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# Lab 10

## PRE-LAB

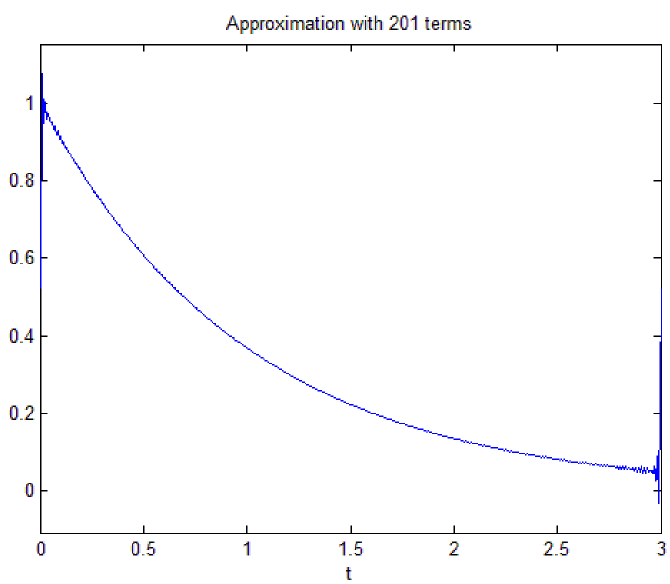
TASK 1:

expand in trigonometric Fourier series the signal $x(t) = e^{-t}, 0 \le t \le 3$.

ANSWER:

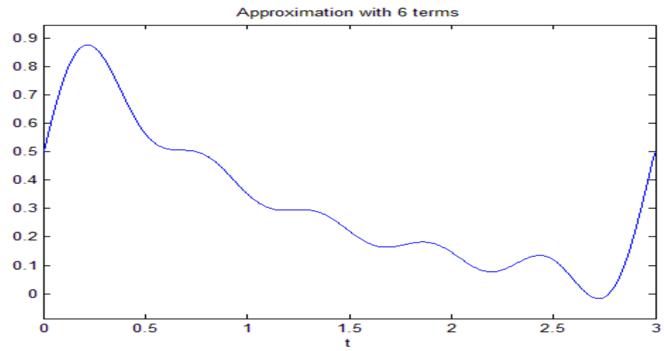
```
T=3;
t0=0;
w=2*pi/T;
syms t
x=exp(-t);

a0=(1/T)*int(x,t,t0,t0+T);
for n=1:200
b(n)=(2/T)*int(x*cos(n*w*t),t,t0,t0+T);
end
for n=1:200
c(n)=(2/T)*int(x*sin(n*w*t),t,t0,t0+T);
end
k=1:200;
xx=a0+sum(b.*cos(k*w*t))+sum(c.*sin(k*w*t))
ezplot(xx, [t0 t0+T]);
title('Approximation with 201 terms')
```

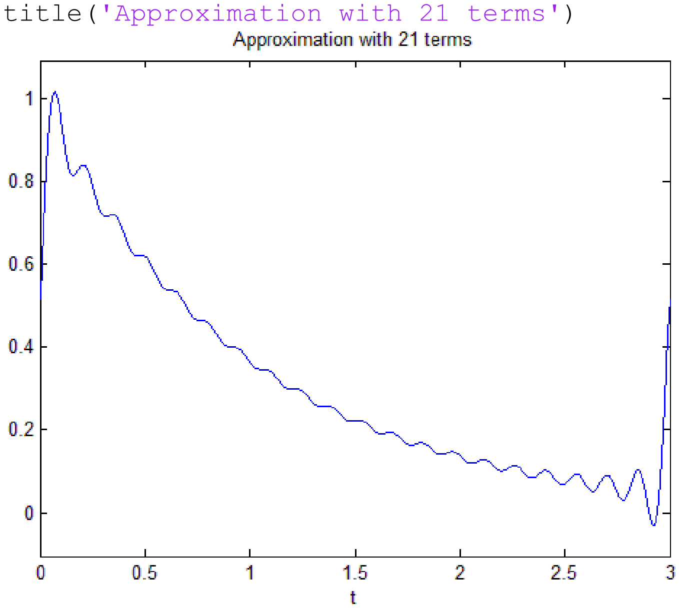



```
for n=1:5
b(n)=(2/T)*int(x*cos(n*w*t),t,t0,t0+T);
c(n)=(2/T)*int(x*sin(n*w*t),t,t0,t0+T);
```

```
end
k=1:5;
xx=a0+sum(b.*cos(k*w*t))+sum(c.*sin(k*w*t))
ezplot(xx, [t0 t0+T]);
title('Approximation with 6 terms')
```




```
for n=1:20
b(n)=(2/T)*int(x*cos(n*w*t),t,t0,t0+T);
c(n)=(2/T)*int(x*sin(n*w*t),t,t0,t0+T);
end
k=1:20;
xx=a0+sum(b.*cos(k*w*t)) +sum(c.*sin(k*w*t));
ezplot(xx, [t0 t0+T]);
title('Approximation with 21 terms')
```



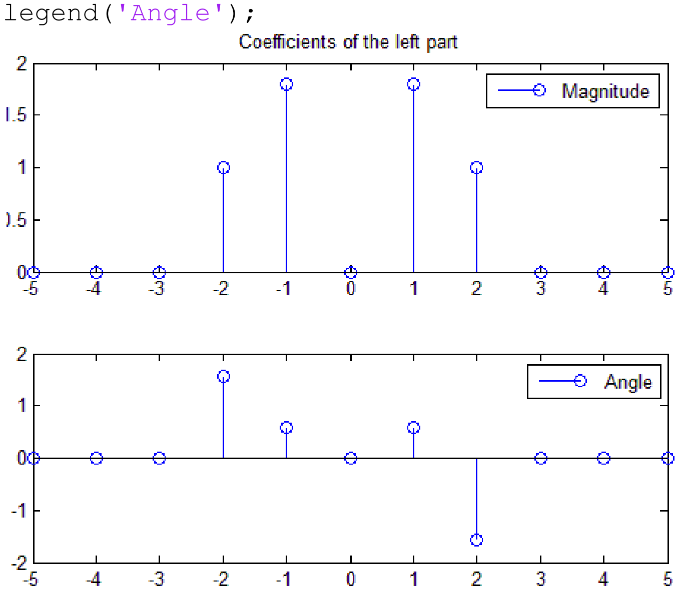

## TASK 2:

To verify the linearity property, we consider the periodic signals $x(t) = \cos(t)$, $y(t) = \sin(2t)$ and the scalars $z_1 = 3 + 2i$ and $z_2 = 2$.

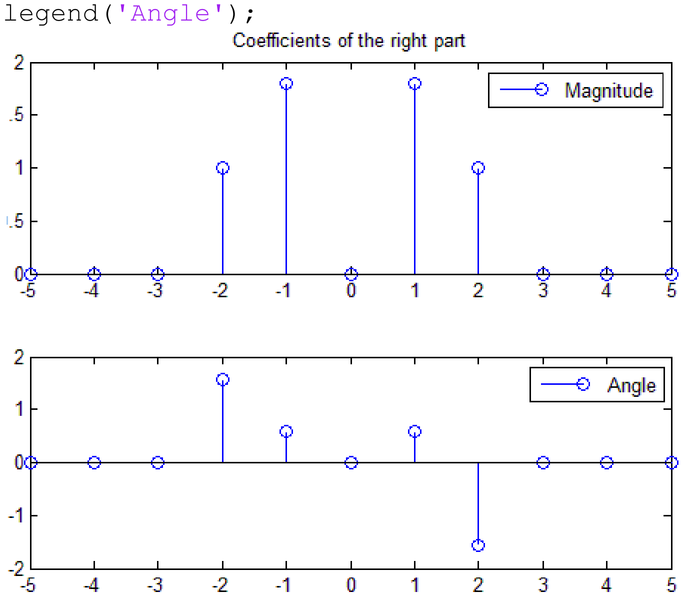
## ANSWER:

```
t0=0;
T=2*pi;
w=2*pi/T;
syms t
z1=3+2i; z2=2;
x=cos(t); y=sin(2*t);
```

```
f=z1*x+z2*y;
k=-5:5;
left=(1/T)*int(f*exp(-j*k*w*t),t,t0,t0+T);
left=eval(left);
subplot(211);
stem(k,abs(left));
legend('Magnitude');
title('Coefficients of the left part');
subplot(212);
stem(k,angle(left));
legend('Angle');
```




```
a=(1/T)*int(x*exp(-j*k*w*t),t,t0,t0+T);
b=(1/T)*int(y*exp(-j*k*w*t),t,t0,t0+T);
right=z1*a+z2*b;
subplot(211);
right=eval(right);
stem(k,abs(right));
legend('Magnitude');
title('Coefficients of the right part');
subplot(212);
stem(k,angle(right));
legend('Angle');
```

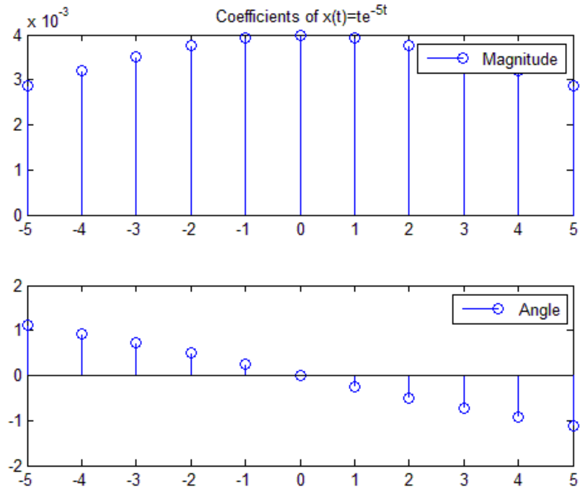



TASK 3:

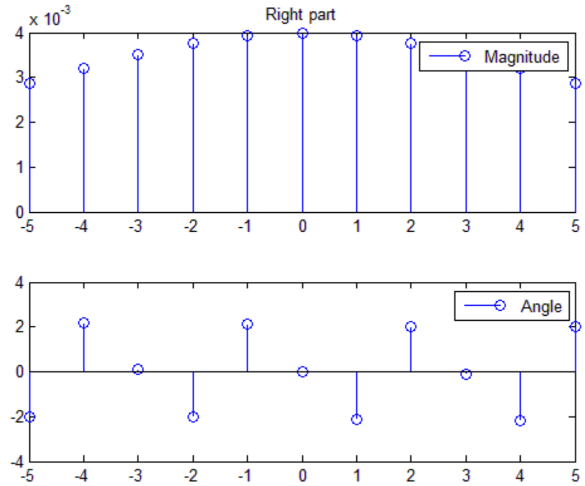
In order to verify time shifting property, we consider the periodic signal that in one period is given by $x(t) = te^{-5t}, 0 \le t \le 10$. Moreover, we set $t_1 = 3$. Consequently the signal $x(t-t_1)$ is given by $x(t-t_1) = x(t-3) = (t-3)e^{-5(t-3)}$.

ANSWER:

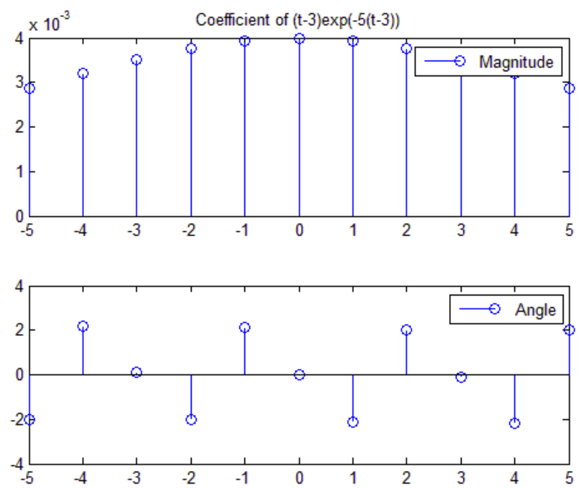
```
t0=0;
T=10;
w=2*pi/T;
syms t
x=t*exp(-5*t)
k=-5:5;
a=(1/T)*int(x*exp(-j*k*w*t),t,t0,t0+T);
a1=eval(a);
subplot(211);
stem(k,abs(a1));
title(' Coefficients of x(t)=te^-^5^t');
legend('Magnitude');
subplot(212);
stem(k,angle(a1));
legend('Angle');
```




```
t1=3;
right= exp(-j*k*w*t1).*a;
right =eval(right);
subplot(211);
stem(k,abs(right));
legend('Magnitude');
title('Right part');
subplot(212);
stem(k,angle(right));
legend('Angle');
```




```
x=(t-t1).*exp(-5*(t-t1));
a=(1/T)*int(x*exp(-j*k*w*t),t,t0+t1,t0+T+t1);
coe=eval(a);
subplot(211);
stem(k,abs(coe));
legend('Magnitude');
title(' Coefficient of (t-3)exp(-5(t-3)) ');
subplot(212);
stem(k,angle(coe));
legend('Angle');
```

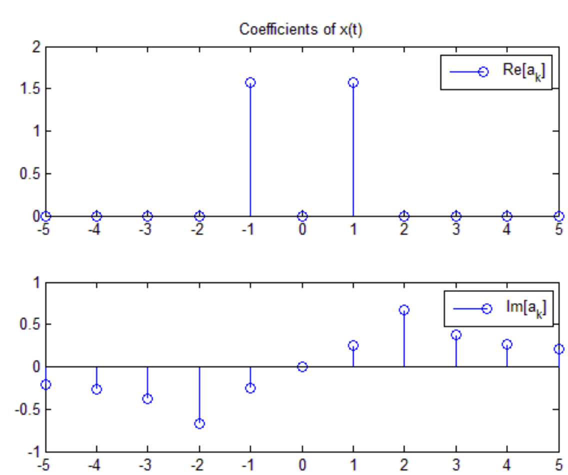



## TASK 4:

In order to validate the time reversal property, we consider the periodic signal that in one period is given by $x(t) = t\cos(t), 0 \le t \le 2\pi$ .

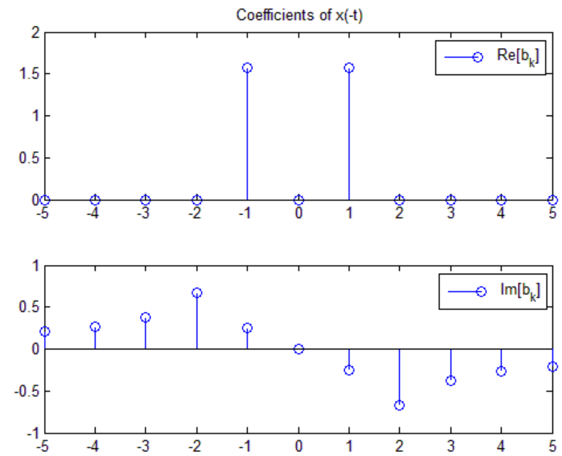
## ANSWER:

```
t0=0;
T=2*pi;
w=2*pi/T;
syms t
x=t*cos(t) ;
k=-5:5;
a=(1/T)*int(x*exp(-j*k*w*t),t,t0,t0+T);
a1=eval(a);
subplot(211);
stem(k,real(a1));
legend('Re[a_k]');
title('Coefficients of x(t)');
```



```
subplot(212);
stem(k,imag (a1));
legend('Im[a_k]');

x_=-t*cos(-t) ;
b=(1/T)*int(x_*exp(-j*k*w*t),t,t0-T,t0);
b1=eval(b)
subplot(211);
stem(k,real(b1));
legend('Re[b_k]');
title(' Coefficients of x(-t)');
subplot(212);
stem(k,imag (b1));
legend('Im[b_k]');
```



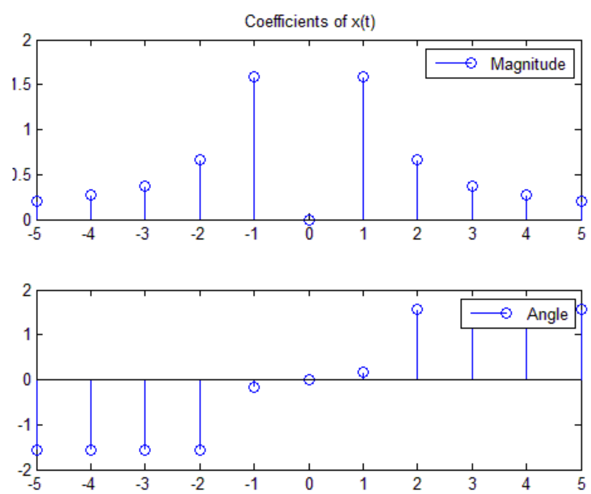

## TASK 5:

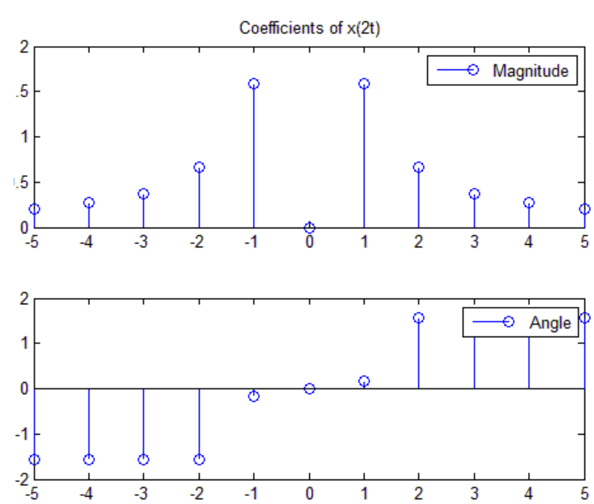
The time scaling property is confirmed by using the periodic signal that in one period is given by $x(t) = t\cos(t), 0 \le t \le 2\pi$ .

## ANSWER:

```
syms t
t0=0;
T=2*pi;
w=2*pi/T;
x=t*cos(t) ;
k=-5:5;
a=(1/T)*int(x*exp(-j*k*w*t),t,t0,t0+T);
a1=eval(a)
subplot(211);
stem(k,abs(a1));
legend('Magnitude');
title(' Coefficients of x(t)');
subplot(212);
stem(k,angle(a1));
legend('Angle');

lamda=2;
T=T/ lamda ;
w=2*pi/T;
x= lamda *t*cos(lamda *t) ;
k=-5:5;
a=(1/T)*int(x*exp(-j*k*w*t),t,t0,t0+T);
a1=eval(a)
subplot(211);
stem(k,abs(a1));
legend('Magnitude');
title(' Coefficients of x(2t)');
subplot(212);
stem(k,angle(a1));
legend('Angle');
```



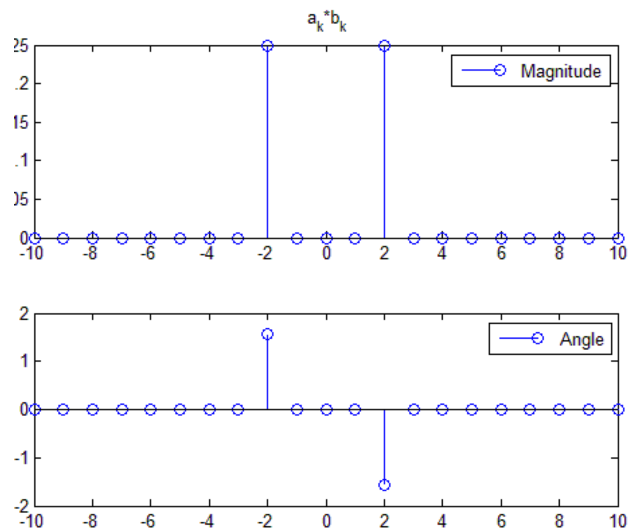
## TASK 6:

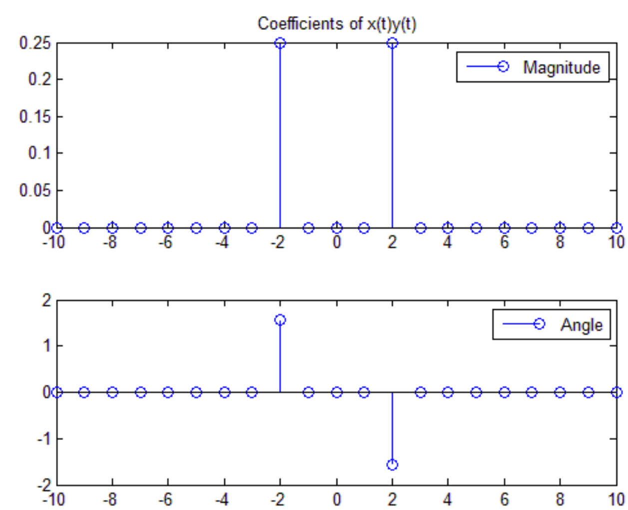
To verify property 10.6, we consider the signals $x(t) = \cos(t)$ and $y(t) = \sin(t)$.

## ANSWER:

```
syms t
t0=0;
T=2*pi;
w=2*pi/T;
x=cos(t) ;
k=-5:5;
a=(1/T)*int(x*exp(-j*k*w*t),t,t0,t0+T);
a1=eval(a);
y=sin(t);
b=(1/T)*int(y*exp(-j*k*w*t),t,t0,t0+T);
b1=eval(b);
left=conv(a1,b1);
subplot(211);
stem(-10:10,abs(left));
legend('Magnitude');
title(' a_k*b_k');
subplot(212);
stem(-10:10,angle(left));
legend('Angle');

z=x*y;
k=-10:10;
c=(1/T)*int(z*exp(-j*k*w*t),t,t0,t0+T);
c1=eval(c)
subplot(211);
stem(k,abs(c1));
legend('Magnitude');
title(' Coefficients of x(t)y(t)');
subplot(212);
stem(k,angle(c1));
legend('Angle');
```

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