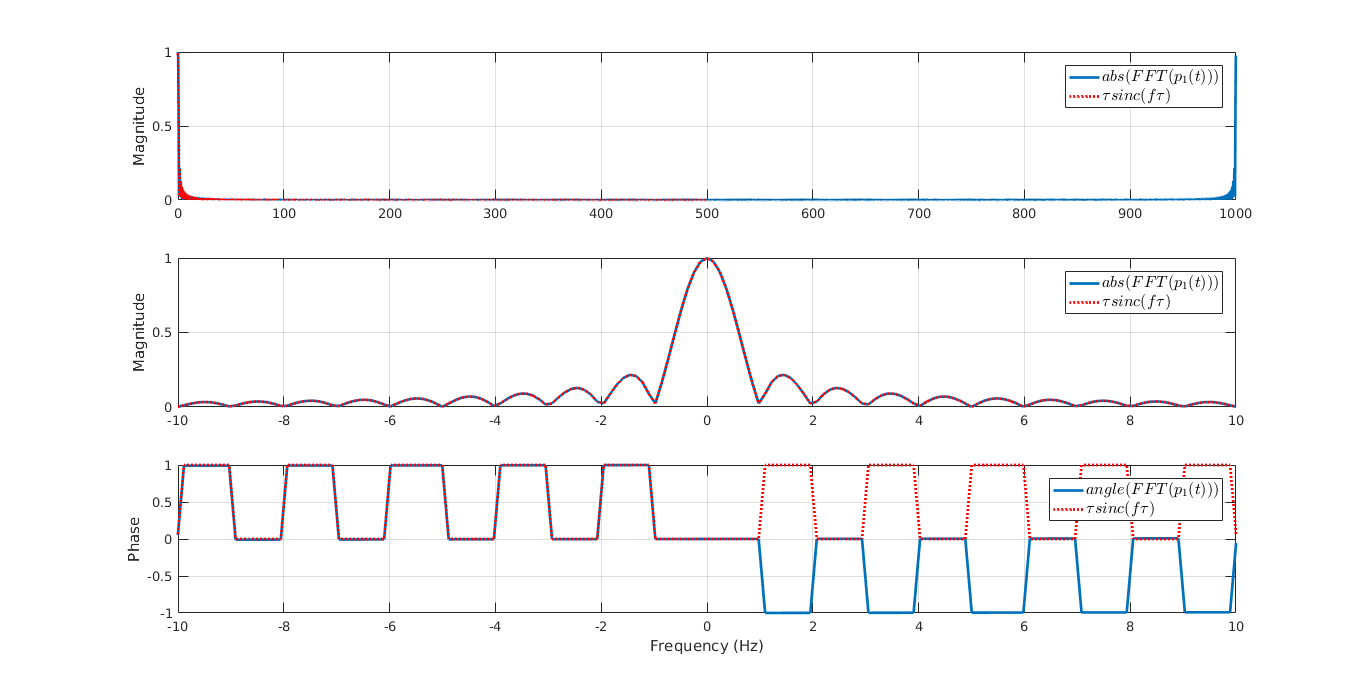


**Figure 1: Basic Unit Pulses**

An algorithm to estimate the Discrete Time Fourier Transform of the three pulses was developed, where DTFT is defined

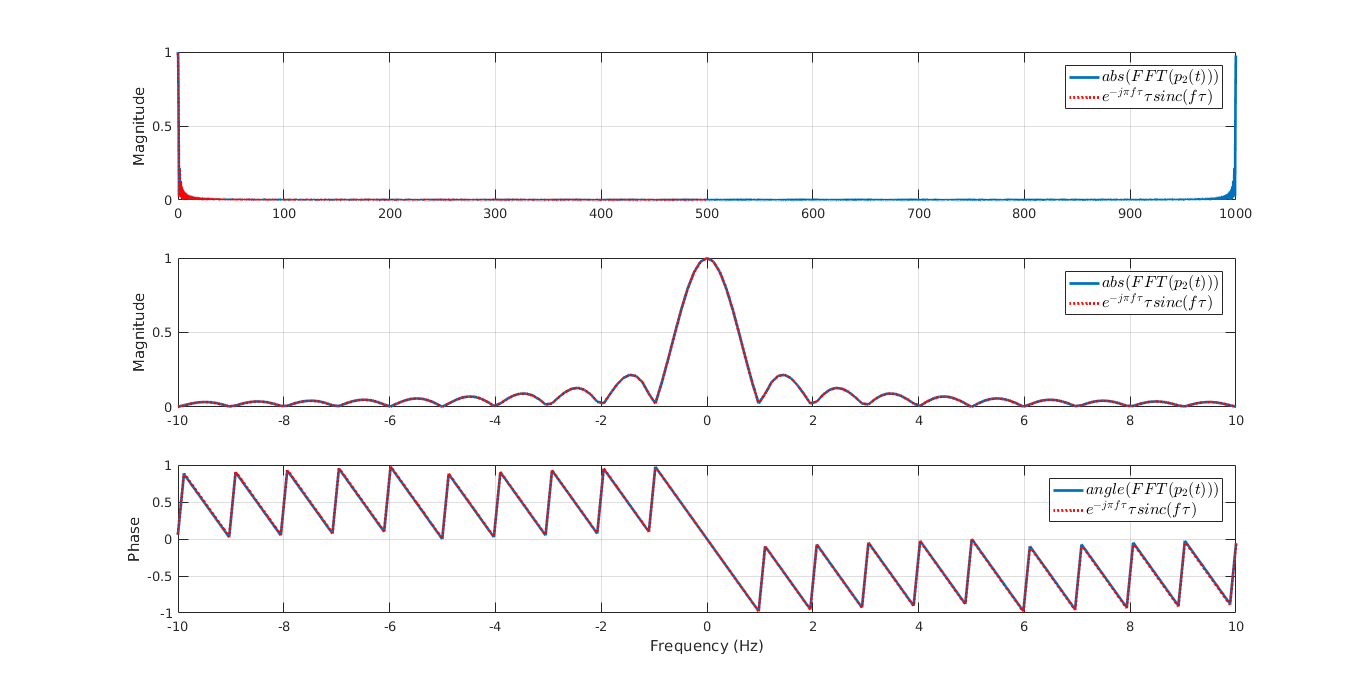
with is the result at , where , and where.

The Discrete Fourier Transform of the basic unshifted pulse is known to be

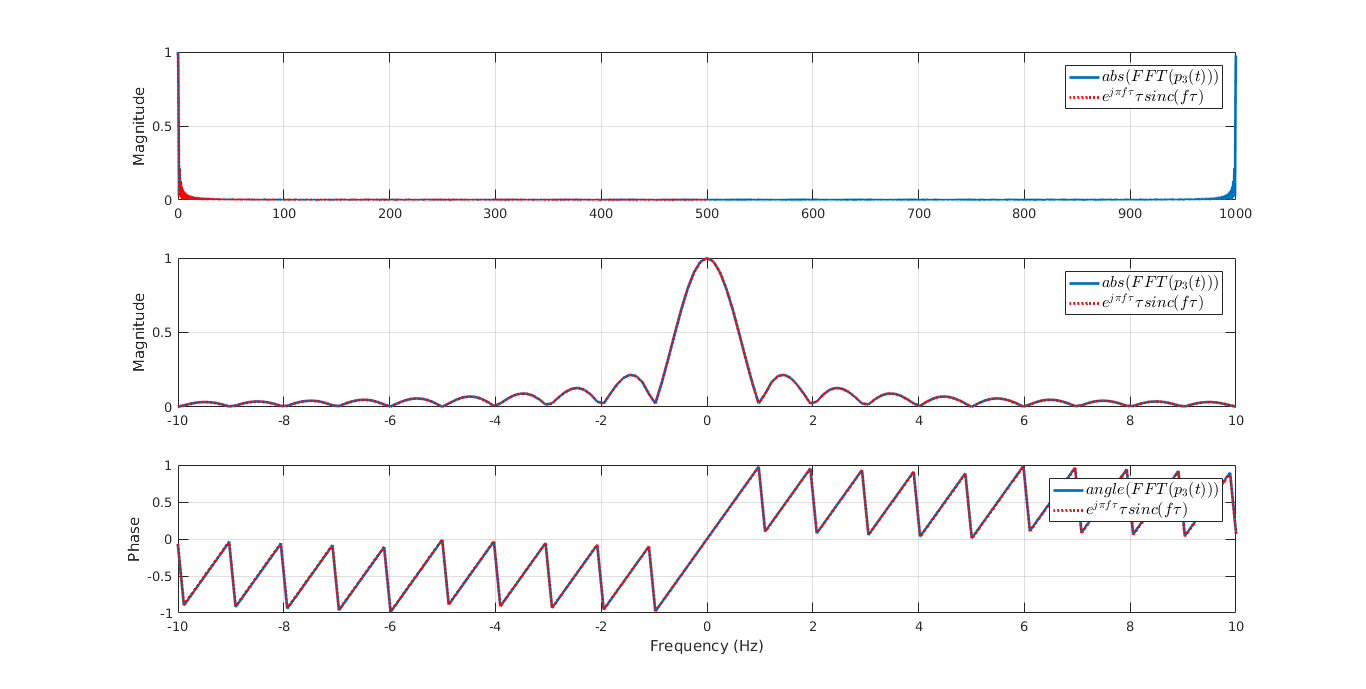
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**Figure 2: Fast Fourier Transform of p1(t)**

Using the time shift property of Fourier Transform:

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**Figure 3: Fast Fourier Transform of p2(t)**

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**Figure 4: Fast Fourier Transform of p3(t)**

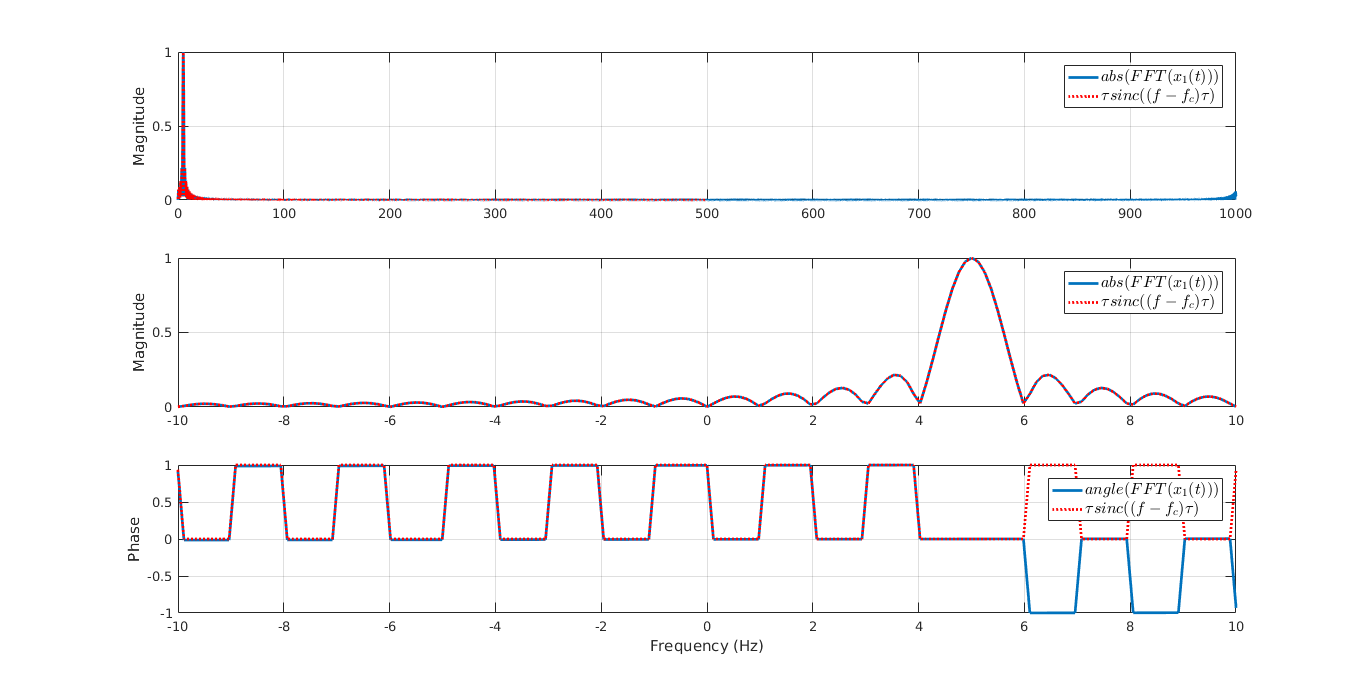
The magnitudes of the DTFT of the three pulses appear identical, even if the shift is obvious in the time domain. The phases however show distinction in the frequency domain. The shifted functions (p2(t) and p3(t)) have their phases appearing inverted of each other.

## The Complex Modulation Property

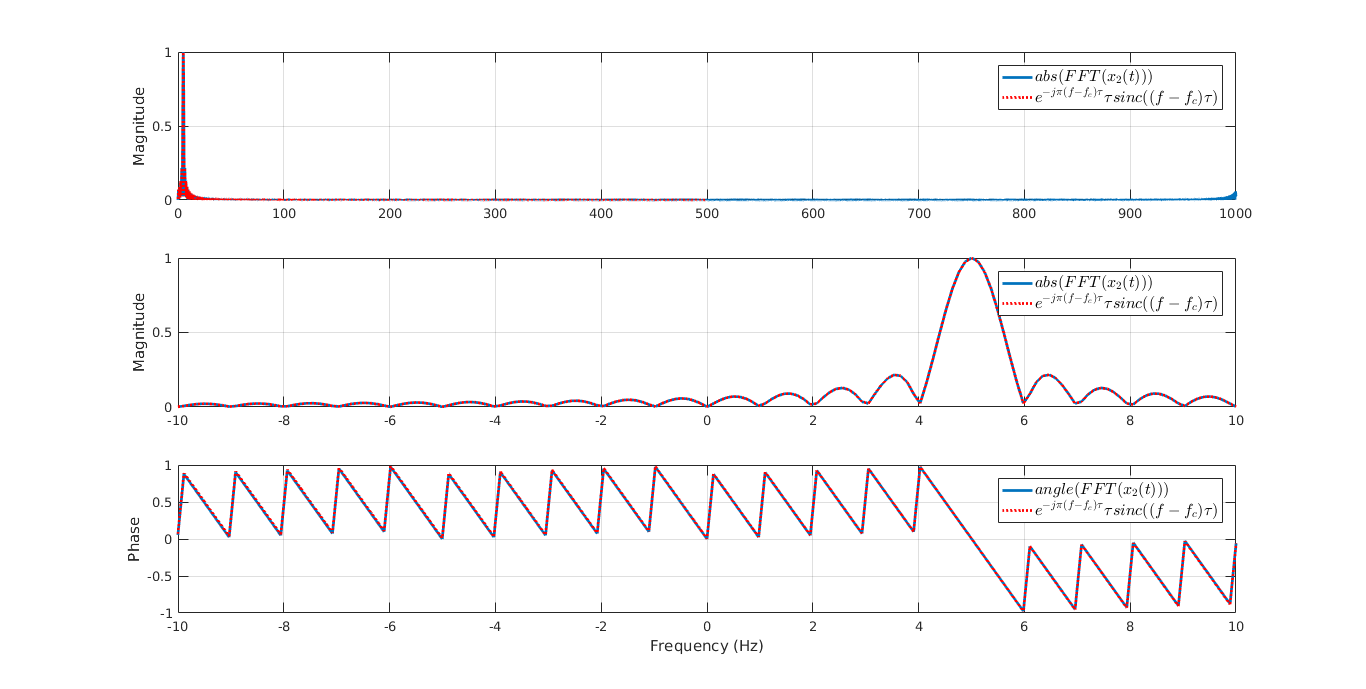
Each of the three pulse functions  were taken and multiplied by

with . The new pulses were called, and were plotted along with their Discrete Time Fourier Transforms.

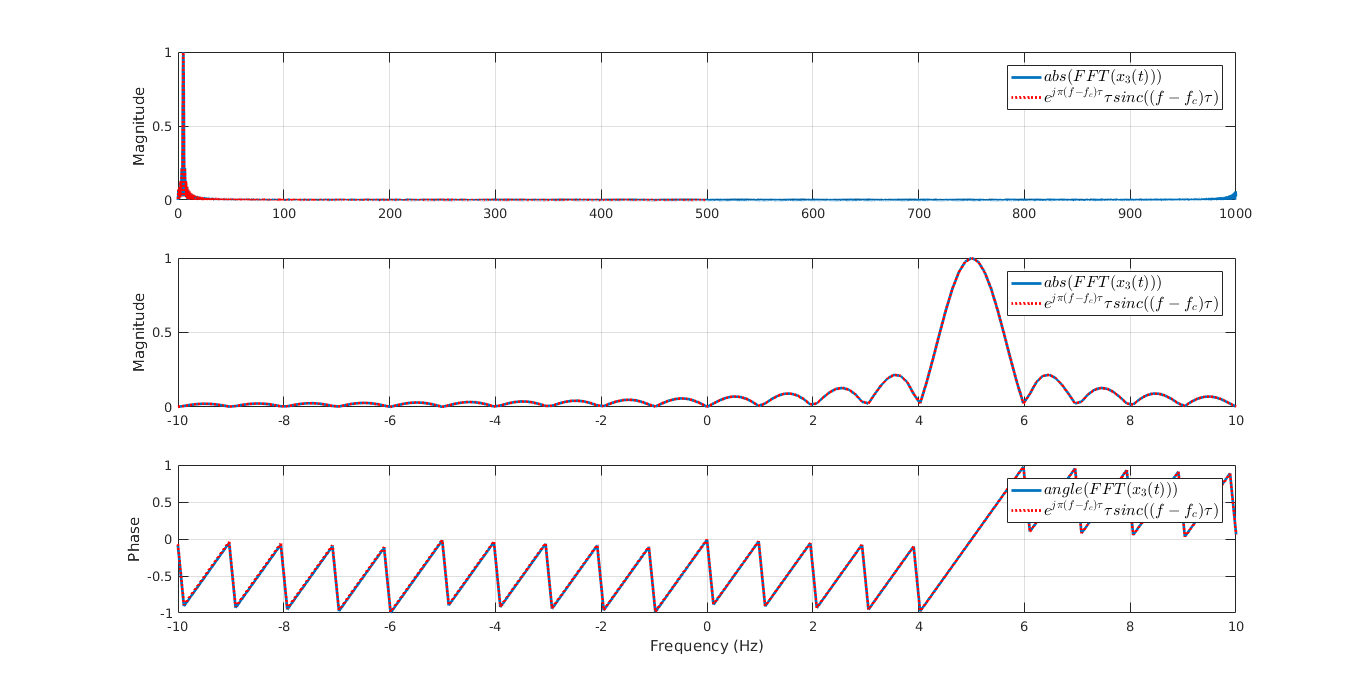
Using the modulation property of Fourier Transform:



**Figure 5: Fast Fourier Transform on x­1(t)**



**Figure 6: Fast Fourier Transform on x­2(t)**



**Figure 7: Fast Fourier Transform on x3(t)**

Similar to before being multiplied by the complex exponential, the magnitudes of the DTFT of the three pulses appear identical. They are however shifted to the right by fc = 5.009 Hz, of the value of fc. Consistent changes in the phases of the functions can also be observed.

## The Cosine Modulation Property

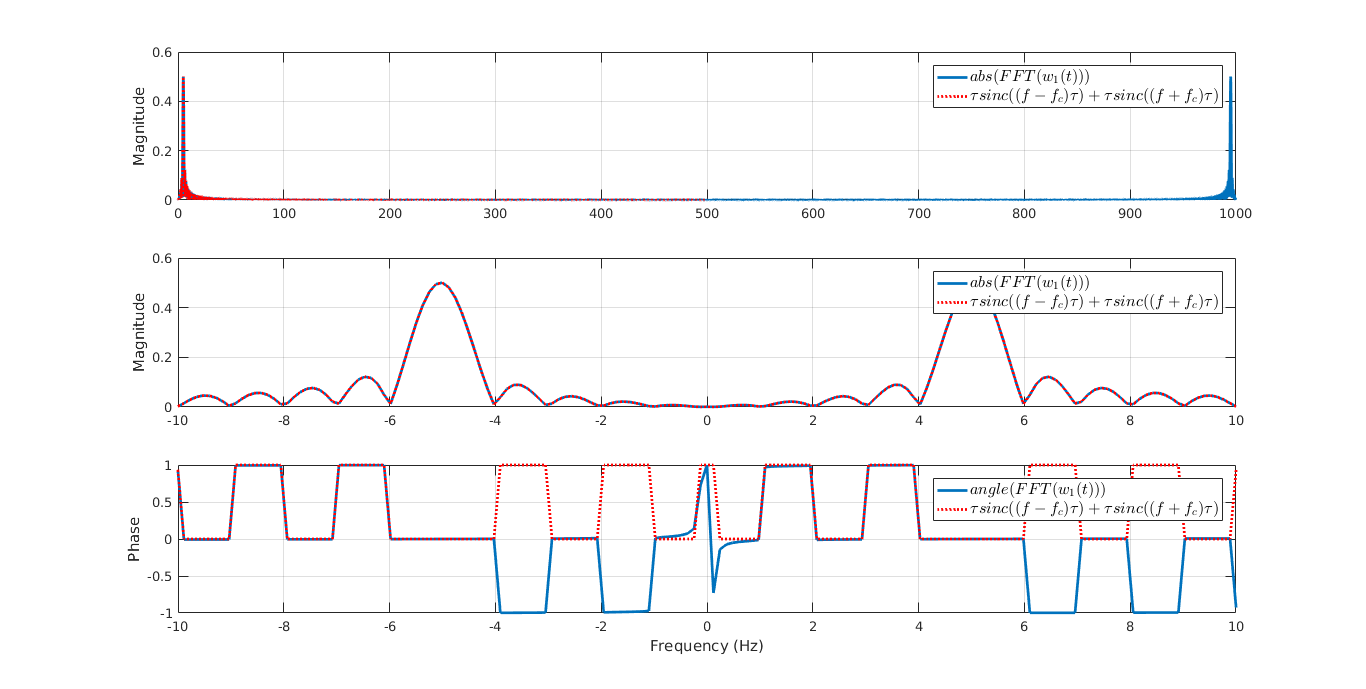
A corollary to the Complex Modulation Theorem is the Cosine Modulation Property, which uses the Euler expansion of the cosine and applies the Complex Modulation Property. Each of the original pulses were taken and multiplied by

with . The new pulses were called, and were plotted along with their Discrete Time Frequency Transforms.

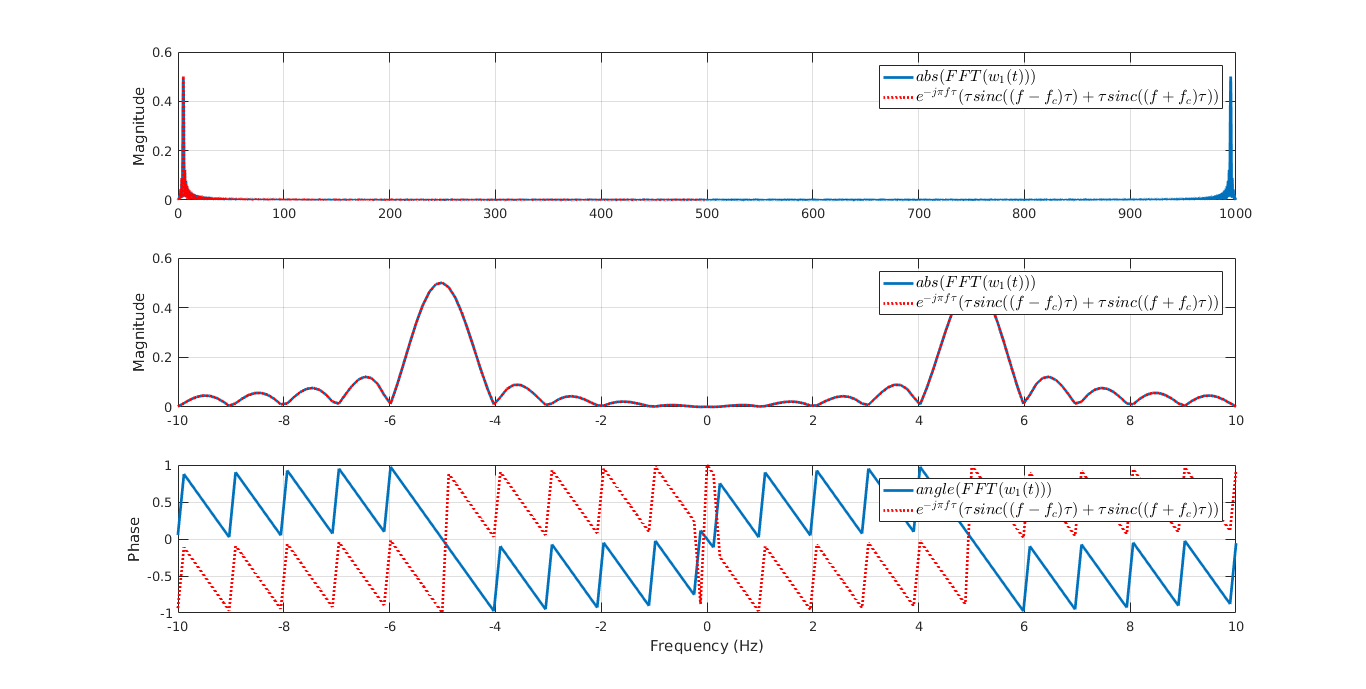
Using the modulation property of Fourier Transform:

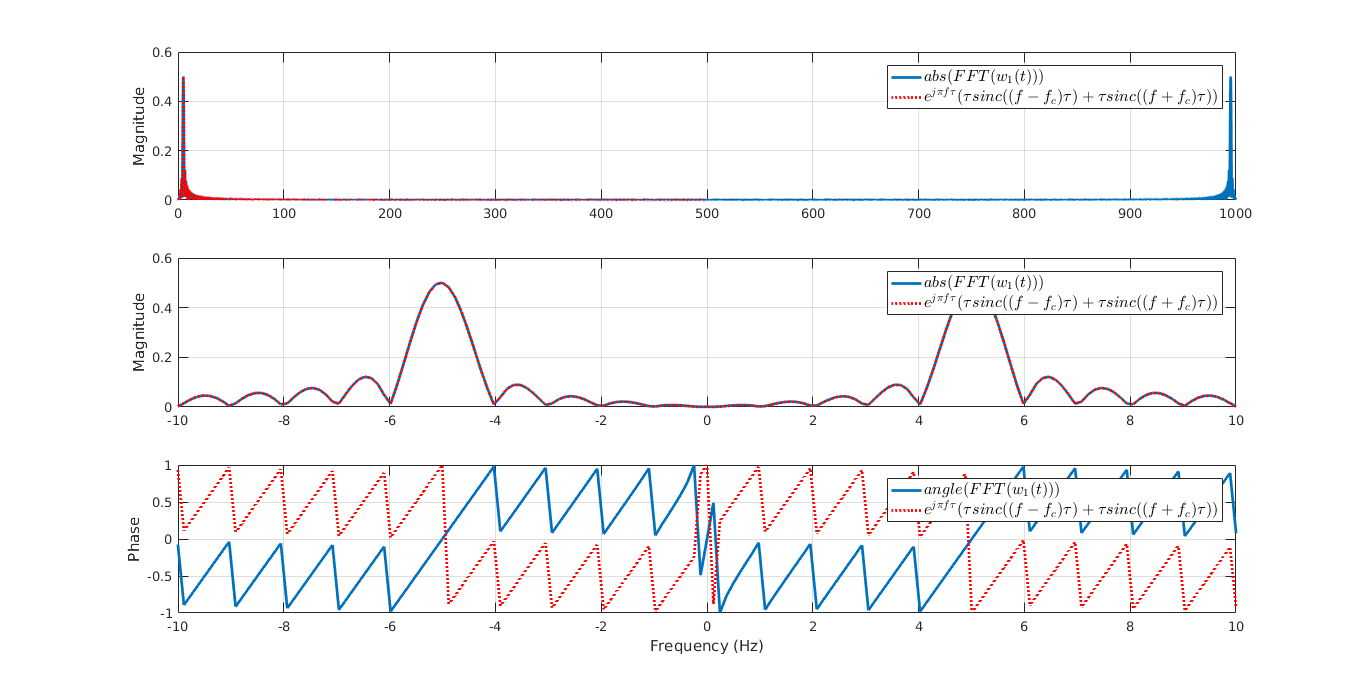
And Euler’s Identity:

and



**Figure 8: Discrete Time Fourier Transform on w1(t)**



**Figure 9: Discrete Time Fourier Transform on w2(t)**

**Figure 10: Fast Fourier Transform on w3(t)**

The functions appear to be identical to when they were multiplied by the complex exponential.