
# Advances in Digital Signal Processing

## ---Matlab Exercise

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# 主观题 10分

设置

Please plot the Fourier series coefficients for

$$x(t) = 1 + \sin(\Omega_0 t) + 2\cos(\Omega_0 t) + \cos(3\Omega_0 t + \pi/4)$$

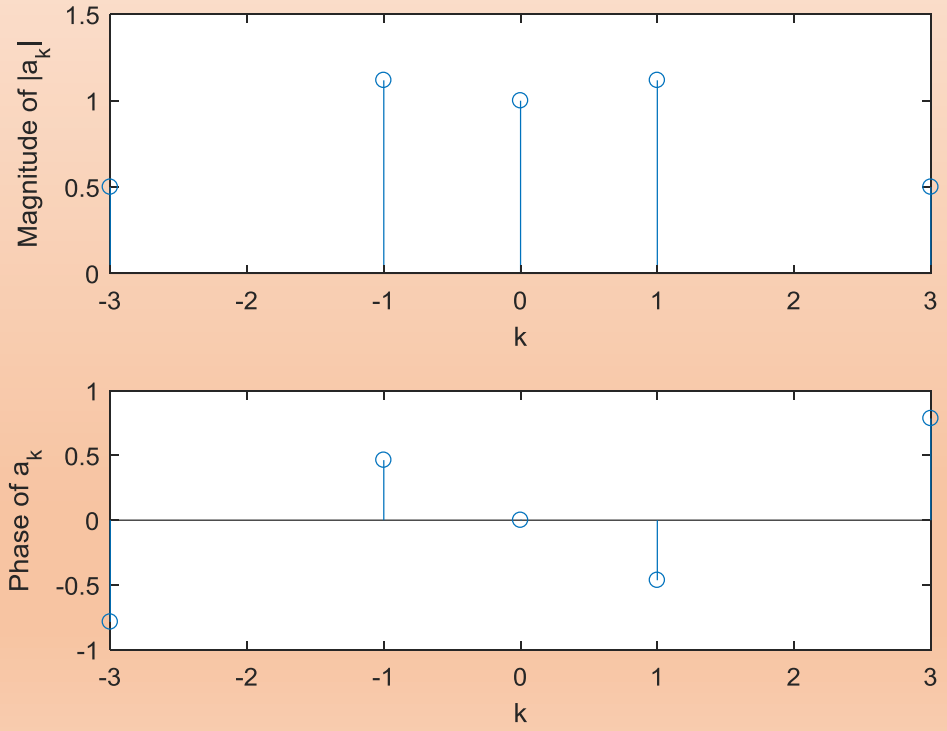
which is

$$a_k = \begin{cases} \frac{\sqrt{2}}{4}(1-j), & k = -3 \\ 1 + \frac{j}{2}, & k = -1 \\ 1, & k = 0 \\ 1 - \frac{j}{2}, & k = 1 \\ \frac{\sqrt{2}}{4}(1+j), & k = 3 \\ 0, & \text{otherwise} \end{cases}$$

作答

# Answer:

```
k=[-3 -1 0 1 3];
a_k=[sqrt(2)/4*(1-j)  1+j/2 1 1-j/2 sqrt(2)/4*(1+j)];
figure
subplot(211)
stem(k,abs(a_k)),hold on
xlabel('k')
ylabel('Magnitude of |a_k|')
subplot(212)
stem(k,phase(a_k)),hold on
xlabel('k')
ylabel('Phase of a_k')
```



# Homework

Find the Fourier series coefficients for $x(t)$, which is a periodic continuous-time signal of fundamental period $T$ and is a pulse with a width of $2T_0$ in each period. Over the specific period from $-T/2$ to $T/2$, $x(t)$ is:

$$x(t) = \begin{cases} 1, & -T_0 < t < T_0 \\ 0, & \text{otherwise} \end{cases}$$

with $T > 2T_0$.

For $k = 0$:

$$a_0 = \frac{1}{T}\int_{-T_0}^{T_0} 1dt = \frac{2T_0}{T}$$

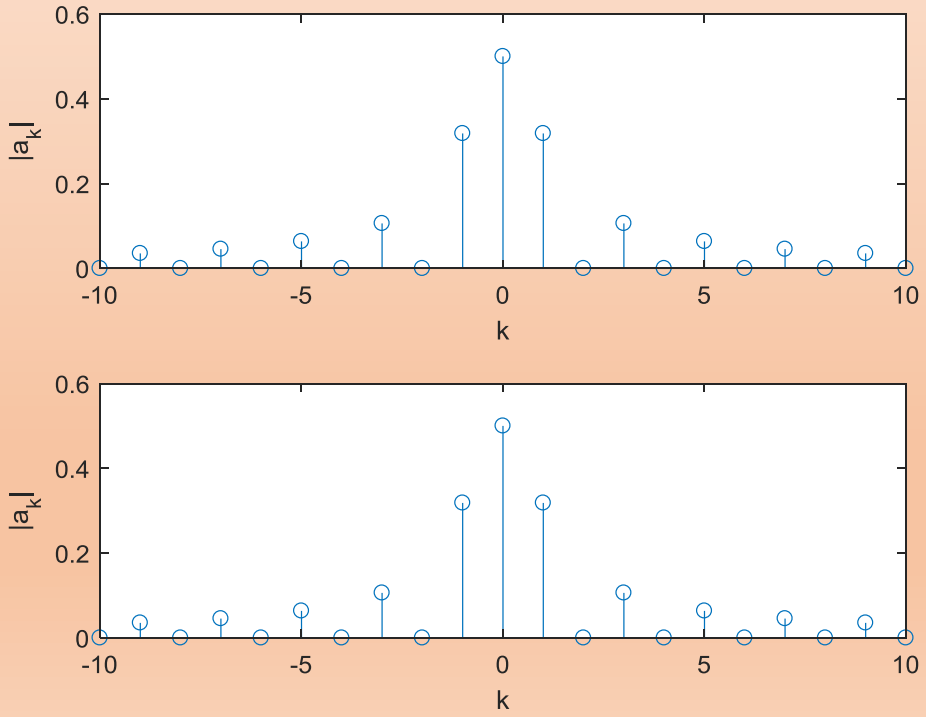
For $k \neq 0$:

$$a_k = \frac{1}{T}\int_{-T_0}^{T_0} e^{-jk\Omega_0 t}dt = -\frac{1}{jk\Omega_0 T}e^{-jk\Omega_0 t}\Big|_{-T_0}^{T_0} = \frac{\sin(k\Omega_0 T_0)}{k\pi} = \frac{\sin\left(2\pi k T_0/T\right)}{k\pi}$$

# Matlab

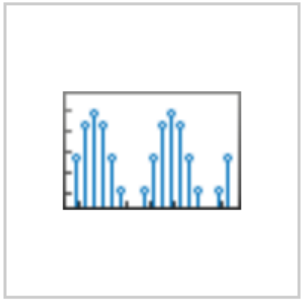
$$\mathrm{sinc}(u) = \frac{\sin(\pi u)}{\pi u}$$

```
T = 20;
T_0= 5;

k=-10:1:10;
a_k = sin(2*pi*k*T_0/T)./(k*pi);
a_k(11)=2*T_0/T;

subplot(211)
stem(k,abs(a_k)),hold on
xlabel('k');
ylabel('|a_k|')

a_k=2*T_0/T*sinc(2*k*T_0/T);
subplot(212)
stem(k,abs(a_k)),hold on
xlabel('k');
ylabel('|a_k|')
```



# stem

Plot discrete sequence data

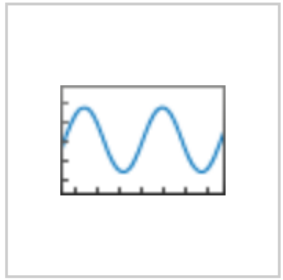


## Syntax

```
stem(Y)
stem(X,Y)
stem( __ ,"filled")
stem( __ ,LineSpec)

stem(tbl,yvar)
stem(tbl,xvar,yvar)

stem( __ ,Name,Value)
stem(ax, __ )
h = stem( __ )
```

# plot

2-D line plot



## Syntax

```
plot(X,Y)
plot(X,Y,LineSpec)
plot(X1,Y1,...,Xn,Yn)
plot(X1,Y1,LineSpec1,...,Xn,Yn,LineSpecn)
plot(Y)
plot(Y,LineSpec)

plot(tbl,xvar,yvar)
plot(tbl,yvar)

plot(ax, __ )
plot( __ ,Name,Value)
p = plot( __ )
```

Example 2.5

Find the inverse Fourier transform of $X(j\Omega)$ which is a rectangular pulse of the form:

$$X(j\Omega) = \begin{cases} 1, & -W_0 < \Omega < W_0 \\ 0, & \text{otherwise} \end{cases}$$

Using (2.9), we get:

$$x(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} X(j\Omega)e^{j\Omega t}d\Omega = \frac{1}{2\pi}\int_{-W_0}^{W_0} e^{j\Omega t}d\Omega = \frac{\sin(W_0 t)}{\pi t}$$

$$= \frac{W_0}{\pi}\text{sinc}\left(\frac{W_0 t}{\pi}\right)$$

# Matlab

```
W_0= 0.2*pi;
T = 20;
dt = 0.1;
t=-T:dt:T;

x=2*W_0/pi*sinc(W_0*t/pi);

plot(t,x),hold on
xlabel('t');
ylabel('|x|')
```