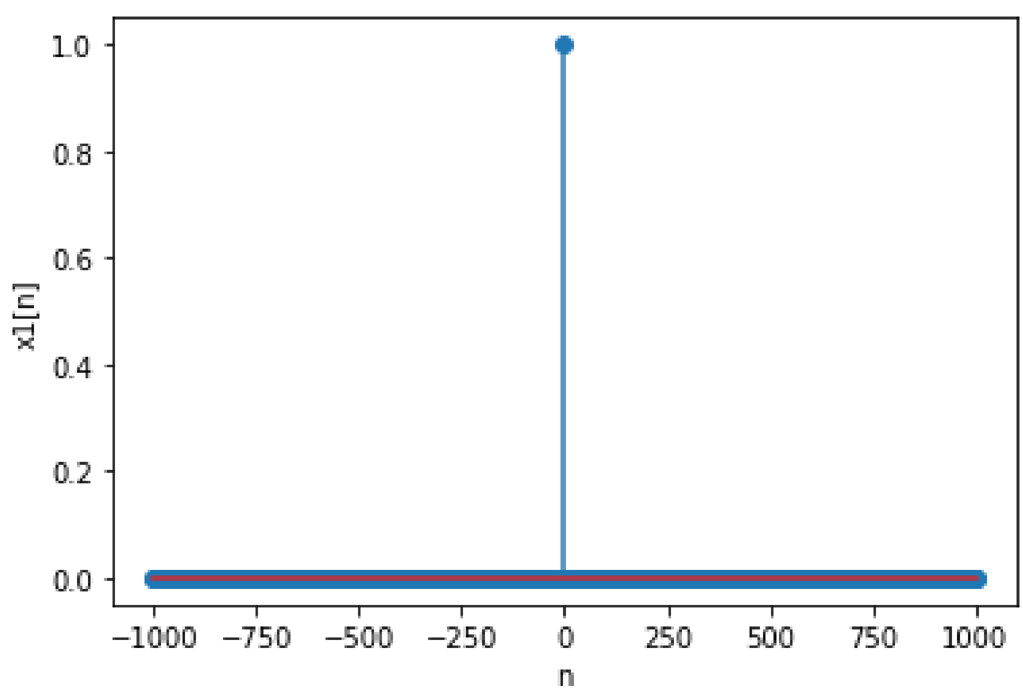
Report for Programming Problems - SnS Assignment 3

Q1) In this problem we were given two problems wherein we are given a discrete signal x[n] as input and we are supposed to compute its Discrete Fourier Transform and plot the following four things:
i) the signal x[n]
ii) real part of the complex DTFT signal
iii) imaginary part of the complex DTFT signal
iv) magnitude spectrum of the complex DTFT signal

Part a)
Here we have been given the input signal x1[n] as the unit impulse signal i.e. x1[n] = 1 for n = 0 and 0 otherwise.

For plotting x1[n] and computing the DFT, we have been given the following assumptions:
i) Range of n = {-1000,1000}
ii) Range of $\omega = [-2\pi, 2\pi]$

The plot for the signal x1[n] is as follows:



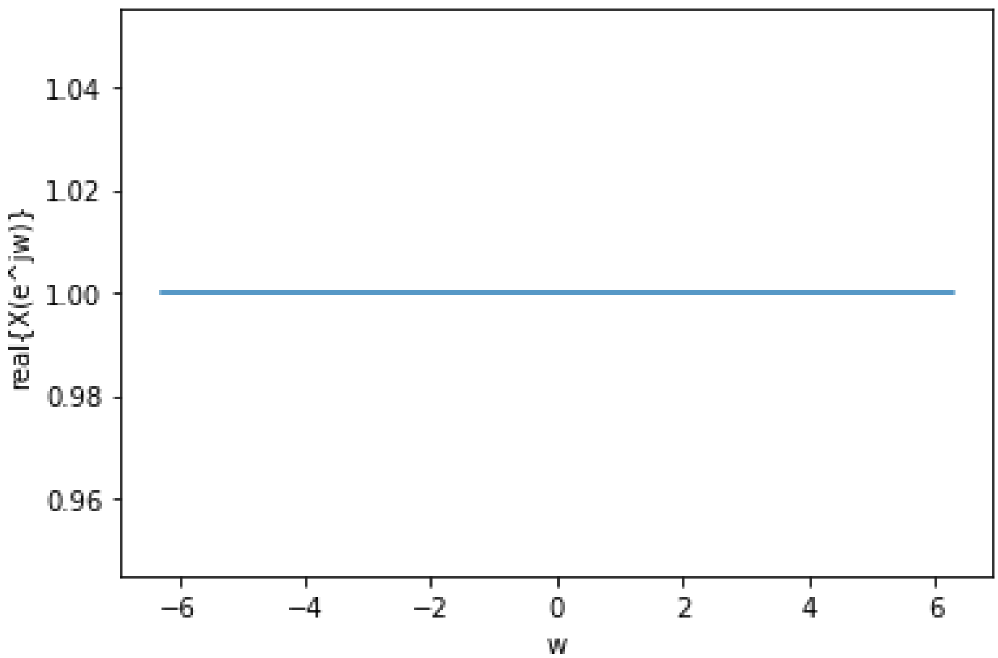
Formula for the **Discrete Fourier Transform** is given below:

$$X(e^{j\omega}) = \sum_{n=-\infty}^{\infty} (x[n]) \cdot e^{-j\omega n}$$

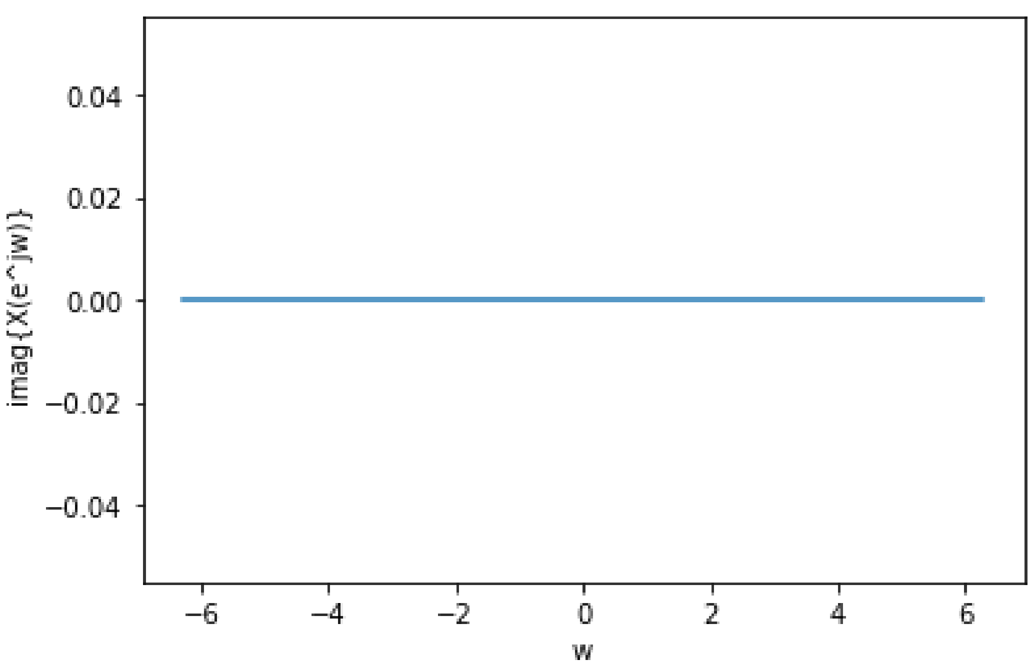
Discrete Fourier Transform is given by the signal $X(e^{j\omega})$

Plots for the Discrete Fourier Transform of x1[n]:

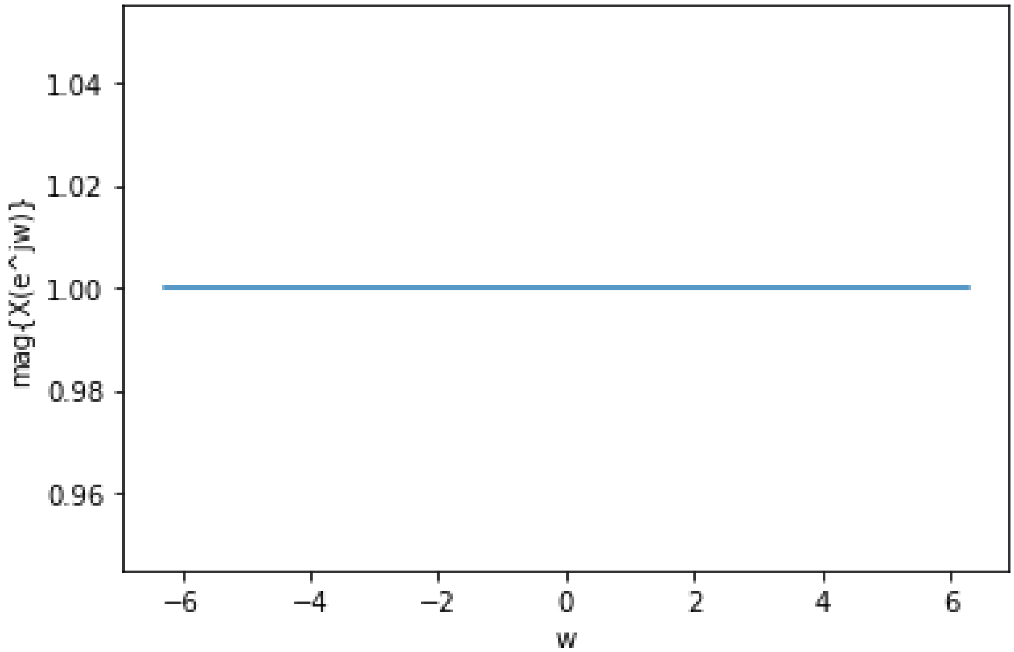
1) **Real Part of DFT:**



2) **Imaginary Part of DFT:**



3) Magnitude Spectrum of DFT:



Explanation and Inference from the Plots:

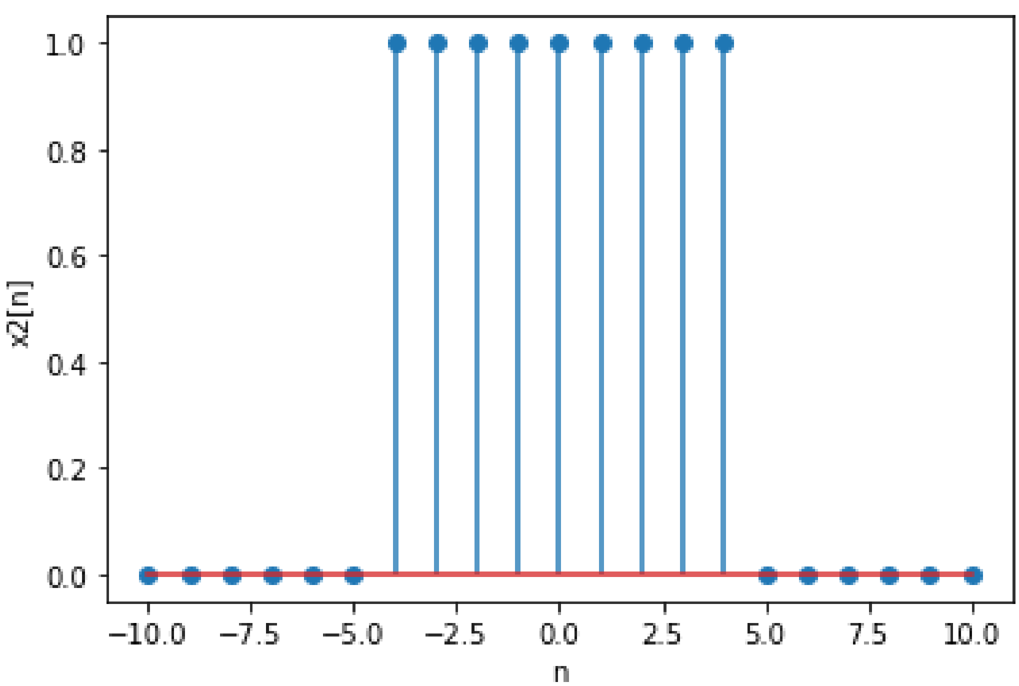
- The formula of discrete fourier transform can we rewritten by opening the exponential function we multiply with x[n] using the **Euler's Identity i.e.** $e^{ix} = cosx + isinx$
- Hence the real part of the Discrete Fourier Transform can be computed by multiplying cos(-w*n) with x[n] for every n from -1000 to 1000 and summing this up.
  Note: This needs to be done for every value of w in the given range i.e. ω = [-2π, 2π] to obtain the plot of the real part of the Discrete Fourier Transform.
- Similarly, the imaginary part of the Discrete Fourier Transform can be computed by multiplying sin(-w*n) with x[n] for every n from -1000 to 1000 and summing this up.
  Note: This needs to be done for every value of w in the given range i.e. ω = [-2π, 2π] to obtain the plot of the imaginary part of the Discrete Fourier Transform.
- For the magnitude spectrum of the Discrete Fourier Transform, we take the real part and imaginary part for every value of w in the given range. Then I take the square of both of these, add them up and then take the square root to get the magnitude of the DFT for that particular value of w.

- **Inference about Periodicity:** Here all the three signals are constant value signals and thus it is not right to comment about their periodicity. They can be called periodic with an infinite time period or a not well defined time period. The imaginary part of the DFT is zero which implies that the DFT of the unit impulse signal is purely real and is equal to 1.

Part b)
Here we have been given the input signal x2[n] wherein x2[n] = 1 for n = [-4, -3, -2, -1, 0, 1, 2, 3, 4] and 0 for any other value for n.

For plotting x2[n] and computing the DFT, we have been given the following assumptions:
i) Range of n = {-1000,1000}
ii) Range of ω = [-2π, 2π]

The plot for the signal x2[n] is as follows:



Note: We have been given the range for n as [-1000, 1000], but I have plotted x2[n] for the values of n from -10 to 10 for better accuracy and representation as in the figure above.

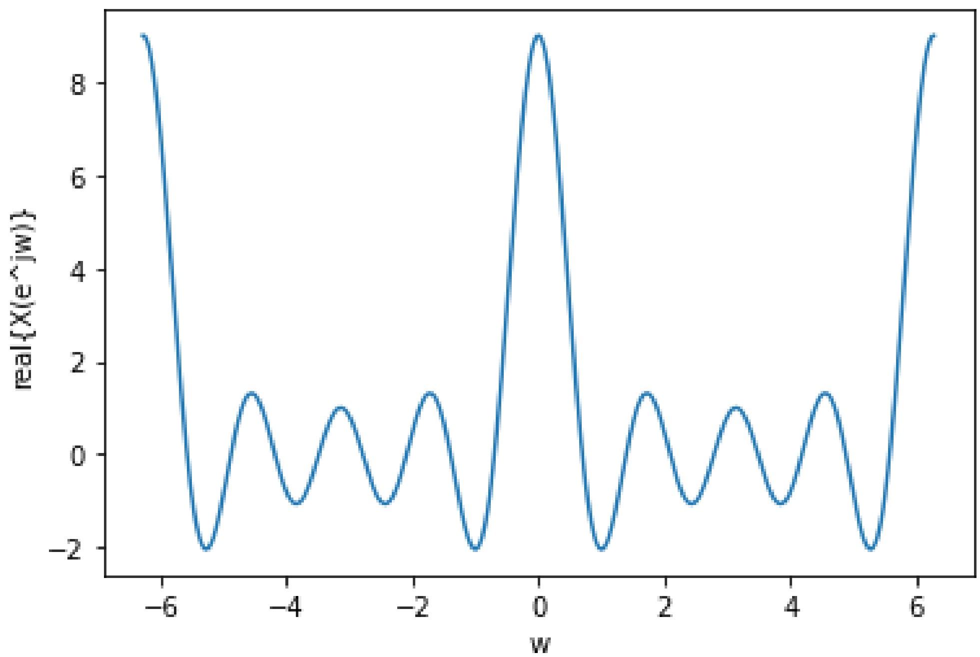
Formula for the **Discrete Fourier Transform** is given below:

$$X(e^{j\omega}) = \sum_{n=-\infty}^{\infty} (x[n]) \cdot e^{-j\omega n}$$

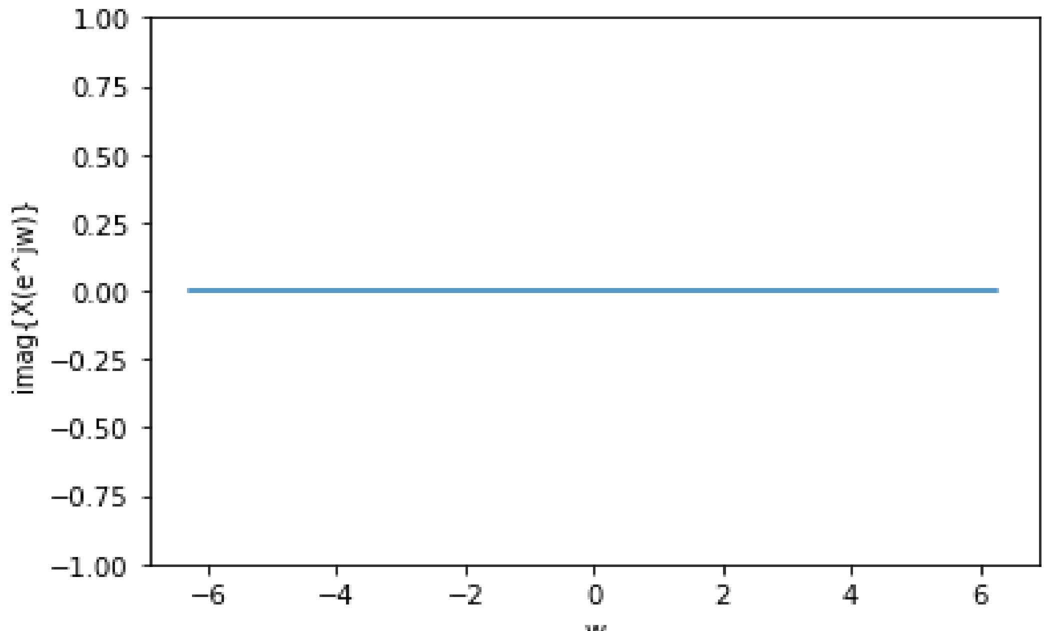
Discrete Fourier Transform is given by the signal $X(e^{j\omega})$

Plots for the Discrete Fourier Transform of x1[n]:

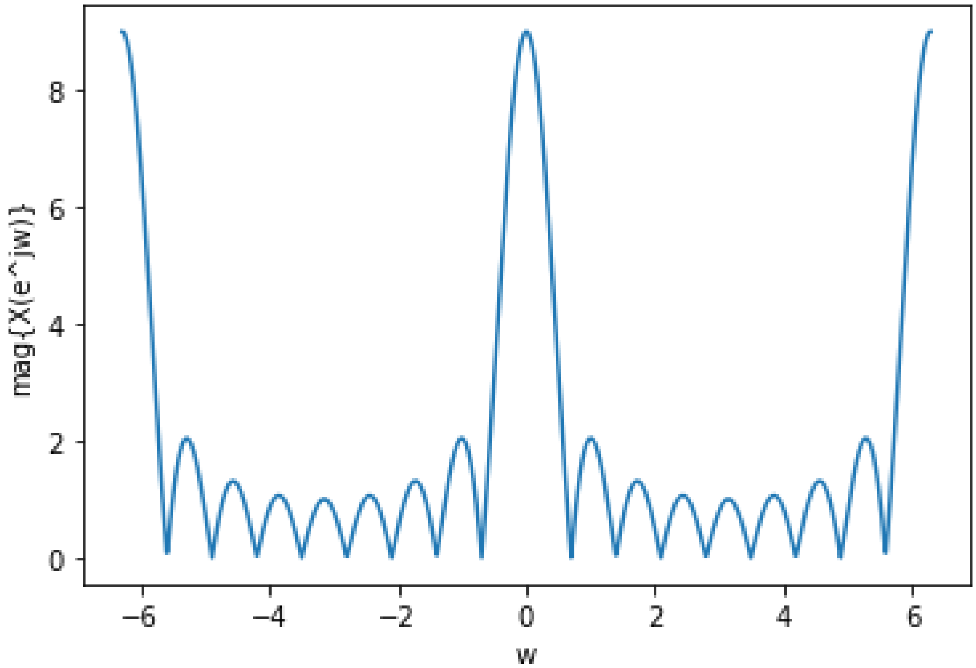
1) **Real Part of DFT:**



2) **Imaginary Part of DFT:**



3) Magnitude Spectrum of DFT:



Explanation and Inference from the Plots:

- The formula of discrete fourier transform can we rewritten by opening the exponential function we multiply with x[n] using the **Euler's Identity i.e.** $e^{ix} = cosx + isinx$
- Hence the real part of the Discrete Fourier Transform can be computed by multiplying cos(-w*n) with x[n] for every n from -1000 to 1000 and summing this up.
  Note: This needs to be done for every value of w in the given range i.e. ω = [-2π, 2π] to obtain the plot of the real part of the Discrete Fourier Transform.
- Similarly, the imaginary part of the Discrete Fourier Transform can be computed by multiplying sin(-w*n) with x[n] for every n from -1000 to 1000 and summing this up.
  Note: This needs to be done for every value of w in the given range i.e. ω = [-2π, 2π] to obtain the plot of the imaginary part of the Discrete Fourier Transform.
- For the magnitude spectrum of the Discrete Fourier Transform, we take the real part and imaginary part for every value of w in the given range. Then I take the square of both of these, add them up and then take the square root to get the magnitude of the DFT for that particular value of w.

- **Inference about Periodicity:**
  i) The real part of the fourier transform as seen in the plot is going to be a periodic signal with time period 2π as it repeats from -2π to 0 and then from 0 to 2π.
  ii) Similarly, the magnitude of the DFT as seen in the plot is going to be a periodic signal with time period 2π as it repeats from -2π to 0 and then from 0 to 2π.
  iii) The imaginary part of the DFT is a constant value signal with 0 i.e. the DFT is a **purely real signal** and hence its time period cannot be defined. It can be called a periodic signal with not a well defined time period.