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EE111 Section 21

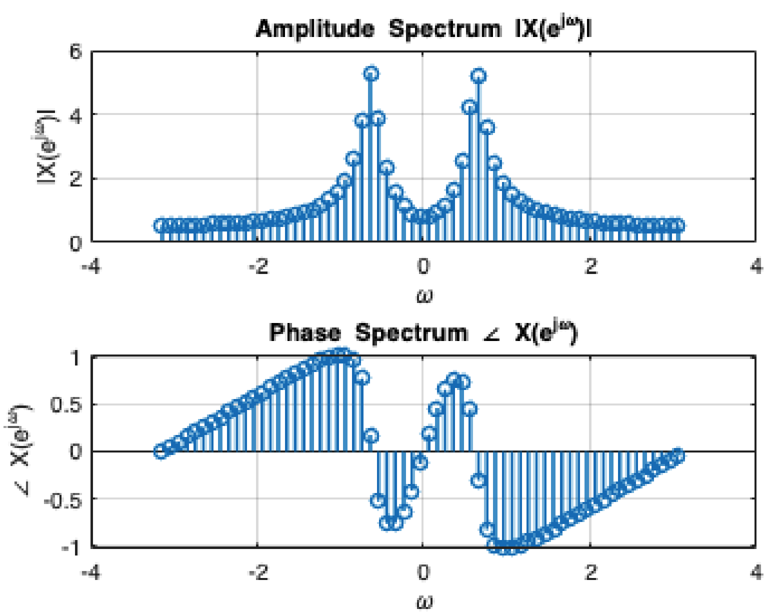
Lab 3

Abstract

The objective of this lab is to analyze and graphically represent both the amplitude spectrum and phase spectrum of specific sequences. This lab will include experimenting with various operations, including amplitude modulation, time shifting, and the application of exponential functions to these sequences.

Procedure

A:

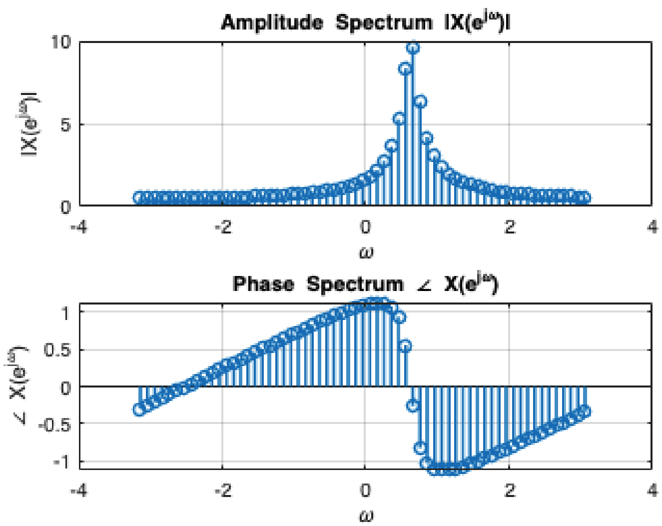


Phase spectrum has a linear relationship with amplitude spectrum. There is also a phase shift in the middle of the graph.

```
X_ejw = 0;

   for n = lower_limit:upper_limit

       x_n = (0.9^n) * cos((pi/5) * n) * (n >= 0); % u[n] is the unit
step function

       X_ejw = X_ejw + x_n * exp(-1j * omega * n);

   end


   % Store amplitude and phase values

   amplitude_spectrum(idx) = abs(X_ejw);
```

```
   phase_spectrum(idx) = angle(X_ejw);
end
```

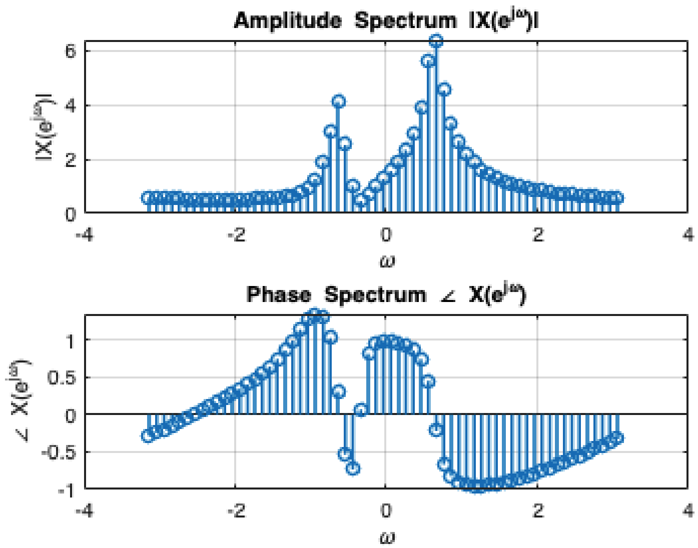
B:



Phase spectrum has a linear relationship with the amplitude spectrum. In this sequence, the system also introduces imaginary parts shown in the second half of the system.

```
X_ejw = 0;
  for n = lower_limit:upper_limit
      x_n = (0.9^n) * exp(j * (pi/5) * n) * (n >= 0); % Incorporating Euler's formula
     X_ejw = X_ejw + x_n * exp(-1j * omega * n);
  end


  % Store amplitude and phase values
  amplitude_spectrum(idx) = abs(X_ejw);
  phase_spectrum(idx) = angle(X_ejw);
```

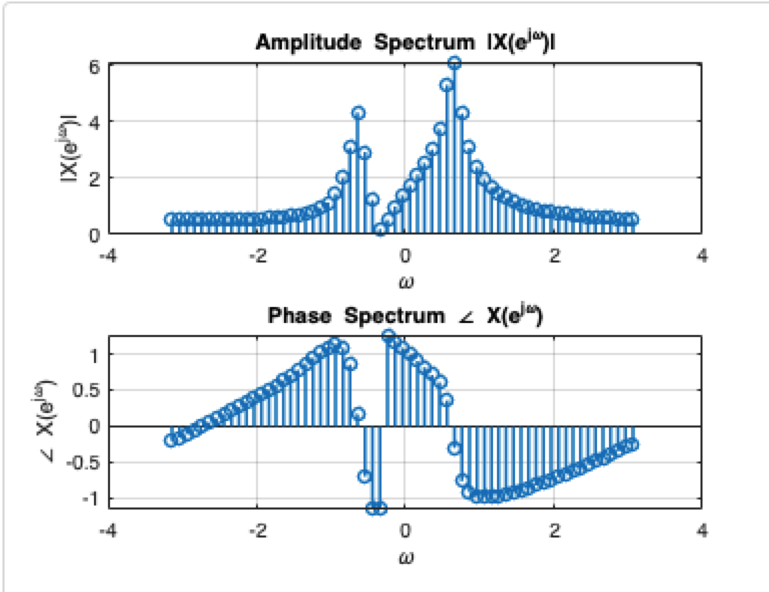
C:



This sequence only adjusts the imaginary part of the system. The phase spectrum also has a linear relationship with the amplitude spectrum.

```
X_ejw = 0;

   for n = lower_limit:upper_limit

      x_n = (0.9^n) * cos((pi/5) * n) * (n >= 0) + j * (0.7^n) *
sin((pi/5) * n) * (n >= 0);

      X_ejw = X_ejw + x_n * exp(-1j * omega * n);

   end


   % Store amplitude and phase values

   amplitude_spectrum(idx) = abs(X_ejw);

   phase_spectrum(idx) = angle(X_ejw);

end
```

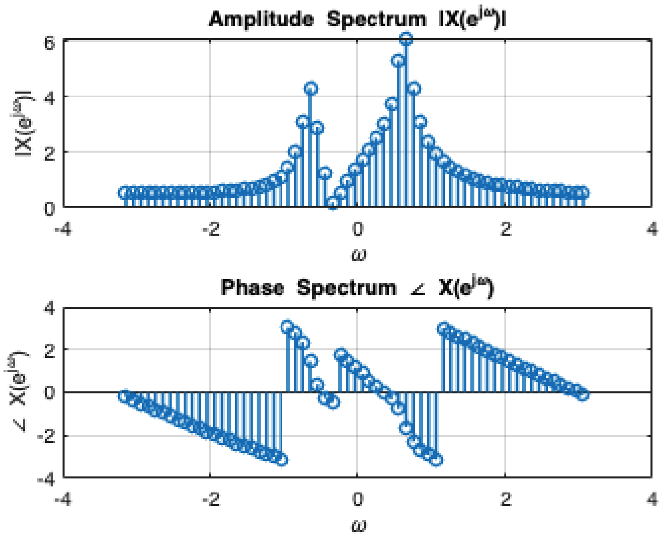
D:



The amplitude spectrum for this sequence is very similar to x3[n] amplitude graph. The only difference is the phase spectrum is adjusted because of the change in the imaginary part of the system.

```
X_ejw = 0;

   for n = lower_limit:upper_limit

       x_n = (0.9^n) * cos((pi/5) * n) * (n >= 0) + j * (0.7^n) *
sin((pi/7) * n) * (n >= 0);

       X_ejw = X_ejw + x_n * exp(-1j * omega * n);

   end


   % Store amplitude and phase values

   amplitude_spectrum(idx) = abs(X_ejw);

   phase_spectrum(idx) = angle(X_ejw);

end
```

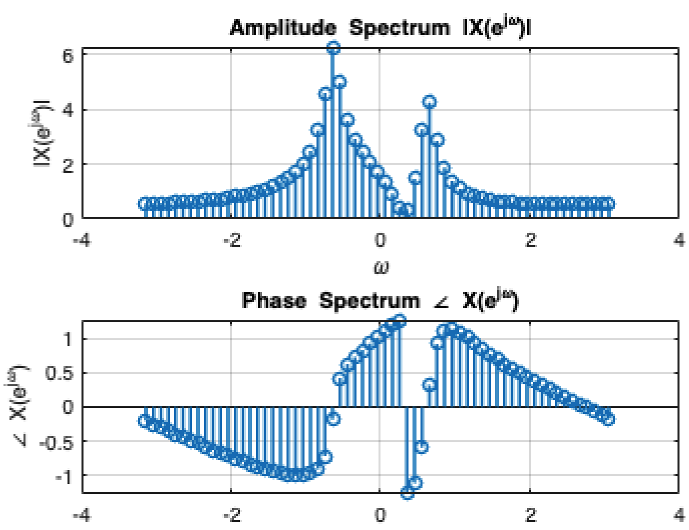
E:



Sequence x4[x] is shifted two units to the right

```
for n = lower_limit:upper_limit

        n_shifted = n - 2;

      x_n = (0.9^n_shifted) * cos((pi/5) * n_shifted) * (n_shifted >=
0) + 1i * (0.7^n_shifted) * sin((pi/7) * n_shifted) * (n_shifted >= 0);

      X_ejw = X_ejw + x_n * exp(-1j * omega * n);

   end
```

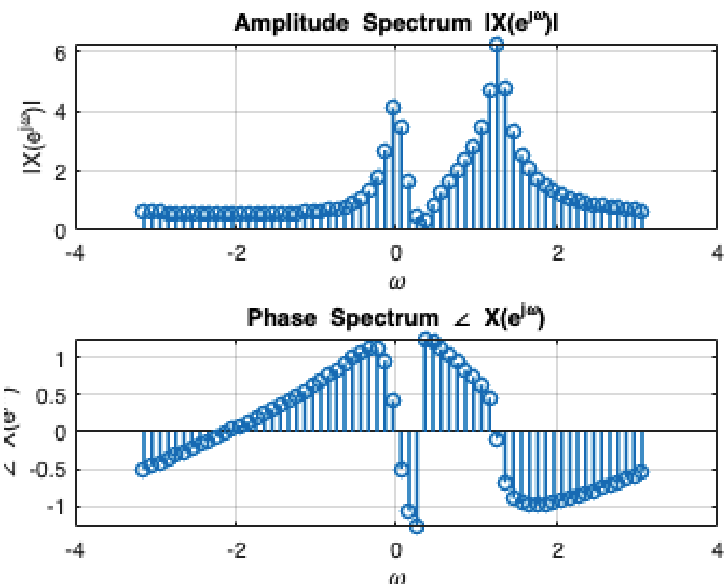
F:



The phase spectrum is indirectly proportional to the amplitude spectrum and its shifted 1 to the right.

```
for n = lower_limit:upper_limit

         n_shifted = -n;

       x_n = (0.9^n_shifted) * cos((pi/5) * n_shifted) * (n_shifted >=
0) + 1i * (0.7^n_shifted) * sin((pi/7) * n_shifted) * (n_shifted >= 0);

       X_ejw = X_ejw + x_n * exp(-1j * omega * n);

   end
```

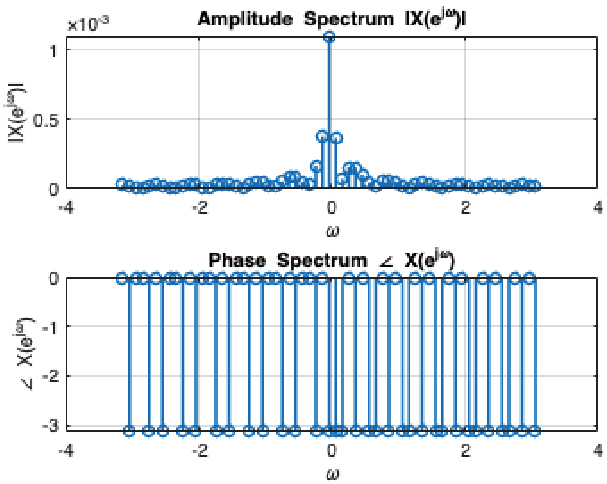
G:



The phase spectrum has a negative time shift.

```
for n = lower_limit:upper_limit

         n_shifted = -n;

        x_n = ((0.9^n) * cos((pi/5) * n) * (n >= 0) + 1i * (0.7^n) *
sin((pi/7) * n) * (n >= 0)) .* exp(1i*2*pi*0.1*n);

       X_ejw = X_ejw + x_n * exp(-1j * omega * n);

end
```

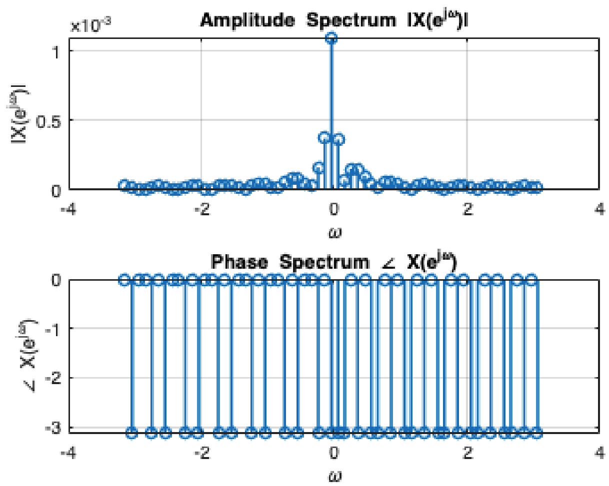
H:



This graph multiplies two sequences which are x1[n] and x4[n].

```
for n = lower_limit:upper_limit

       x1 = (0.9^n) * cos((pi/5) * n) * (n >= 0);

       complex_signal = x1 + 1i * (0.7^n) * sin((pi/7) * n) * (n >= 0);

       X_ejw = X_ejw + x_n * exp(-1j * omega * n);

end
```

I:



We are also multiplying two sequences in this graph.

```
 for n = lower_limit:upper_limit

    x1 = (0.9^n) * cos((pi/5) * n) * (n >= 0);
```

```
    complex_signal = x1 + 1i * (0.7^n) * sin((pi/7) * n) * (n >= 0);

    X_ejw = X_ejw + x_n * exp(-1j * omega * n);

end
```

Discussion/Issues Encountered

During this lab, I had some problems with outputting the graphs, however, after a little troubleshooting, I was able to figure it out.

Conclusion

In this lab we learn how a sequence's amplitude spectrum and a phase spectrum alternate. We also learned how to add imaginary parts to a sequence, perform time shifts, and multiplying sequences on MatLab.