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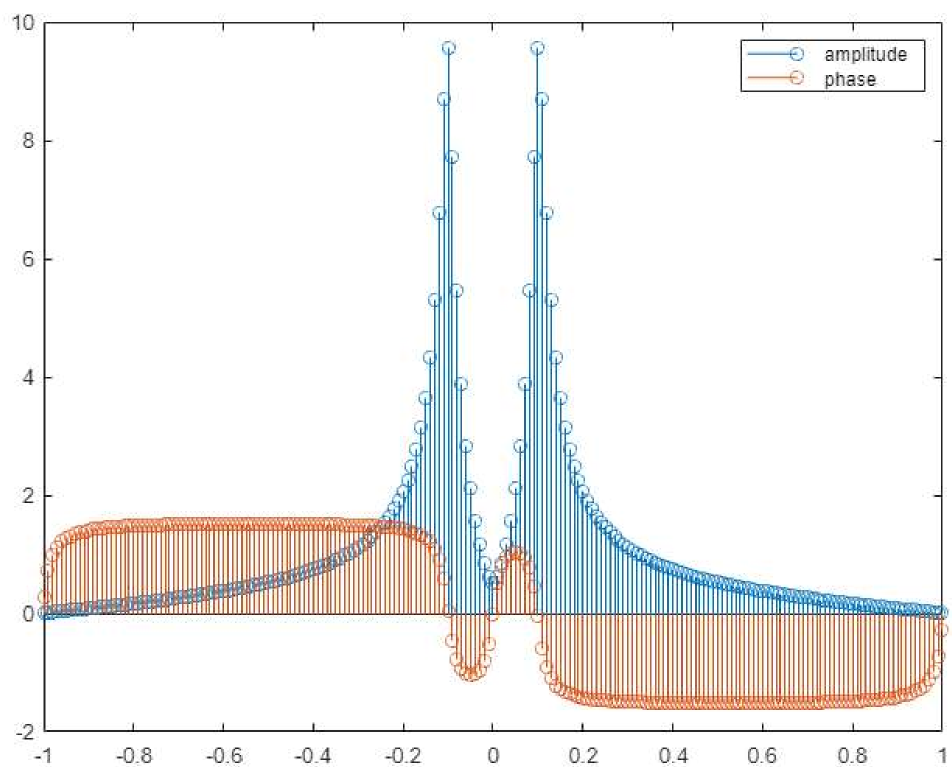
EE 111 lab 3

Abstract: The objective of this lab is to use the discrete time Fourier transformation and plot the amplitude and the phase spectrum of different sequences and determine how changing the sequence changes the graph.

a)

lab3a.m

```
ts = 0.5; %frequency sample
n = 0:ts:100; %length of n is 201

x = (0.9 .^n) .* cos((pi/5) * n) .* heaviside(n);
y = fftshift(fft(x,length(n)));

amplitude = abs(y);
phase = angle(y);
frequency = linspace(-1,1,length(n)) / (ts*2);

stem(frequency, amplitude);

hold on
stem(frequency, phase);
legend('amplitude', 'phase');
```

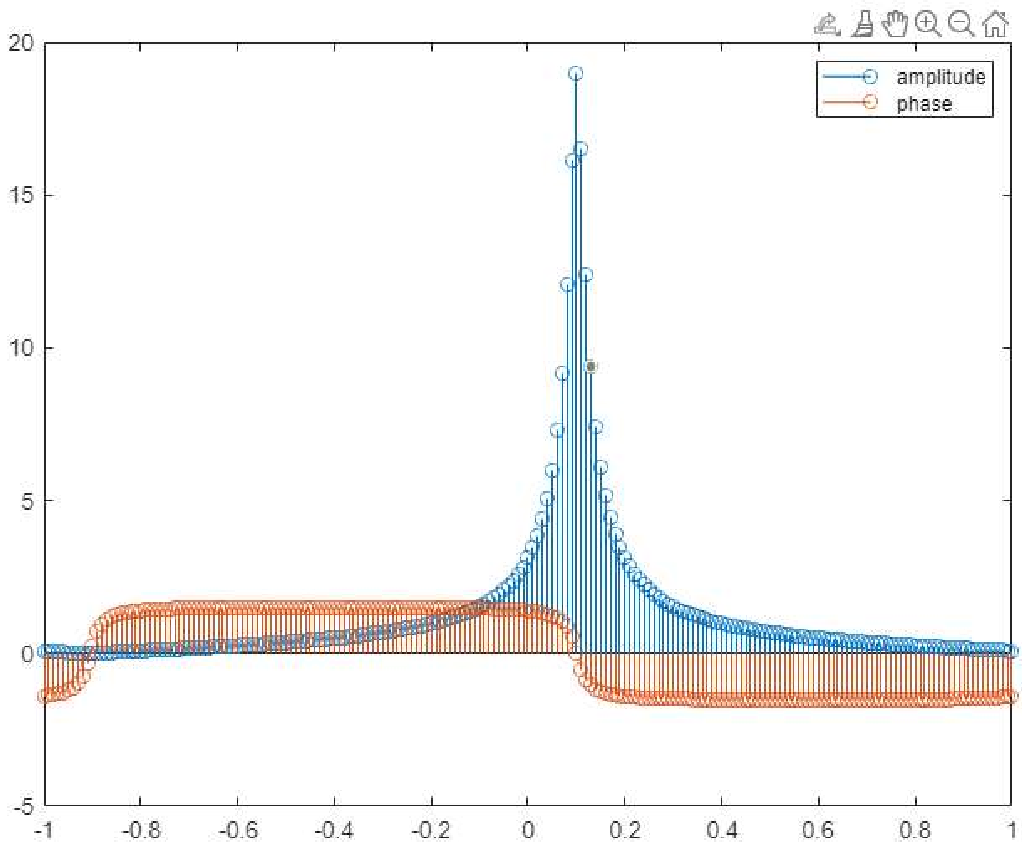


This graph is our base sequence that has been put through the fourier transformation. We will be building in the rest of this lab. We also made it so zero will be in the center of the graph and we will start at -1.

b)

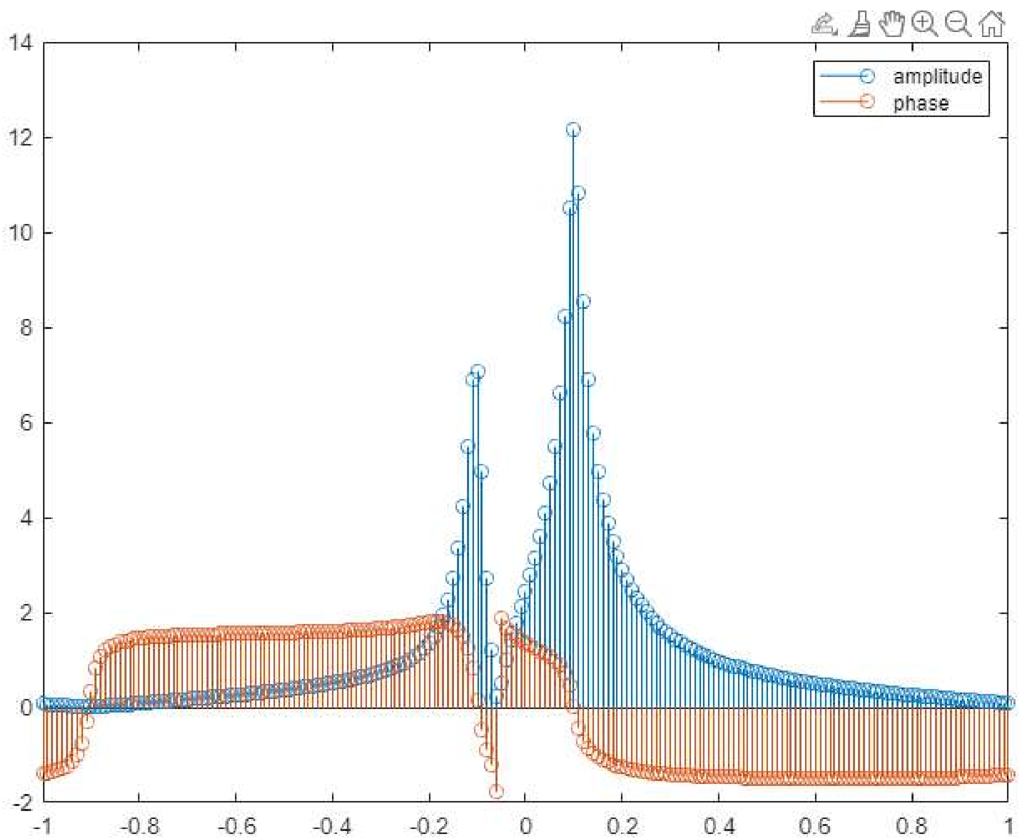
lab3a.m × lab3b.m × +

```
ts = 0.5; %frequency sample
n = 0:ts:100; %length of n is 201

x = ((0.9 .^n) .* cos((pi/5) * n) .* heaviside(n))+ 1i * (0.9 .^n) .*sin((pi/5)*n) .* heav
y = fftshift(fft(x,length(n)));

amplitude = abs(y);
phase = angle(y);
frequency = linspace(-1,1,length(n)) / (ts*2);

stem(frequency, amplitude);

hold on
stem(frequency, phase);
legend('amplitude', 'phase');
```



This part of the lab is showing us how the graph changes when we add an imaginary sequence to our part 1 c)

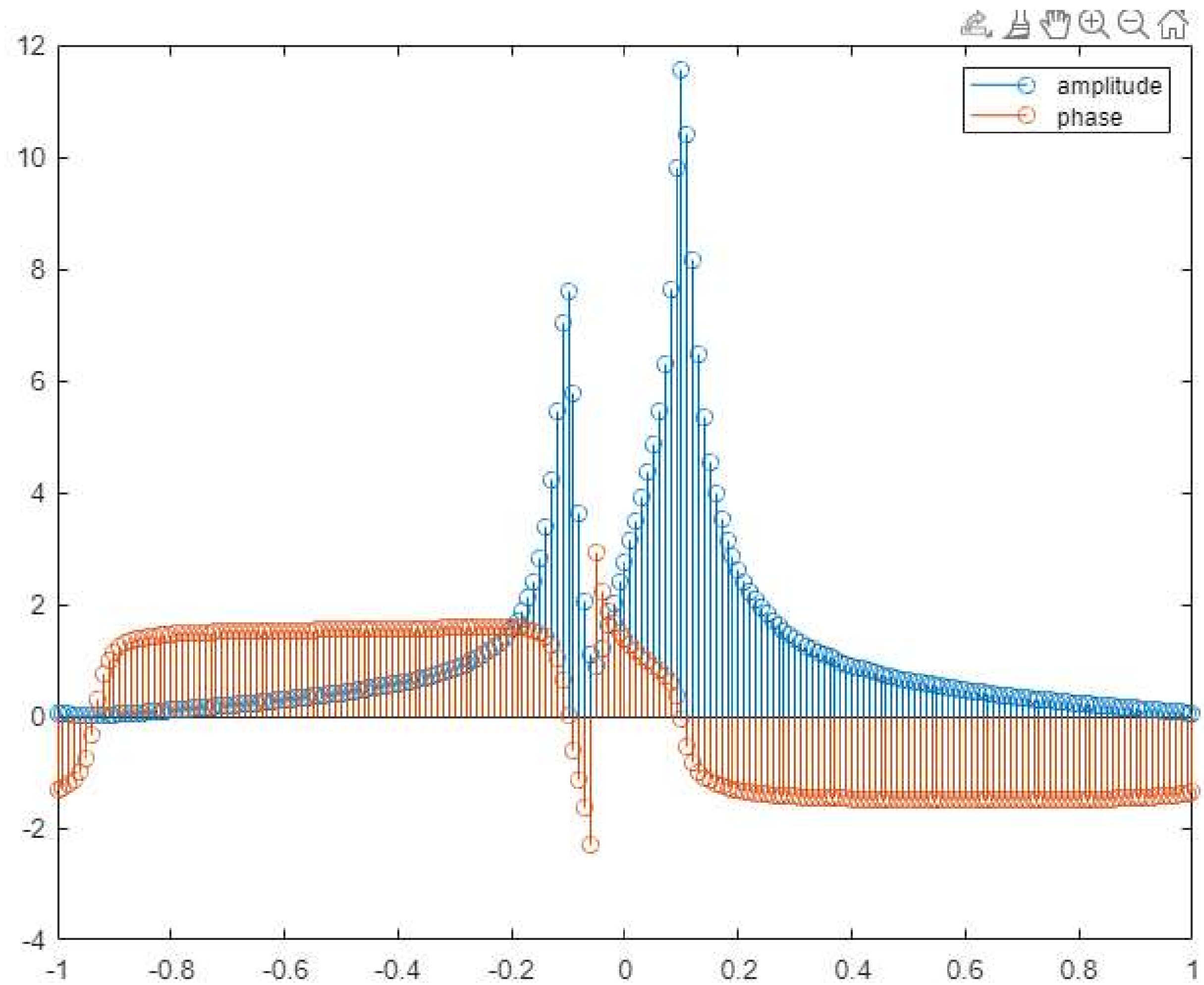
```
ts = 0.5; %frequency sample
n = 0:ts:100; %length of n is 201

x = ((0.9 .^n) .* cos((pi/5) * n) .* heaviside(n))+ 1i * (0.7 .^n) .*sin((pi/5)*n) .* heav
y = fftshift(fft(x,length(n)));

amplitude = abs(y);
phase = angle(y);
frequency = linspace(-1,1,length(n)) / (ts*2);

stem(frequency, amplitude);

hold on
stem(frequency, phase);
legend('amplitude', 'phase');
```



In this part we lower the constant 0.9 to 0.7 on the imaginary part of the sequence and from that we can see that it lowered the overall amplitude and it made our phase dip at the frequency -.1

d)

```
ts = 0.5; %frequency sample
n = 0:ts:100; %length of n is 201

x = ((0.9 .^n) .* cos((pi/5) * n) .* heaviside(n))+ 1i * (0.7 .^n) .*sin((pi/7)*n) .* heav
y = fftshift(fft(x,length(n)));

amplitude = abs(y);
phase = angle(y);
frequency = linspace(-1,1,length(n)) / (ts*2);

stem(frequency, amplitude);

hold on
stem(frequency, phase);
legend('amplitude', 'phase');
```

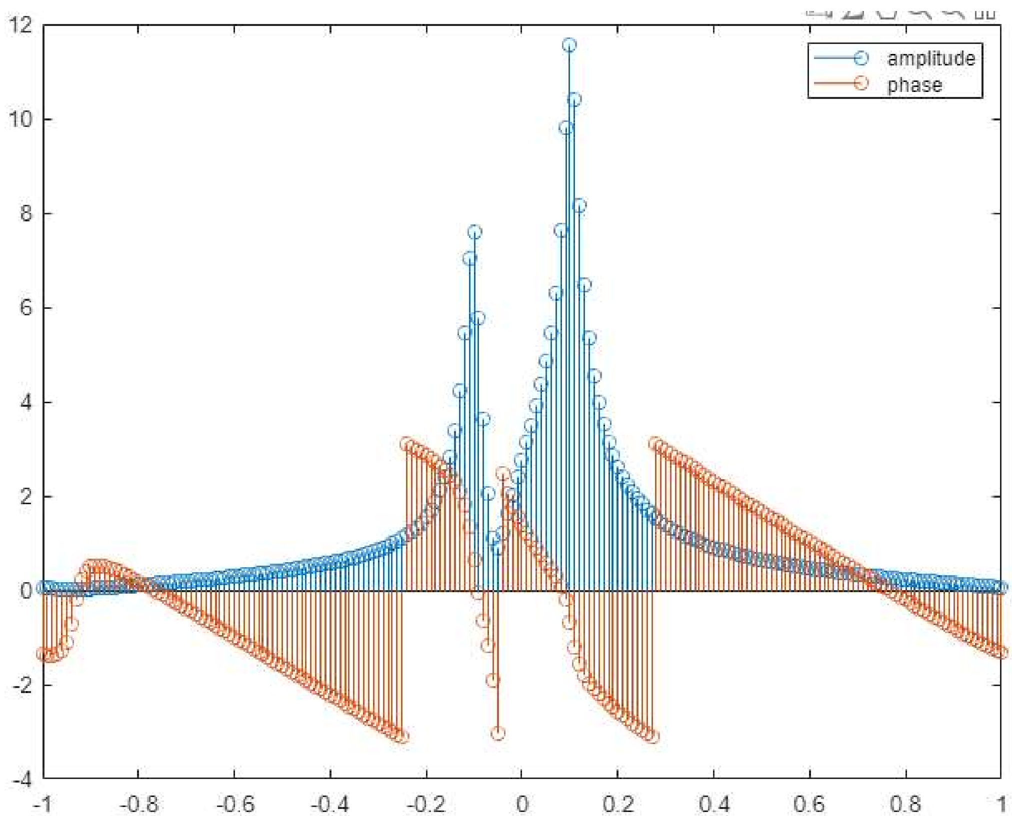


In this part we changed the imaginary sequence and we changed the constant (pi/5 -> pi/7) that we are multiplying by n. From doing this we see that the amplitude is lowered and phase has a bigger spike around 0.

e)

lab3a.m × lab3b.m × lab3c.m × lab3d.m × lab3e.m ×

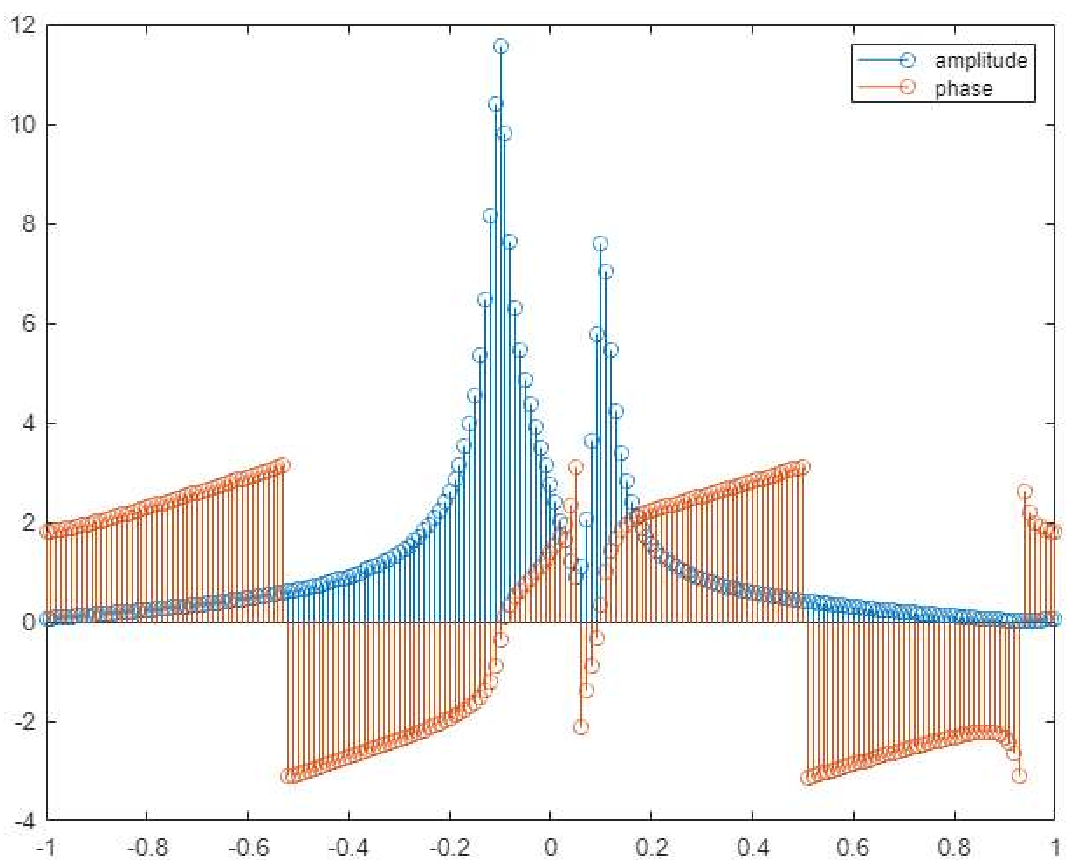
```
ts = 0.5; %frequency sample
n = 0:ts:100; %length of n is 201

x = ((0.9 .^n) .* cos((pi/5) * n) .* heaviside(n))+ 1i * (0.7 .^n) .*sin((pi/7)*n) .* hea
X = [0,0,x]; %adds 2 zeros to the begining of x
y = fftshift(fft(X,length(n)));

amplitude = abs(y);
phase = angle(y);
frequency = linspace(-1,1,length(n)) / (ts*2);

stem(frequency, amplitude);

hold on
stem(frequency, phase);
legend('amplitude', 'phase');
```



In this part of the lab we are time shifting the x function by two and to do this we add two zeros at the beginning of x. With this change we mostly see a change in the phase.

f)

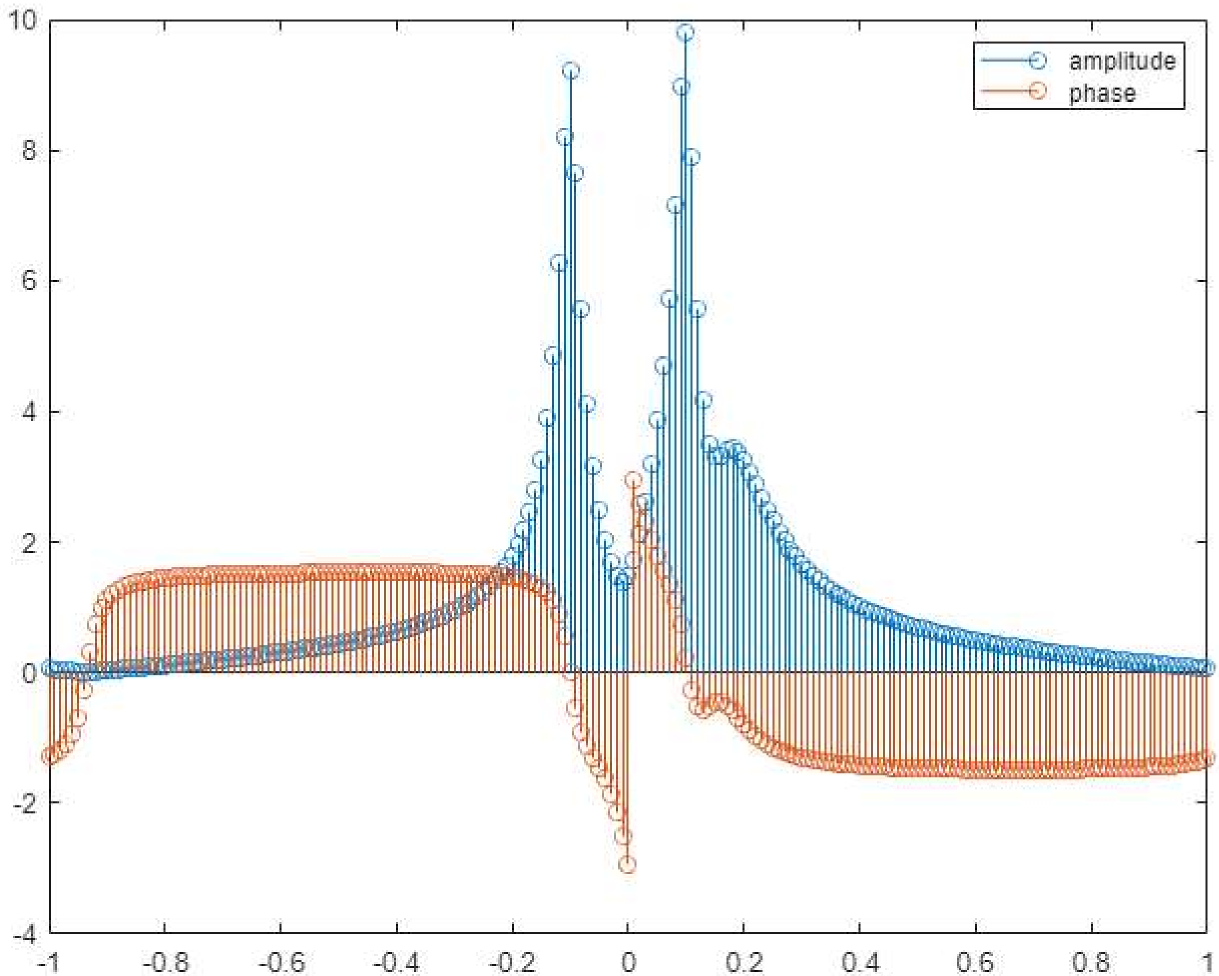
```
ts = 0.5; %frequency sample
n = 0:ts:100; %length of n is 201

x = ((0.9 .^n) .* cos((pi/5) * n) .* heaviside(n))+ 1i * (0.7 .^n) .*sin((pi/7)*n) .* heav
y = fftshift(fft(flip(x),length(n)));

amplitude = abs(y);
phase = angle(y);
frequency = linspace(-1,1,length(n)) / (ts*2);

stem(frequency, amplitude);

hold on
stem(frequency, phase);
legend('amplitude', 'phase');
```



In this part we flip x so that x[n] = x[-n] (time reversal). When we do this we can see that the amplitude has been reversed and it spikes higher then lower. We also see that the phase is almost the inverse of the previous graph.

g)

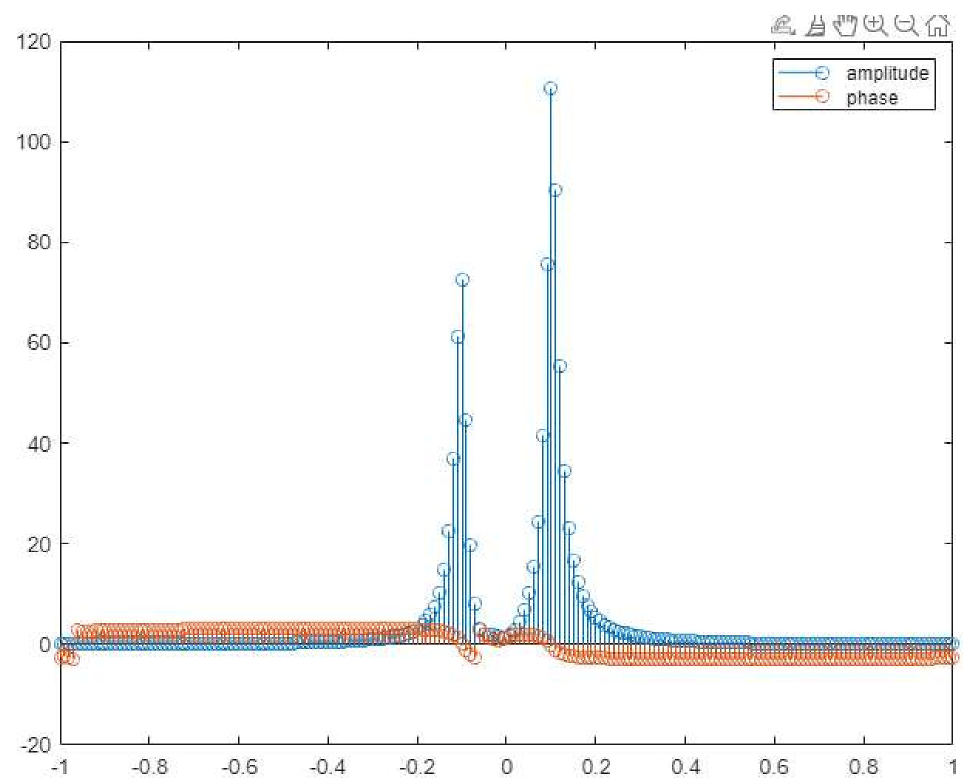
```
ts = 0.5; %frequency sample
n = 0:ts:100; %length of n is 201

x = ((0.9 .^n) .* cos((pi/5) * n) .* heaviside(n))+ 1i * (0.7 .^n) .*sin((pi/7)*n) .* heaviside(n).* exp(1i*2*pi*0.1*n);
y = fftshift(fft(x,length(n)));

amplitude = abs(y);
phase = angle(y);
frequency = linspace(-1,1,length(n)) / (ts*2);

stem(frequency, amplitude);

hold on
stem(frequency, phase);
legend('amplitude', 'phase');
```



In this part of the lab we are frequency shifting the sequence from part d(4). After we shift the values we see that the max amplitude has lowered and the graph has shifted to the right about .1.

h)

```
lab3a.m × lab3b.m × lab3c.m × lab3d.m × lab3e.m × lab3f.m × lab3g.m × lab3h.m × +

ts = 0.5; %frequency sample
n = 0:ts:100; %length of n is 201

x1 = (0.9 .^n) .* cos((pi/5) * n) .* heaviside(n);
x4 = ((0.9 .^n) .* cos((pi/5) * n) .* heaviside(n))+ 1i * (0.7 .^n) .*sin((pi/7)*n) .* heaviside(n);
x= conv(x1,x4);
y = fftshift(fft(x,length(n)));

amplitude = abs(y);
phase = angle(y);
frequency = linspace(-1,1,length(n)) / (ts*2);

stem(frequency, amplitude);

hold on
stem(frequency, phase);
legend('amplitude', 'phase');
```

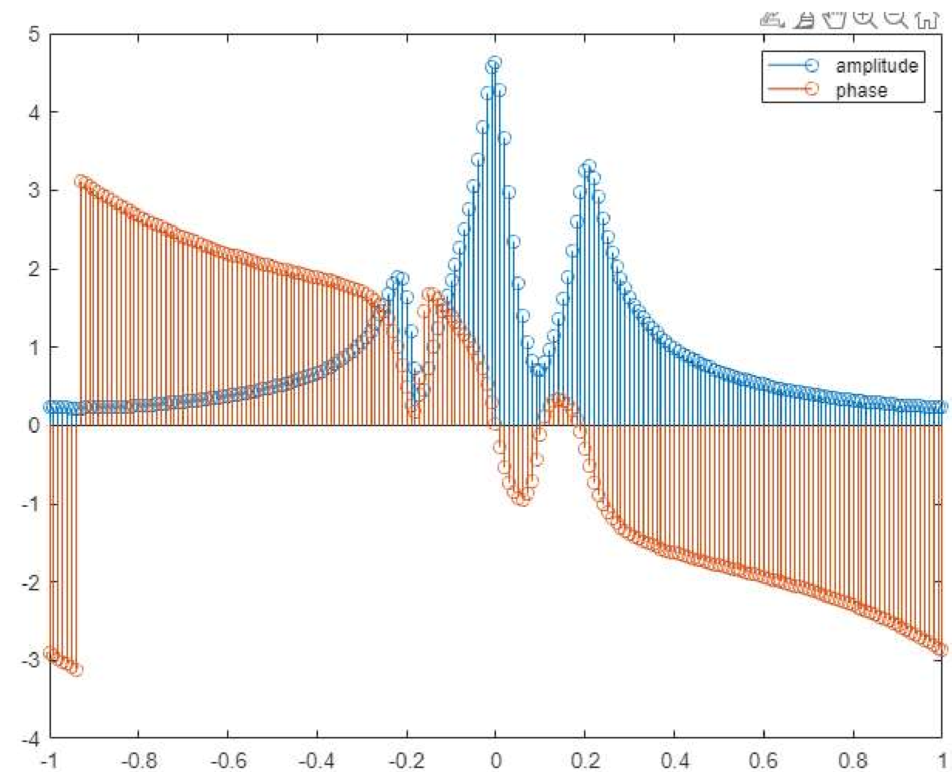


In this part of the lab we are taking the convergence of part d and part a. We are doing this to later compare against the product of part a and d. From the convergence we see that our max amplitude is way higher than anything we have seen in this lab. We also see that the phase stays pretty consistent with part d.

i)

lab3a.m × lab3b.m × lab3c.m × lab3d.m × lab3e.m × lab3f.m × lab3g.m × lab3h.m × lab3i.m ×

```
ts = 0.5; %frequency sample
n = 0:ts:100; %length of n is 201

x1 = (0.9 .^n) .* cos((pi/5) * n) .* heaviside(n);
x4 = ((0.9 .^n) .* cos((pi/5) * n) .* heaviside(n))+ 1i * (0.7 .^n) .*sin((pi/7)*n) .* heaviside(n);
x= x1 .* x4;
y = fftshift(fft(x,length(n)));

amplitude = abs(y);
phase = angle(y);
frequency = linspace(-1,1,length(n)) / (ts*2);

stem(frequency, amplitude);

hold on
stem(frequency, phase);
legend('amplitude', 'phase');
```



In this part we found the product between part a and part d to see the difference between convergence and multiplication. From this graph we can see that when we multiply the two sequences we get a lower max amplitude and the phase has a decreasing trend.

Conclusion: In this lab our purpose was to see how different sequences react to being put through the Fourier transformation. Throughout this lab we were able to see how making small changes to the sequence impacts the amplitude and phase. From the graphs above we can see that you can get the highest amplitude from getting the convergence between part a and part b. On the other hand when you multiply part a and part b we get the lowest amplitude. From the phase we can see the most changes when we shift x.