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Task 1: Compute, plot and discuss the discrete-time Fourier transform (DTFT) $X(f) = \sum_{n=-\infty}^{\infty} x[n]\exp(-j2\pi fn)$ of each of the following sequences. For each $X(f)$, plot the amplitude spectrum: $|X(f)|$ versus f, and the phase spectrum: $\angle X(f)$ versus f, for $-1.5 \le f \le 1.5$ with 50 samples per cycle, i.e., $f = \frac{k}{50}$ where k is integer. In your program, you can set the lower and upper limits in the above summation to -100 and 100, respectively.

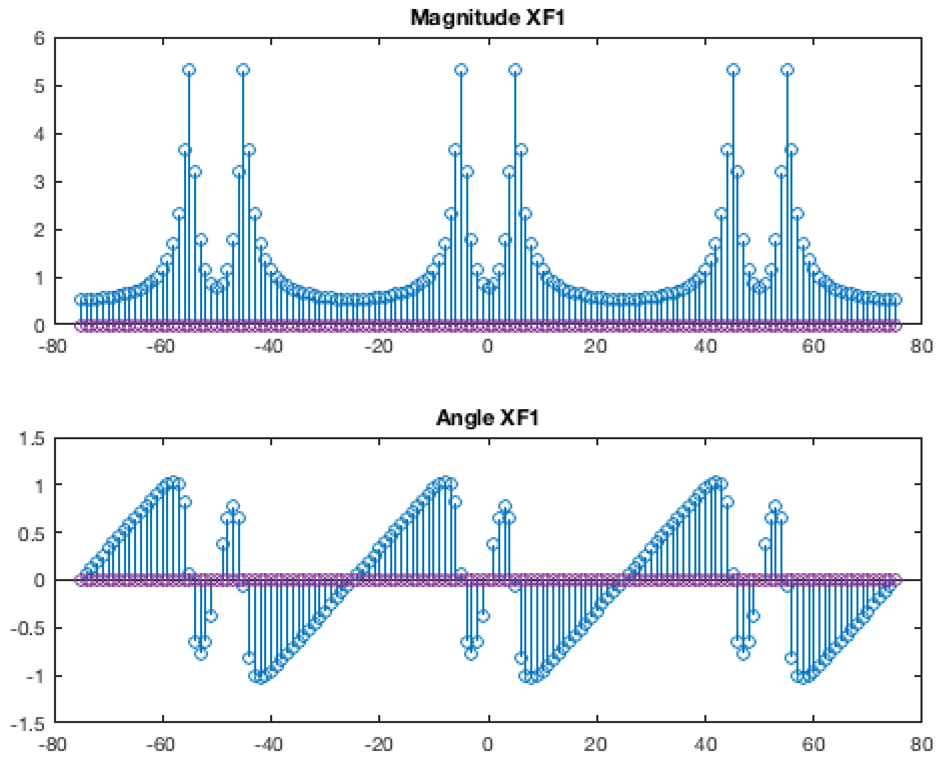
1.a

$$x_1[n] = 0.9^n \cos\left(\frac{\pi}{5}n\right)u[n];$$

```
clear all


n = 0:100;
x1 = 0.9.^n .* cos(pi/5*n); % step function cuts out negative n\
XF1 = zeros(151);
N = 50;
for k = -75:75
   for ll = 0 : 100
       XF1(k+76) = XF1(k+76) + x1(ll+1) * exp(-1j*2*pi*k/N*ll);
   end
end
```

```
figure
subplot(2,1,1)
stem(-75:75,abs(XF1));
title('Magnitude XF1')
subplot(2,1,2)
stem(-75:75,angle(XF1));
title('Angle XF1')
```



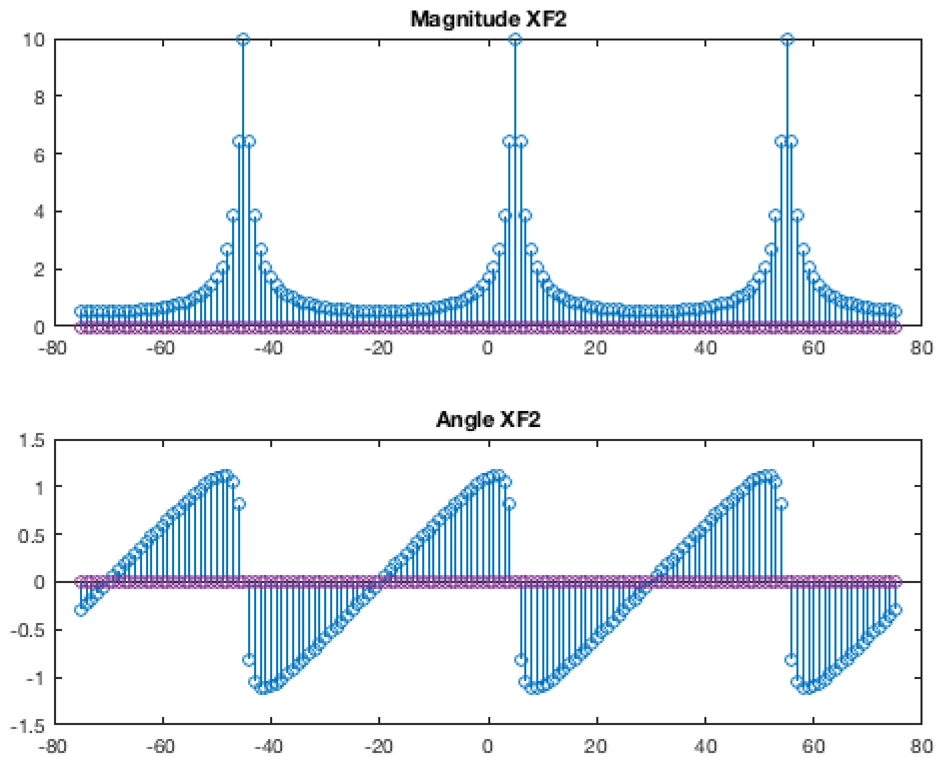
1.b

$$x_2[n] = 0.9^n \cos\left(\frac{\pi}{5}n\right)u[n] + j0.9^n \sin\left(\frac{\pi}{5}n\right)u[n]$$

```
clear all

n = 0:100;
x1 = 0.9.^n .* cos(pi/5*n); % step function cuts out negative n
x2 = 1j.*(0.9 .^n) .* sin(pi/5*n);
XF2 = zeros(151);
N = 50;
for k = -75:75
   for ll = 0 : 100
       XF2(k+76) = XF2(k+76) + (x1(ll+1)+ x2(ll+1)) * exp(-1j*2*pi*k/
N*ll);
```

```
    end
end
figure
subplot(2,1,1)
stem(-75:75,abs(XF2));
title('Magnitude XF2')
subplot(2,1,2)
stem(-75:75,angle(XF2));
title('Angle XF2')
```



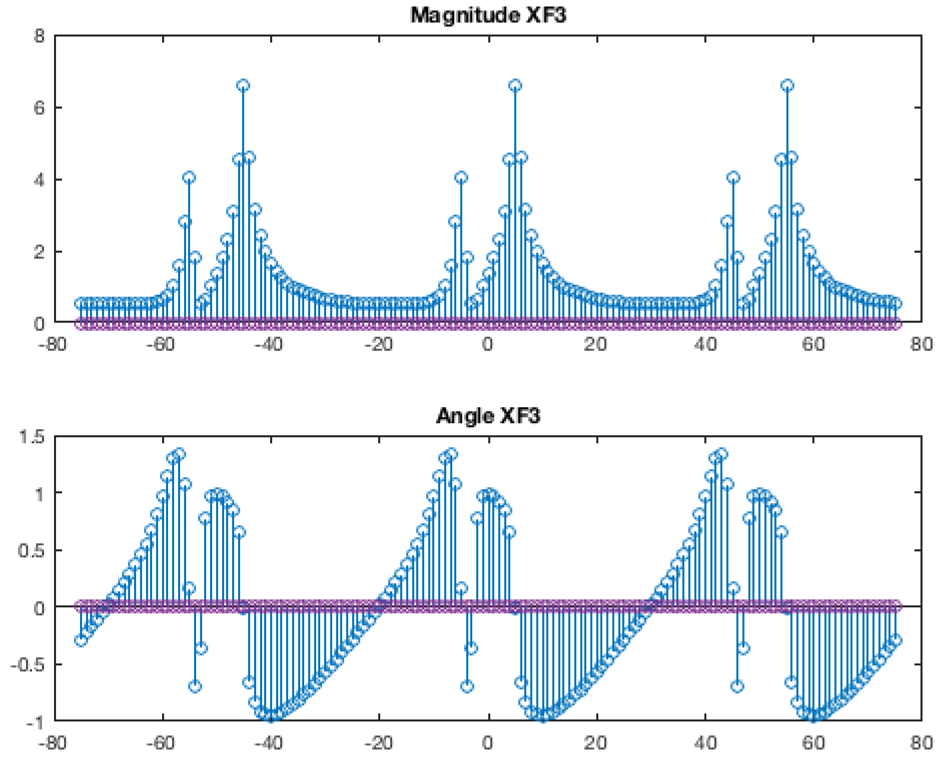
1.c

$$x_3[n] = 0.9^n \cos\left(\frac{\pi}{5}n\right)u[n] + j0.7^n \sin\left(\frac{\pi}{5}n\right)u[n]$$

```
clear all

n = 0:100;
x1 = 0.9.^n .* cos(pi/5*n); % step function cuts out negative n
x3 = 1j.*(0.7 .^n) .* sin(pi/5*n);
XF3 = zeros(151);
N = 50;
for k = -75:75
    for ll = 0 : 100
```

```
        XF3(k+76) = XF3(k+76) + (x1(ll+1)+ x3(ll+1)) * exp(-1j*2*pi*k/
N*ll);
   end
end
figure
subplot(2,1,1)
stem(-75:75,abs(XF3));
title('Magnitude XF3')
subplot(2,1,2)
stem(-75:75,angle(XF3));
title('Angle XF3')
```



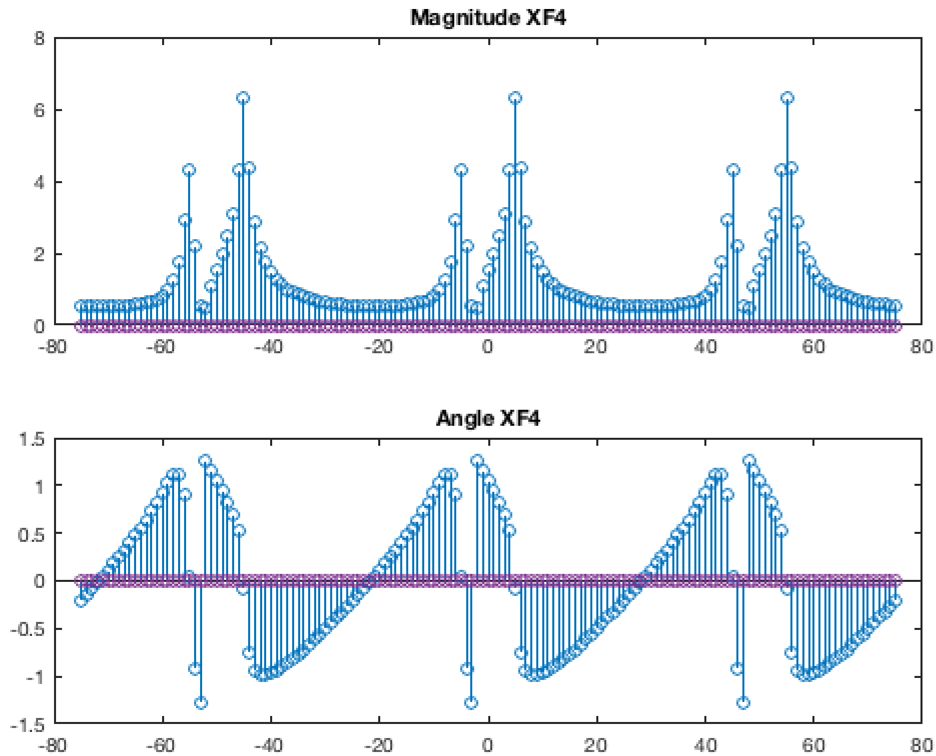
1.d

$$x_4[n] = 0.9^n \cos\left(\frac{\pi}{5}n\right)u[n] + j0.7^n \sin\left(\frac{\pi}{7}n\right)u[n]$$

```
clear all

n = 0:100;
x1 = 0.9.^n .* cos(pi/5*n); % step function cuts out negative n
x4 = 1j.*(0.7 .^n) .* sin(pi/7*n);
x4 = x1 + x4;
XF4 = zeros(151);
```

```
N = 50;
for k = -75:75
   for ll = 0 : 100
        XF4(k+76) = XF4(k+76) + x4(ll+1) * exp(-1j*2*pi*k/N*ll);
   end
end
figure
subplot(2,1,1)
stem(-75:75,abs(XF4));
title('Magnitude XF4')
subplot(2,1,2)
stem(-75:75,angle(XF4));
title('Angle XF4')
```



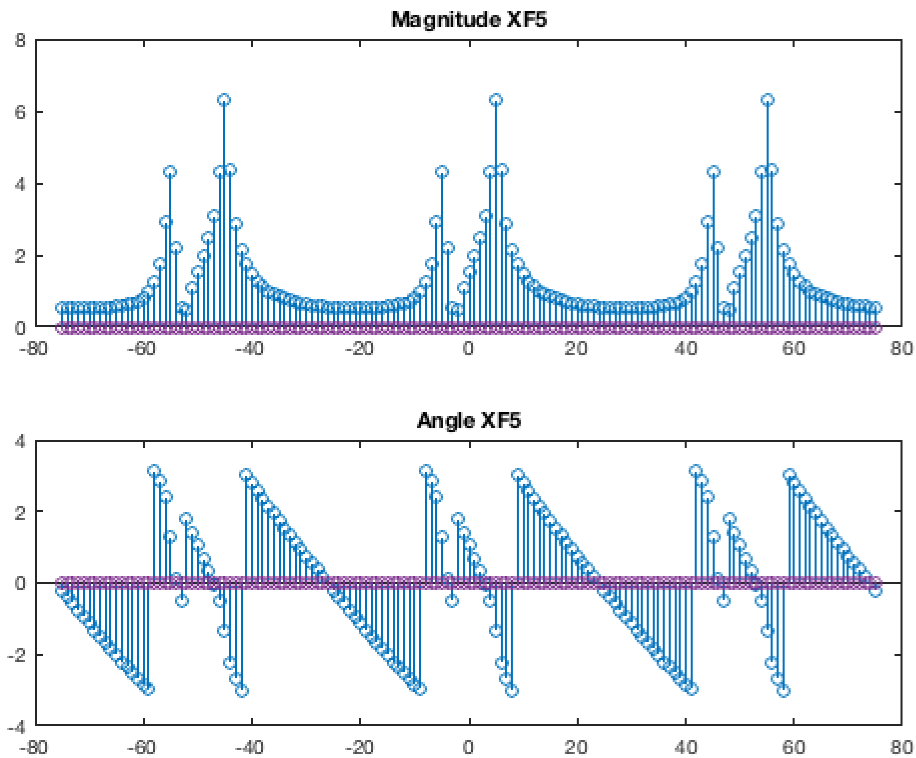
1.e

$$x_5[n] = x_4[n-2]$$

```
clear all

n = 0:100;
x1 = 0.9.^n .* cos(pi/5*n); % step function cuts out negative n
x4 = 1j.*(0.7 .^n) .* sin(pi/7*n);
x4 = x1 + x4;
```

```
x4 = [0 0 x4(1:99)];
XF5 = zeros(151);
N = 50;
for k = -75:75
   for ll = 0 : 100
       XF5(k+76) = XF5(k+76) + x4(ll+1) * exp(-1j*2*pi*k/N*ll);
   end
end
figure
subplot(2,1,1)
stem(-75:75,abs(XF5));
title('Magnitude XF5')
subplot(2,1,2)
stem(-75:75,angle(XF5));
title('Angle XF5')
```



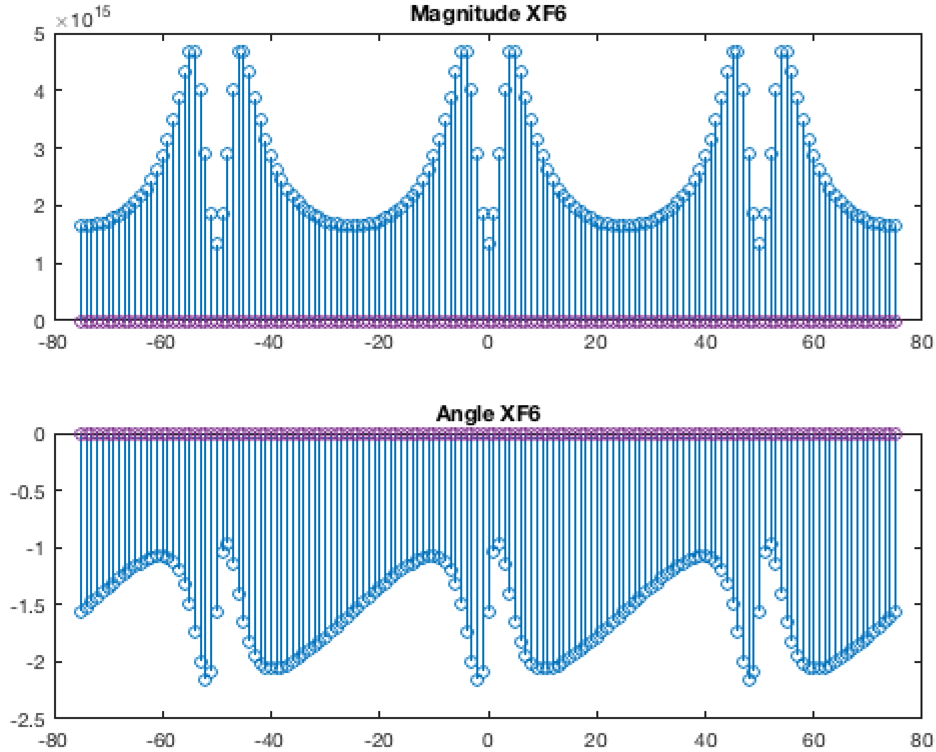
1.f

$$x_6[n] = x_4[-n]$$

```
clear all

n = -100:0;
x1 = 0.9.^n .* cos(pi/5*n); % step function cuts out negative n
```

```
x4 = 1j.*(0.7 .^n) .* sin(pi/7*n);
x4 = x1 + x4;
XF6 = zeros(151);
N = 50;
for k = -75:75
   for ll = 0 : 100
       XF6(k+76) = XF6(k+76) + x4(ll+1) * exp(-1j*2*pi*k/N*ll);
   end
end
figure
subplot(2,1,1)
stem(-75:75,abs(XF6));
title('Magnitude XF6')
subplot(2,1,2)
stem(-75:75,angle(XF6));
title('Angle XF6')
```



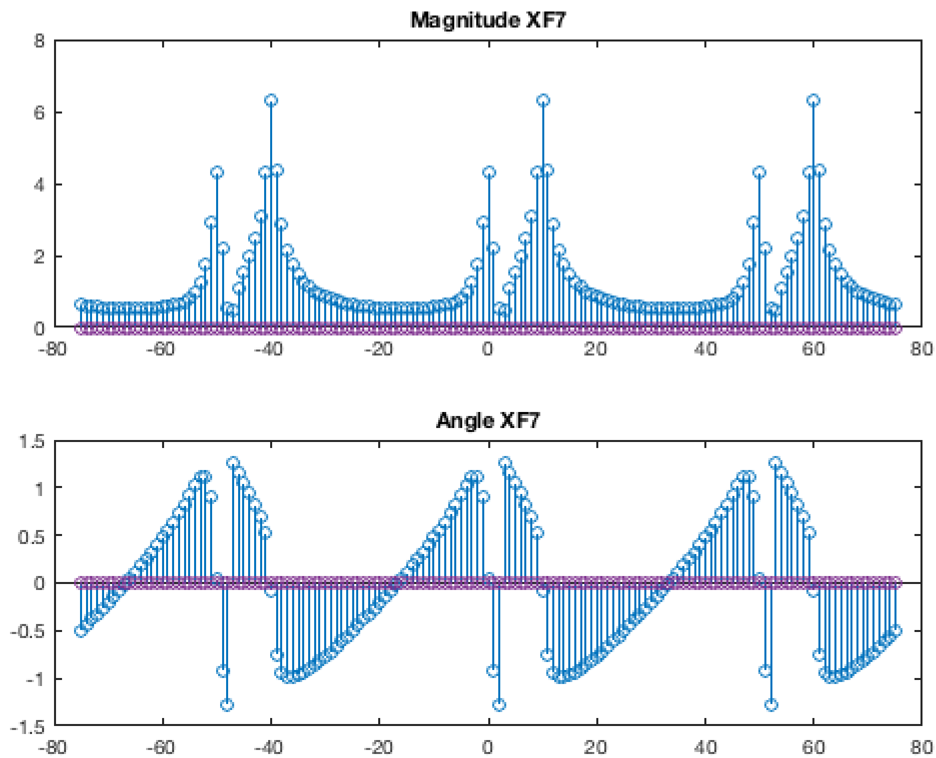
1.g

$$x_7[n] = x_4[n]\exp\left(j2\pi 0.1n\right)$$

```
clear all

n = 0:100;
x1 = 0.9.^n .* cos(pi/5*n); % step function cuts out negative n
```

```
x4 = 1j.*(0.7 .^n) .* sin(pi/7*n);
x4 = x1 + x4;
x4 = x4 .* exp(1j*2*pi*0.1*n);
XF7 = zeros(151);
N = 50;
for k = -75:75
   for ll = 0 : 100
       XF7(k+76) = XF7(k+76) + x4(ll+1) * exp(-1j*2*pi*k/N*ll);
   end
end
figure
subplot(2,1,1)
stem(-75:75,abs(XF7));
title('Magnitude XF7')
subplot(2,1,2)
stem(-75:75,angle(XF7));
title('Angle XF7')
```



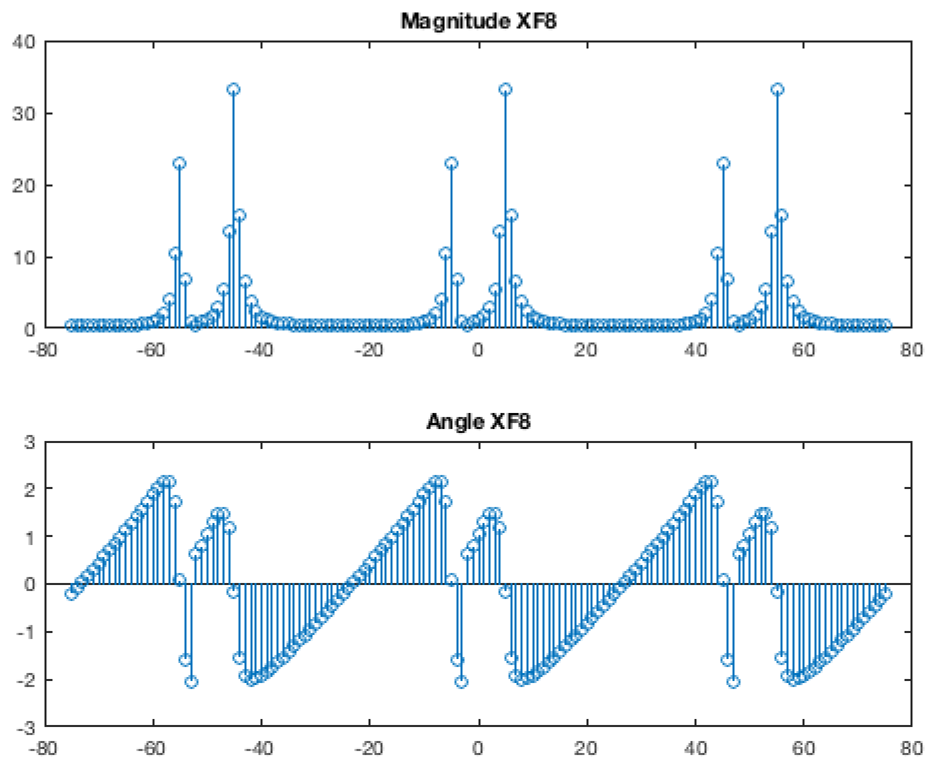
1.h

$$x_8[n] = x_1[n] * x_4[n]$$

```
clear all

n = 0:100;
```

```
x1 = 0.9.^n .* cos(pi/5*n); % step function cuts out negative n
x4 = 1j.*(0.7 .^n) .* sin(pi/7*n);
x4 = x1 + x4;
x8 = conv(x1,x4);
XF8 = zeros(151);
N = 50;
for k = -75:75
   for ll = 0 : 100
       XF8(k+76) = XF8(k+76) + x8(ll+1) * exp(-1j*2*pi*k/N*ll);
   end
end
figure
subplot(2,1,1)
stem(-75:75,abs(XF8(1:151)));
title('Magnitude XF8')
subplot(2,1,2)
stem(-75:75,angle(XF8(1:151)));
title('Angle XF8')
```

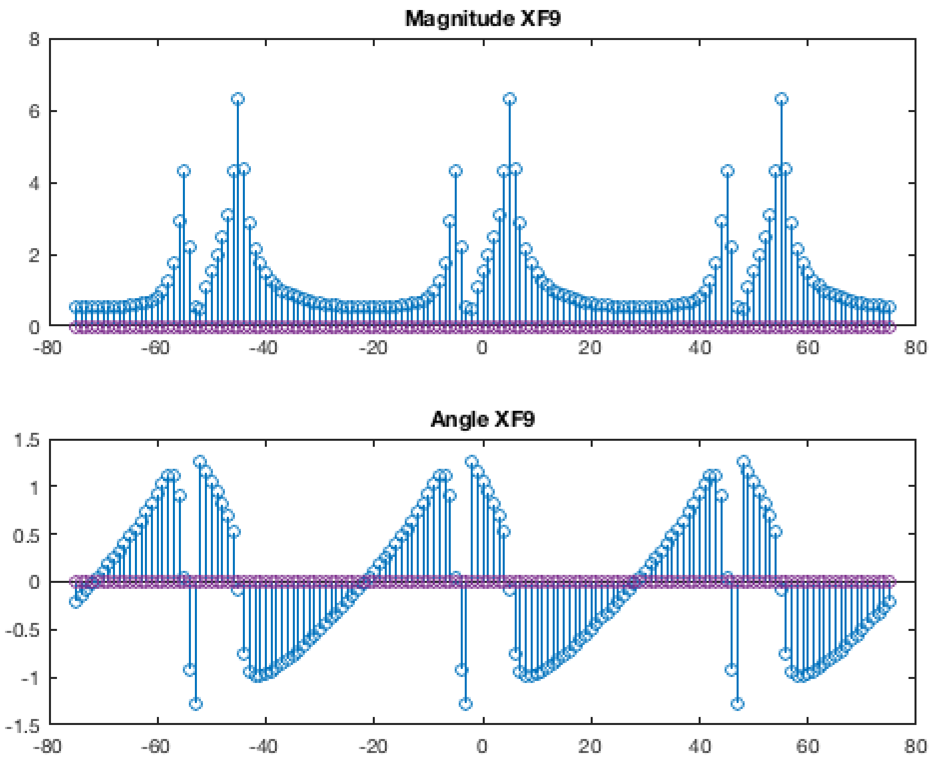


1.i

$$x_9[n] = x_1[n]x_4[n]$$

```
clear all
```

```
n = 0:100;
x1 = 0.9.^n .* cos(pi/5*n); % step function cuts out negative n
x4 = 1j.*(0.7 .^n) .* sin(pi/7*n);
x4 = x1 + x4;
x9 = x1 .* x4;
XF9 = zeros(151);
N = 50;
for k = -75:75
   for ll = 0 : 100
       XF9(k+76) = XF9(k+76) + x4(ll+1) * exp(-1j*2*pi*k/N*ll);
   end
end
figure
subplot(2,1,1)
stem(-75:75,abs(XF9));
title('Magnitude XF9')
subplot(2,1,2)
stem(-75:75,angle(XF9));
title('Angle XF9')
```



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