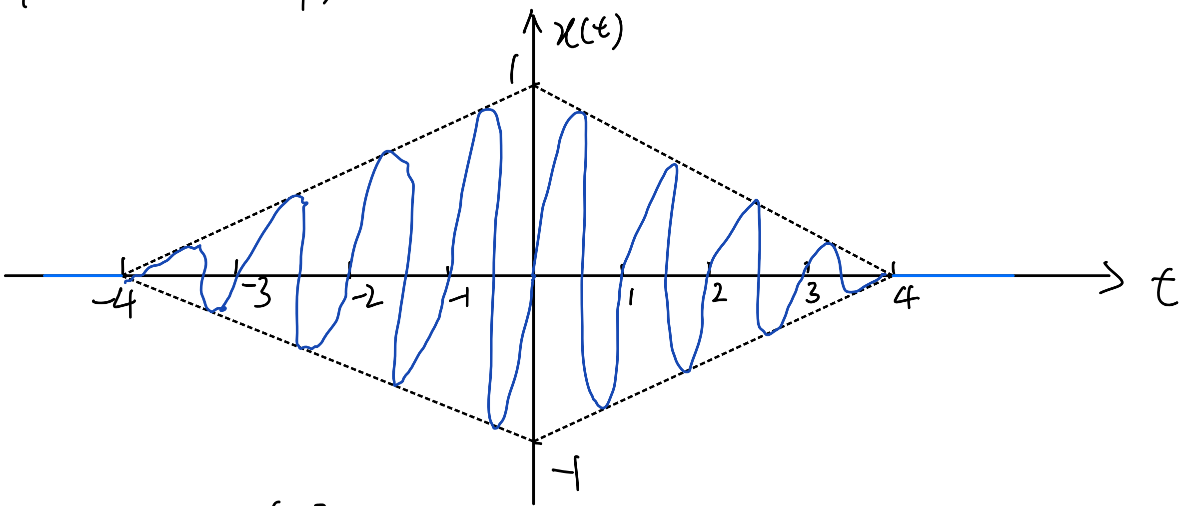
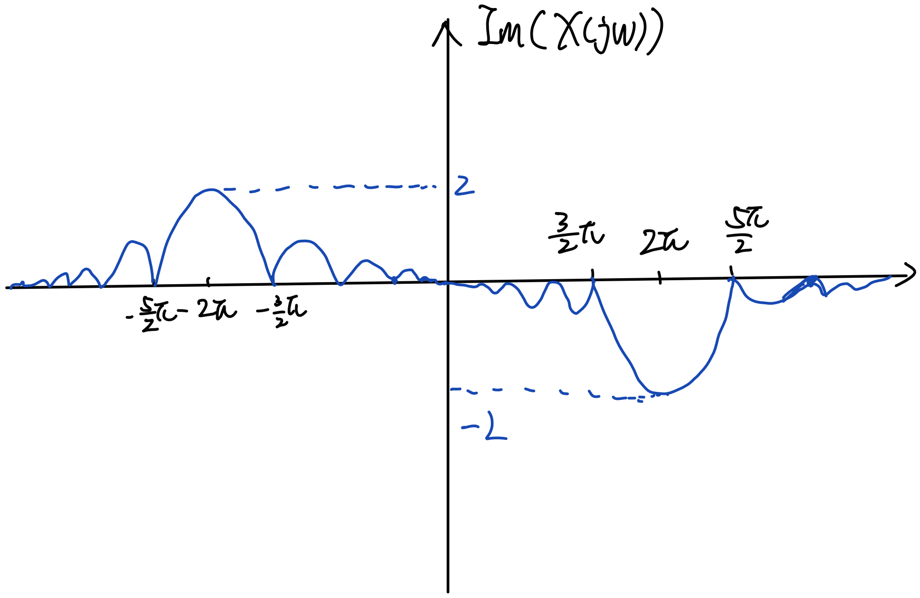
1.(a) $x(t) = \Lambda\left(\frac{t}{4}\right)\sin(2\pi t)$



$X_1(j\omega) = \mathcal{F}\left\{\Lambda\left(\frac{t}{4}\right)\right\} = 4\,\mathrm{sinc}^2\left(\frac{2\omega}{\pi}\right)$

$X(j\omega) = \mathcal{F}\left\{\Lambda\left(\frac{t}{4}\right)\sin(2\pi t)\right\} = \frac{j}{2}\left(4\,\mathrm{sinc}^2\left(\frac{2(\omega+2\pi)}{\pi}\right) - 4\,\mathrm{sinc}^2\left(\frac{2(\omega-2\pi)}{\pi}\right)\right)$

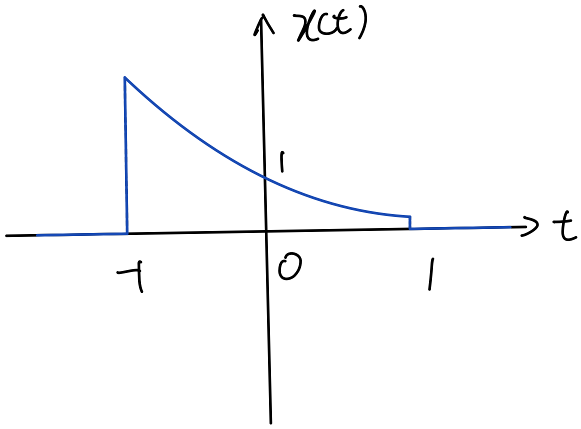
$= j\left[2\,\mathrm{sinc}^2\left(\frac{2(\omega+2\pi)}{\pi}\right) - 2\,\mathrm{sinc}^2\left(\frac{2(\omega-2\pi)}{\pi}\right)\right]$



$x(t)$: real & odd

$X(j\omega)$: imaginary & odd.

(b)



$$x(t) = e^{-t}(u(t+1) - u(t-1))$$
$$= e \cdot e^{-(t+1)} u(t+1) - e^{-(t-1)} u(t-1) \cdot e^{-1}$$
$$X(jw) = e \cdot e^{jw} \cdot \left(\frac{1}{1+jw}\right) - \frac{1}{e} \cdot e^{-jw}\left(\frac{1}{1+jw}\right)$$
$$= (e^{jw+1} - e^{-jw-1})\left(\frac{1}{1+jw}\right) = \frac{e^{jw+1} - e^{-jw-1}}{1+jw}$$

$x(t)$ real, $X(jw)$ has conjugate symetry.

2.(a.) $X_1(jw) = |X_1(jw)| e^{j\pi}$

$$= \Pi\left(\frac{w}{2\pi}\right) e^{j\pi}$$

$$x(t) = e^{j\pi} \operatorname{sinc}(t) = -\operatorname{sinc}(t).$$

$x_1(t)$ real & even

$X_1(jw)$ real & even

(b) $X_2(j\omega) = |X_2(j\omega)| e^{j\cdot\angle X_2(j\omega)}$

$$= \Pi\left(\frac{\omega+\frac{\pi}{2}}{\pi}\right)\cdot e^{j\frac{\pi}{2}} + \Pi\left(\frac{\omega-\frac{\pi}{2}}{\pi}\right) e^{-j\frac{\pi}{2}}$$

$$x(t) = \frac{1}{2}\operatorname{sinc}\left(\frac{t}{2}\right)\cdot e^{-j\frac{\pi}{2}t}\cdot e^{j\frac{\pi}{2}} + \frac{1}{2}\operatorname{sinc}\left(\frac{t}{2}\right) e^{j\frac{\pi}{2}t}\cdot e^{-j\frac{\pi}{2}}$$

$$= \frac{j}{2}\operatorname{sinc}\left(\frac{t}{2}\right)\cdot\left(e^{-j\frac{\pi}{2}t} - e^{j\frac{\pi}{2}t}\right)$$

$$= 2j\cdot\frac{1}{2j}\cdot\frac{j}{2}\operatorname{sinc}\left(\frac{t}{2}\right)\cdot\left(e^{-j\frac{\pi}{2}t} - e^{j\frac{\pi}{2}t}\right)$$

$$= \operatorname{sinc}\left(\frac{t}{2}\right)\left(\frac{e^{j\frac{\pi}{2}t} - e^{-j\frac{\pi}{2}t}}{2j}\right)$$

$$= \operatorname{sinc}\left(\frac{t}{2}\right)\sin\left(\frac{\pi}{2}t\right)$$

$x(t)$: odd, real

$X_2(j\omega)$: odd, imaginery.

3. a. $X(j\omega) = \mathcal{F}\{x(t)\}$

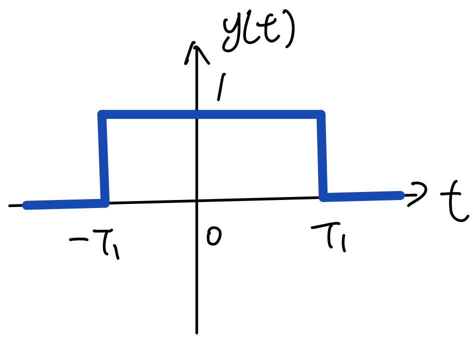
$$= \mathcal{F}\{\delta(t+T_1) - \delta(t-T_1)\}$$

$$= e^{-j\omega(-T_1)} \cdot 1 - e^{-j\omega T_1} \cdot 1$$

$$= \frac{e^{j\omega T_1} - e^{-j\omega T_1}}{2j} \cdot 2j$$

$$= j \cdot 2\sin(\omega T_1)$$

b.



c. $Y(j\omega) = \frac{1}{j\omega} X(j\omega) + \pi X(j0)\delta(\omega)$

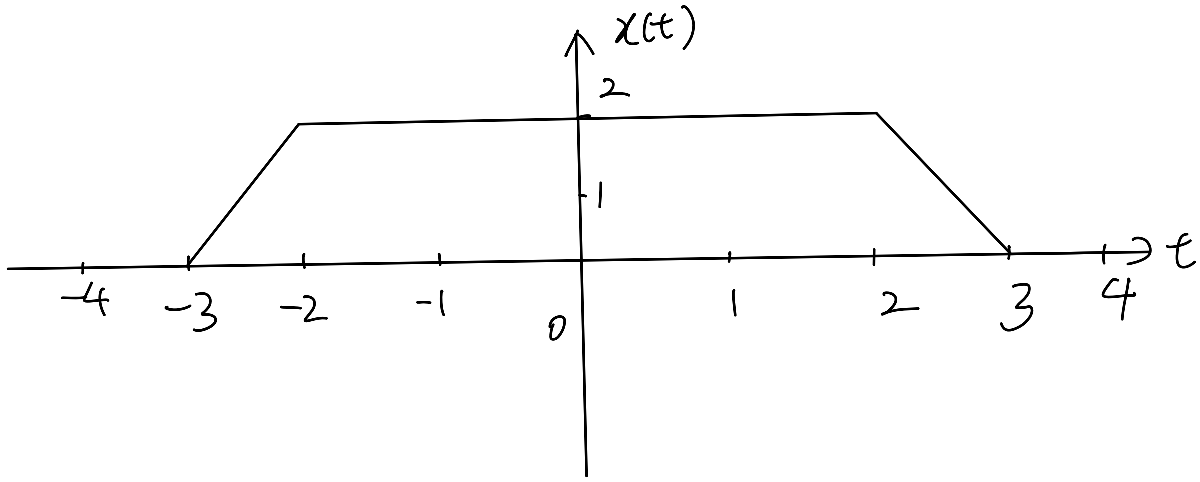
$$= \frac{1}{j\omega} \cdot 2j\sin(T_1\omega) + \pi \cdot 2j \cdot \sin(T_1 \cdot 0)\delta(\omega)$$

$$= \frac{2\sin(T_1\omega)}{\omega} = \frac{2T_1\sin(\omega T_1)}{\omega T_1}$$

$$= \frac{2T_1 \sin\left(\frac{\omega T_1 \pi}{\pi}\right)}{\frac{\pi \omega T_1}{\pi}} = 2T_1 \operatorname{sinc}\left(\frac{\omega T_1}{\pi}\right)$$

4. a. $x_1(t) = \Pi\left(\frac{t}{2}\right)$, $x_2(t) = \Pi\left(\frac{t}{4}\right)$

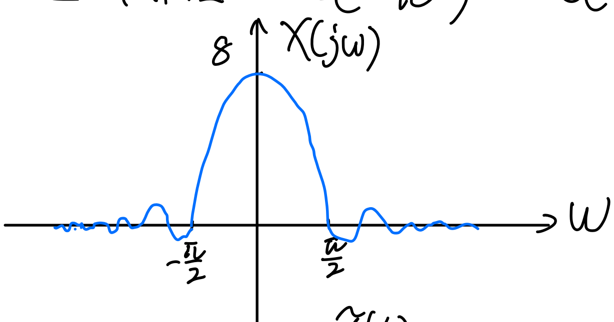
$x(t) = x_1(t) * x_2(t)$



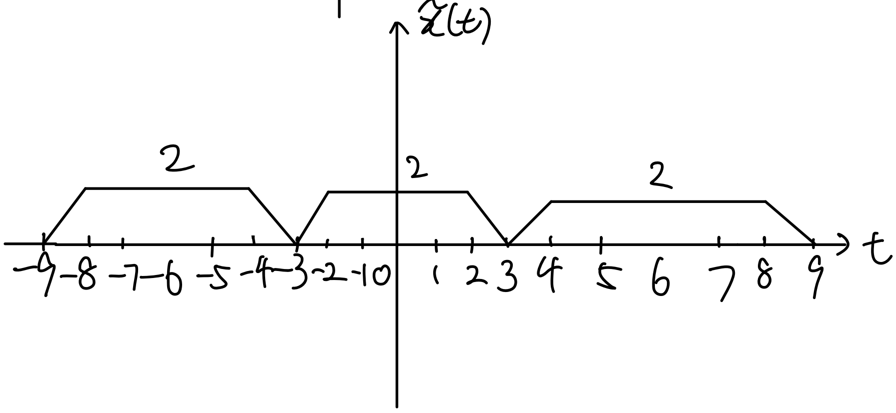
b. $X(j\omega) = X_1(j\omega)\, X_2(j\omega)$

$= 2T_1 \,\mathrm{sinc}\left(\frac{\omega T_1}{\pi}\right) \cdot 2T_2 \,\mathrm{sinc}\left(\frac{\omega T_2}{\pi}\right)$

$= 4T_1 T_2 \,\mathrm{sinc}\left(\frac{\omega T_1}{\pi}\right) \mathrm{sinc}\left(\frac{\omega T_2}{\pi}\right)$



c.

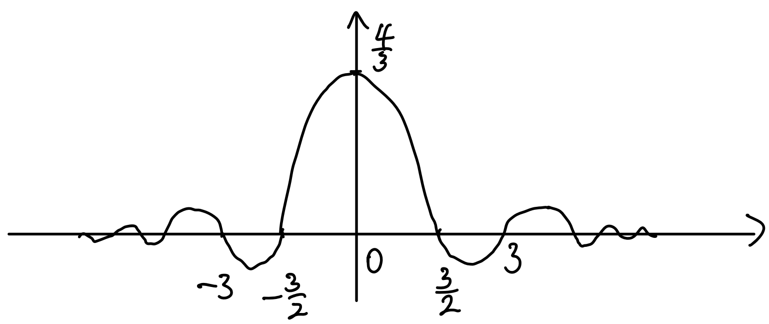


d. $T_0 = 6$. $T_1 = 1, T_2 = 2$ by sampling at $\omega = \omega_0 k$. $\left(\omega_0 = \frac{2\pi}{T_0}\right)$

$$X(j\omega)\big|_{\omega=\omega_0 k} = 8\,\mathrm{sinc}\left(\frac{\omega_0 k}{\pi}\right)\mathrm{sinc}\left(\frac{2\omega_0 k}{\pi}\right) = 6a_k$$

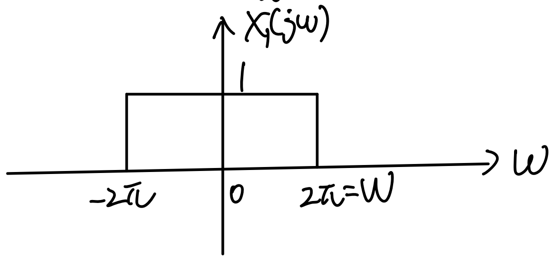
$$a_k = \frac{4}{3}\,\mathrm{sinc}\left(\frac{2\pi k}{6\pi}\right)\mathrm{sinc}\left(\frac{4\pi k}{6\pi}\right)$$

$$= \frac{4}{3}\,\mathrm{sinc}\left(\frac{k}{3}\right)\cdot\mathrm{sinc}\left(\frac{2k}{3}\right)$$



5. a. $x_1(t) = \frac{W}{\pi}\,\mathrm{sinc}\left(\frac{Wt}{\pi}\right) = 2\,\mathrm{sinc}(2t)$

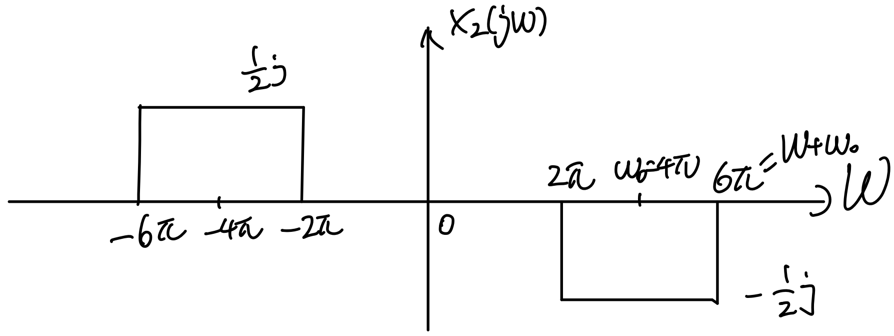
$$X_1(j\omega) = \Pi\left(\frac{\omega}{2W}\right) = \Pi\left(\frac{\omega}{4\pi}\right)$$



$$X_2(j\omega) = \mathcal{F}\{x(t)\sin(\omega_0 t)\} = \frac{j}{2}[X(j(\omega+\omega_0)) - X(j(\omega-\omega_0))]$$

$$= \frac{j}{2}[X(j(\omega+4\pi)) - X(j(\omega-4\pi))]$$

$$= \frac{j}{2}\left[\Pi\left(\frac{\omega+4\pi}{4\pi}\right) - \Pi\left(\frac{\omega-4\pi}{4\pi}\right)\right]$$



b. $E_{x_1} = \int_{-\infty}^{\infty} |x_1(t)|^2 dt = \frac{1}{2\pi} \int_{-\infty}^{\infty} |X_1(jw)|^2 dw$

$= \frac{W}{\pi}$

$E_{x_2} = \int_{-\infty}^{\infty} |x_2(t)|^2 dt = \frac{1}{2\pi} \int_{-\infty}^{\infty} |X_2(jw)|^2 dw$

$= \frac{W}{2\pi}$

c. $\langle x_1(t), x_2(t) \rangle = \int_{-\infty}^{\infty} x_1(t) x_2^*(t) dt$

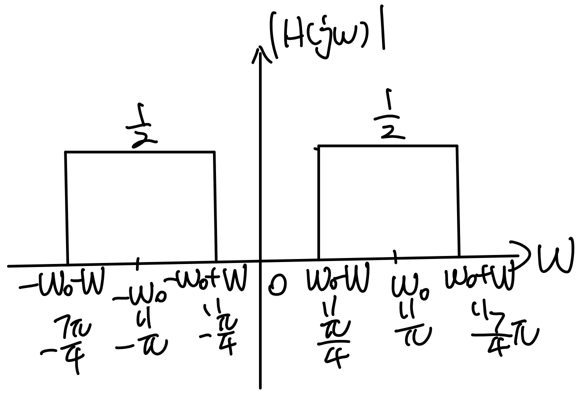
$= \frac{1}{2\pi} \int_{-\infty}^{\infty} X_1(jw)\ X_2^*(jw) dw$

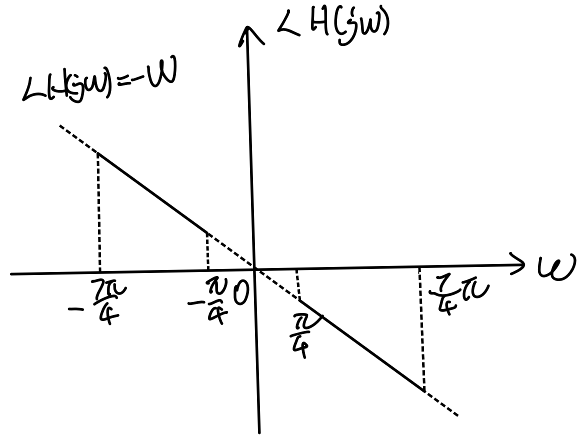
$= 0$

6. a. $H(j\omega) = \frac{1}{2} e^{-j\omega t_0} [\Pi(\frac{\omega+\omega_0}{2W}) + \Pi(\frac{\omega-\omega_0}{2W})]$

$= \frac{1}{2} \Pi(\frac{\omega+\omega_0}{2W}) e^{-j\omega t_0} + \frac{1}{2} \Pi(\frac{\omega-\omega_0}{2W}) e^{-j\omega t_0}$

let $W = \frac{3}{4}\pi$, $\omega_0 = \pi$, $t_0 = 1$.





b. band pass filter

c. $y(t) = x(t) * h(t) = 1 * h(t) + 2\sin(t) * h(t) + \cos(2\pi t) * h(t)$

$Y(j\omega) = 2\pi\delta(\omega) \cdot H(j\omega) + 2\pi j[\delta(\omega+1) - \delta(\omega-1)] \cdot H(j\omega)$

$+ \pi[\delta(\omega-2\pi) + \delta(\omega+2\pi)] \cdot H(j\omega)$

$= 0 + 2\pi j[\delta(\omega+1) - \delta(\omega-1)] \cdot H(j\omega) + 0$

$= 2\pi j[\delta(\omega+1) - \delta(\omega-1)] \cdot H(j\omega)$

$= 2\pi j[\delta(\omega+1) - \delta(\omega-1)] \cdot [\frac{1}{2} e^{-j\omega t_0} (\Pi(\frac{\omega+\omega_0}{2W}) + \Pi(\frac{\omega-\omega_0}{2W}))]$

$(\omega_0 = \pi,\ W = \frac{3}{4}\pi,\ t_0 = 1)$

$= \pi j e^{-j\omega} \cdot \{\delta(\omega+1)[\Pi(\frac{\omega+\pi}{2 \cdot \frac{3}{4}\pi}) + \Pi(\frac{\omega-\pi}{2 \cdot \frac{3}{4}\pi})] - \delta(\omega-1)[\Pi(\frac{\omega+\pi}{2 \cdot \frac{3}{4}\pi}) + \Pi(\frac{\omega-\pi}{2 \cdot \frac{3}{4}\pi})]\}$

$= e^{-j\omega \cdot 1} \cdot \pi j(\delta(\omega+1) - \delta(\omega-1)) = e^{-j\omega} \cdot \pi j(\delta(\omega+1) - \delta(\omega-1))$

thus: $y(t) = \sin(t-1)$

7. a. $y(t) = \frac{1}{2}x(t) + \frac{1}{2}x(t-t_0)$

$h(t) = \frac{1}{2}\delta(t) + \frac{1}{2}\delta(t-t_0)$

b. $H(jw) = \frac{1}{2}\left(\mathcal{F}\{\delta(t)\} + \mathcal{F}\{\delta(t-t_0)\}\right)$

$= \frac{1}{2}\left(1 + e^{-jwt_0}\right)$

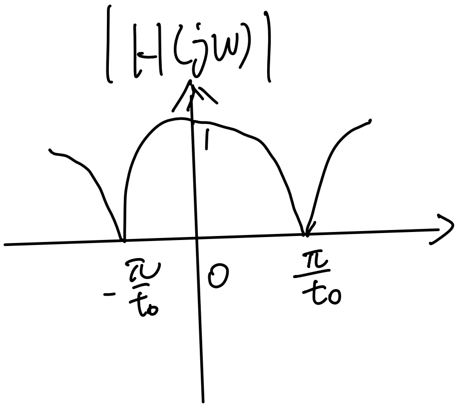
$= \frac{1}{2} + \frac{1}{2}e^{-jwt_0}$

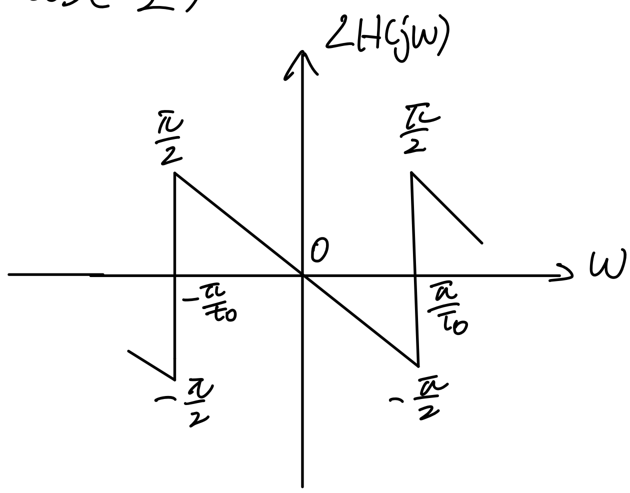
$= e^{-\frac{jwt_0}{2}}\left(\frac{e^{\frac{jwt_0}{2}} + e^{-\frac{jwt_0}{2}}}{2}\right)$

$= e^{-\frac{jwt_0}{2}} \cdot \cos\left(\frac{wt_0}{2}\right)$

$|H(jw)| = \left|e^{-\frac{jwt_0}{2}} \cdot \cos\left(\frac{wt_0}{2}\right)\right| = \left|\cos\frac{wt_0}{2}\right|$

$\angle H(jw) = \begin{cases} -\frac{t_0}{2}w & \cos\left(\frac{wt_0}{2}\right) \geq 0 \\ -\frac{t_0}{2}w + \pi & \cos\left(\frac{wt_0}{2}\right) < 0. \end{cases}$





C. $x(t) = \sin(\omega_0 t)$

$$y(t) = \sin(\omega_0 t) * h(t)$$

$$= \sin(\omega_0 t) * \frac{1}{2}\delta(t) + \sin(\omega_0 t) * \frac{1}{2}\delta(t-t_0)$$

$$Y(t) = j\pi[\delta(\omega+\omega_0) - \delta(\omega-\omega_0)]\cdot\frac{1}{2} + \frac{1}{2}j\pi[\delta(\omega+\omega_0) - \delta(\omega-\omega_0)]\cdot e^{-j\omega t_0}.$$

$$= \frac{1}{2}j\pi[\delta(\omega+\omega_0) - \delta(\omega-\omega_0)](1+e^{-j\omega t_0})$$

$$y(t) = \frac{1}{2}\sin(\omega_0 t) + \frac{1}{2}\sin(\omega_0(t-t_0))$$

$$= \frac{1}{2}(\sin(\omega_0 t) + \sin(\omega_0 t - \omega_0 t_0))$$

$$= \frac{1}{2}(\sin(\omega_0 t) + \sin(\omega_0 t)\cos(\omega_0 t_0) - \cos(\omega_0 t)\sin(\omega_0 t_0))$$

$$= \frac{1}{2}(\sin(\omega_0 t)[1+\cos(\omega_0 t_0)] - \cos(\omega_0 t)\sin(\omega_0 t_0))$$

this requires $\cos(\omega_0 t_0) = -1$ and $\sin(\omega_0 t_0) = 0$.

therefore $\omega_0 t_0 = 2k\pi + \pi$

$$\omega_0 = \frac{2k\pi + \pi}{t_0}, \quad k \in \mathbb{Z}.$$

8. a. $h(t) = \frac{t}{\tau} x(t)$.

thus

$$H(j\omega) = \frac{1}{\tau}\left(j\frac{dX(j\omega)}{d\omega}\right) = \frac{j}{\tau}\cdot\frac{d}{d\omega}\left(\frac{1}{1+j\omega\tau}\right)$$

$$= \frac{j}{\tau}\cdot\frac{-1}{(1+j\omega\tau)^2}\cdot j\tau$$

$$= \frac{1}{(1+j\omega\tau)^2}$$

b. $y(t)=\frac{1}{\tau}e^{-\frac{t}{\tau}}u(t) * \frac{1}{\tau}e^{-\frac{t}{\tau}}u(t)$, $X(j\omega)=\frac{1}{1+j\omega\tau} = F\{x(t)\}$
$= F\{\frac{1}{\tau}e^{-\frac{t}{\tau}}u(t)\}$

$$Y(j\omega) = X(j\omega)\cdot X(j\omega)$$
$$= \frac{1}{(1+j\omega\tau)^2} = H(j\omega)$$

therefore $y(t) = h(t) = \frac{t}{\tau^2}e^{\frac{-t}{\tau}}u(t)$.

9. $x(t) = x_e(t) + x_o(t)$ from "right-sided": $x(t)=x(t)u(t)$

$x_e(t) = \frac{1}{2}[x(t)+x(-t)] = \frac{1}{2}[x(t)u(t)+x(-t)u(-t)]$

$\Longrightarrow x_e(t)u(t) = \frac{1}{2}x(t)u(t) \Longrightarrow x_e(t)=\frac{1}{2}x(t)$

$x(t)$ real thus:

$$F\{x_e(t)\} = \frac{1}{2}[X(j\omega)+X(-j\omega)]$$
$$= \frac{1}{2}[X(j\omega)+X^*(j\omega)]$$
$$= Re[X(j\omega)]$$

thus

$$F^{-1}\{Re[X(j\omega)]\} = x_e(t)$$

for $t\le 0$, $x(t)=0$.

thus: $x(t) = \begin{cases} 2F^{-1}\{Re[X(j\omega)]\}, & t>0 \\ 0 & t\le 0 \end{cases}$

10. $a_k = \frac{4T_1^2}{T_0} \mathrm{sinc}^2\left(\frac{k\,2\pi T_0}{4\pi T_0}\right) \cdot \frac{1}{2T_1}$

$= \frac{1}{2} \mathrm{sinc}^2\left(\frac{k}{2}\right)$

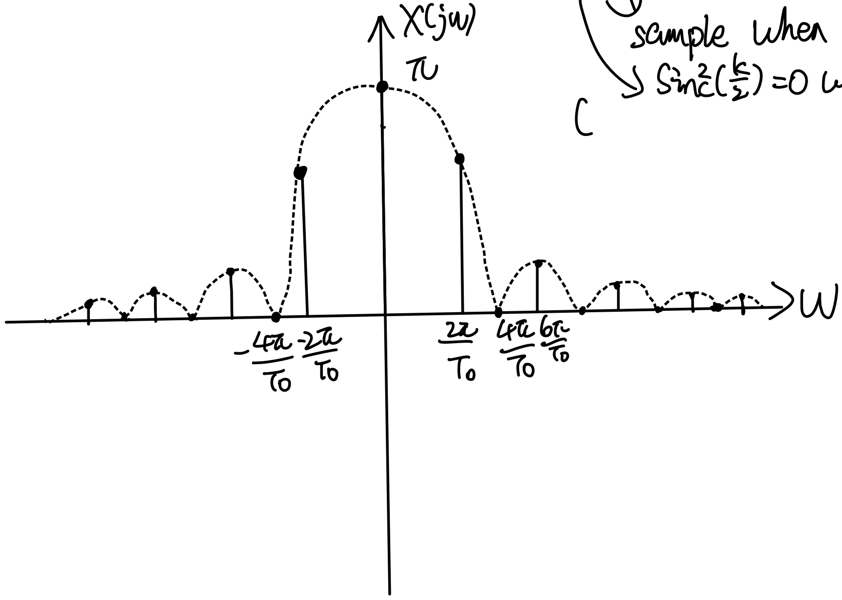
$x(t) = \sum_{k=-\infty}^{\infty} a_k e^{jk\omega_0 t}$

$X(j\omega) = 2\pi \sum_{k=-\infty}^{\infty} a_k \delta(\omega - k\omega_0)$

$= \pi \sum_{k=-\infty}^{\infty} \mathrm{sinc}^2\left(\frac{k}{2}\right) \delta(\omega - k\omega_0)$

sample when $\omega = k\omega_0 = \frac{2\pi k}{T_0}$

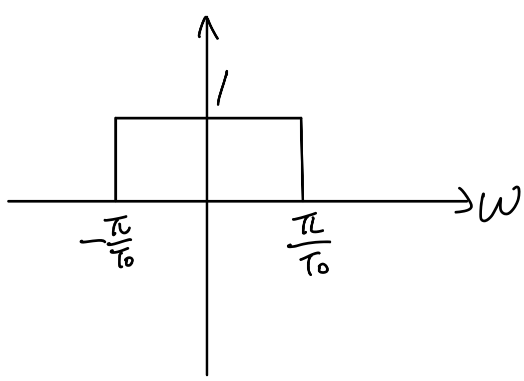
$\mathrm{sinc}^2\left(\frac{k}{2}\right) = 0$ when k even.



b. $h(t) = \frac{1}{T_0} \mathrm{sinc}\left(\frac{t}{T_0}\right)$

$\Updownarrow \mathcal{F}$

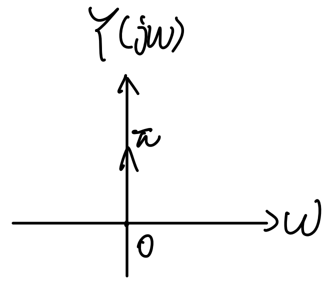
$H(j\omega) = \Pi\left(\frac{T_0 \omega}{2\pi}\right)$



c. $h(t)$ aperiodic

$y(t) = x(t) * h(t)$

$$Y(j\omega) = X(j\omega) \cdot H(j\omega) = \pi\delta(\omega)$$



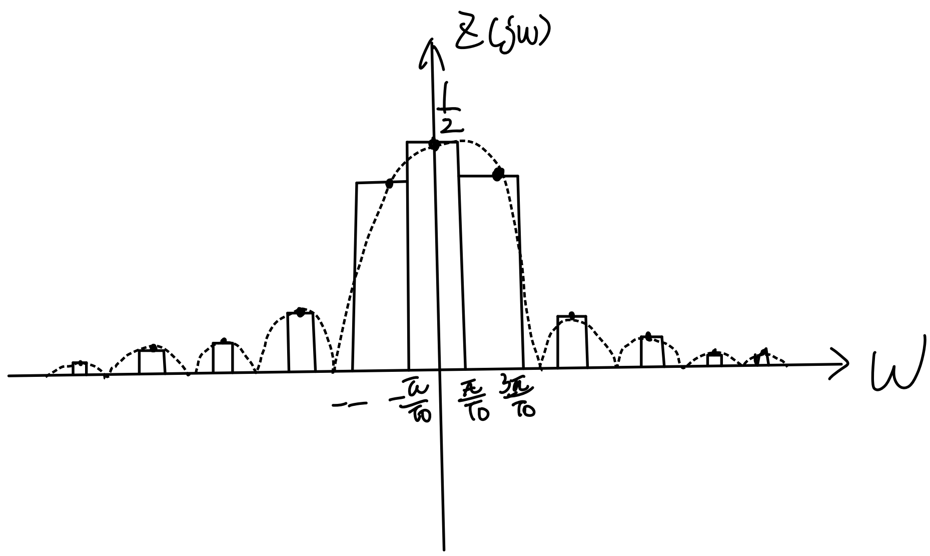
$y(t) = \frac{1}{2}$.   periodic

d. $z(t) = x(t) \times h(t)$

$$Z(j\omega) = \frac{1}{2\pi}\left(X(j\omega) * H(j\omega)\right)$$

$$= \frac{1}{2} \Pi\left(\frac{\omega}{2\pi/T_0}\right) * \sum_{k=-\infty}^{\infty} \operatorname{sinc}^2\left(\frac{k}{2}\right)\delta(\omega - k\omega_0)$$

$$= \frac{1}{2} \sum_{k=-\infty}^{\infty} \Pi\left(\frac{\omega - k\frac{2\pi}{T_0}}{2\pi/T_0}\right) \sin^2\left(\frac{k}{2}\right) \qquad \omega = k\frac{2\pi}{T_0}$$

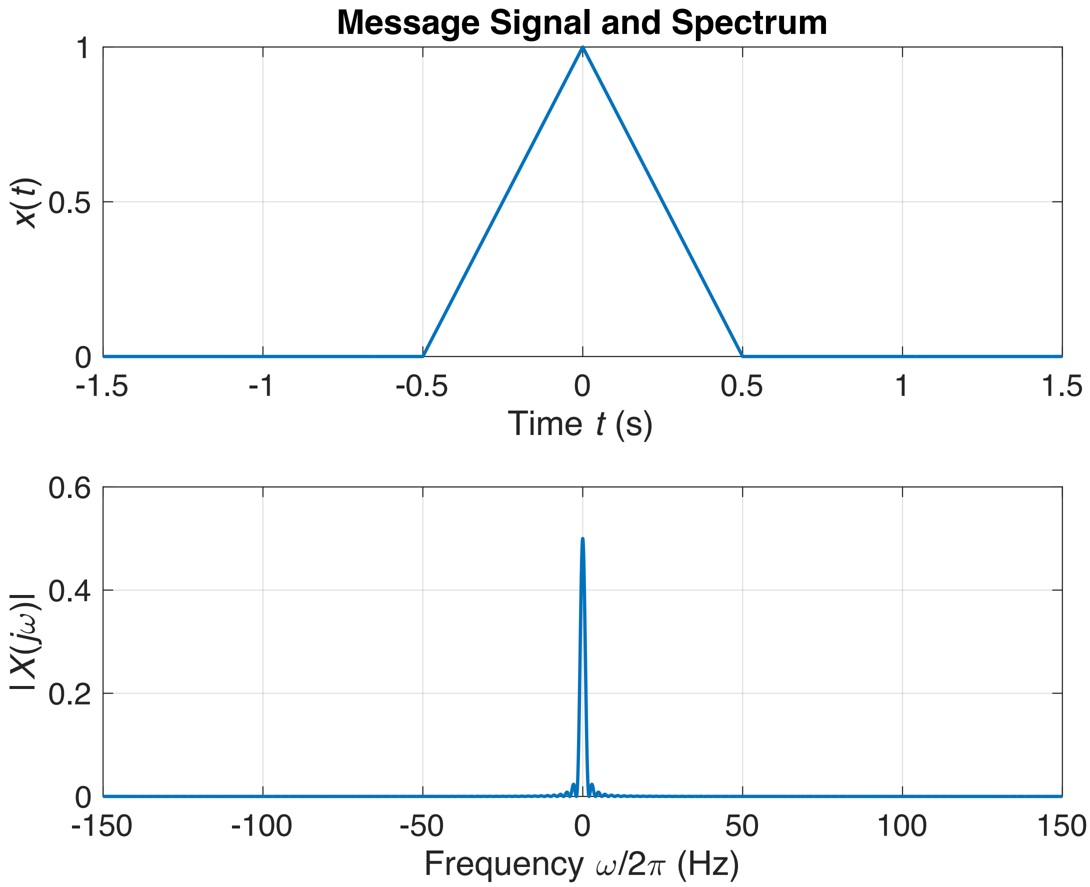


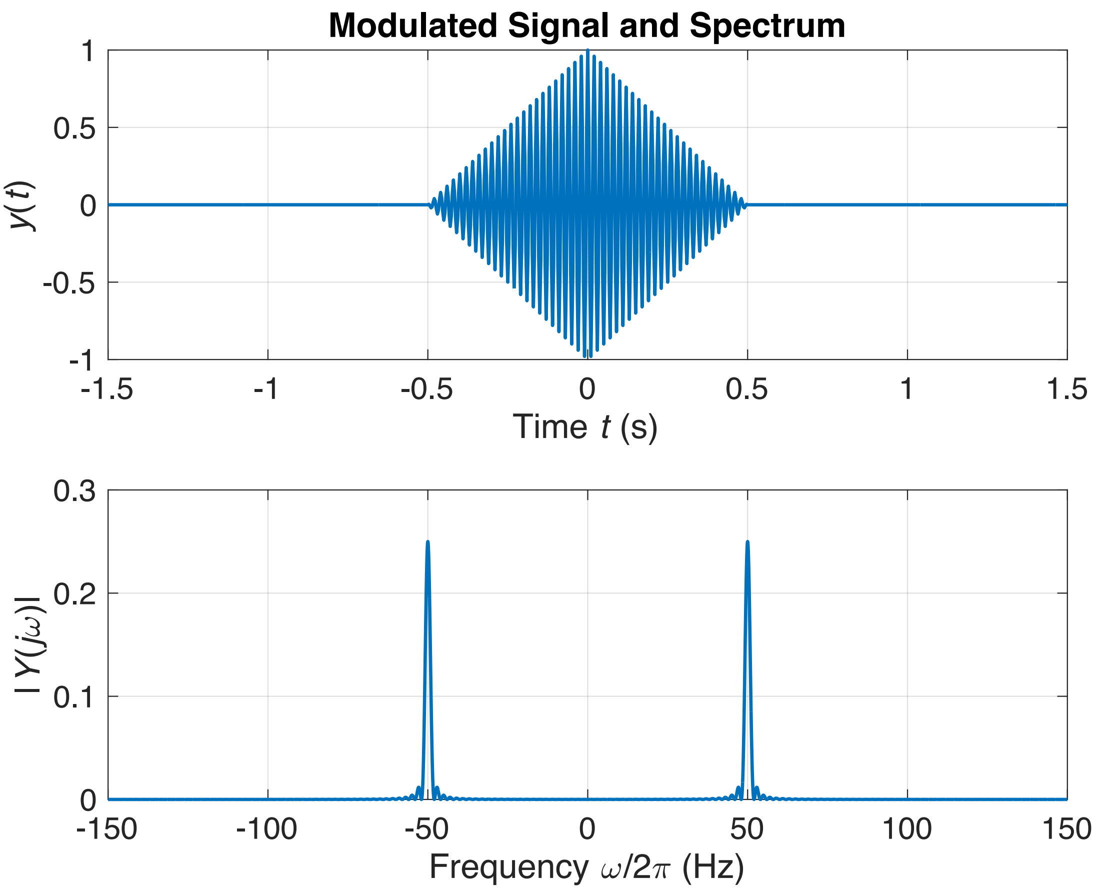
according to the plot above,
the area/integration of pulse trains of the Fourier transform is not equal, thus $z(t)$ is not periodic.

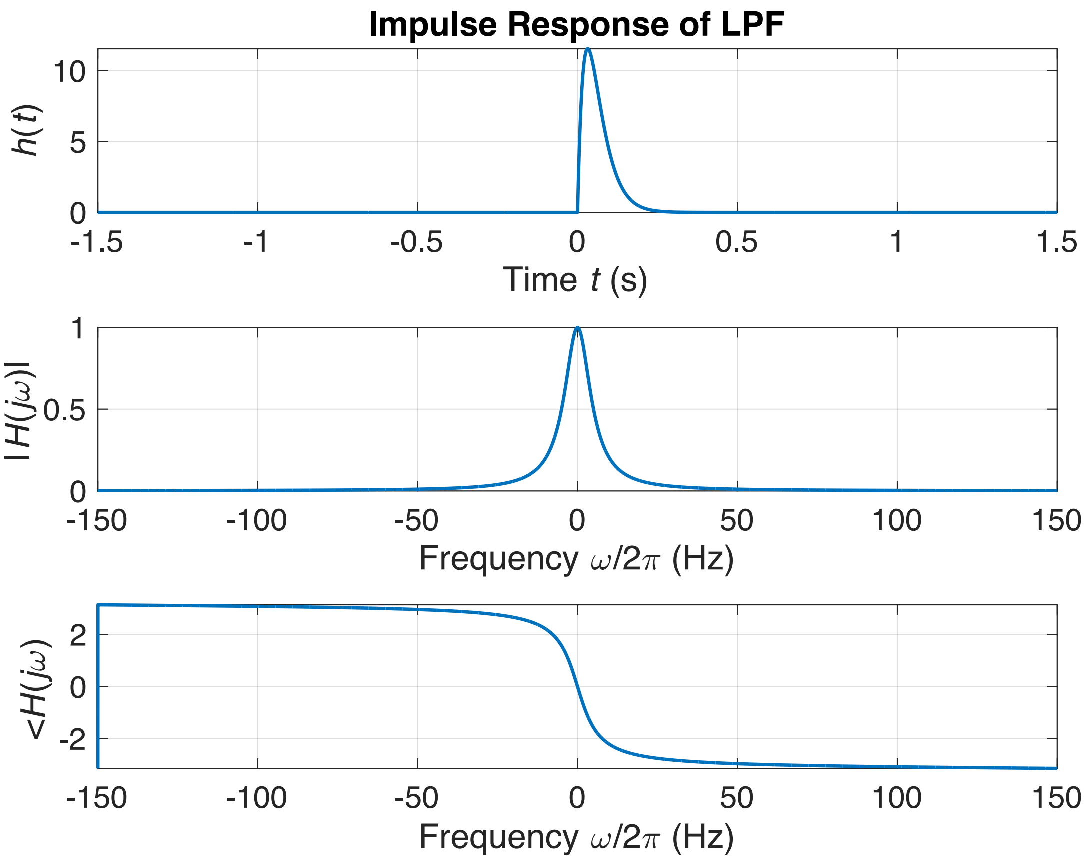
```matlab
function y = lambda(t)
% unit triangular pulse
y=1-abs(t);
y(t>=1)=0;
y(t<=-1)=0;
end

deltat=1/300;
tmax=1.5;
t=-tmax:deltat:tmax;
x=lambda(2*t);
[X,omega]=CTFT_approx(x,t);
phi = 0;


figure(1);
subplot(211);
plot(t,x);
l=get(gca,'children');set(l,'linewidth',1.5)
set(gca,'FontName','arial');set(gca,'FontSize',14);
xlabel('Time \itt\rm (s)');
ylabel('\itx\rm(\itt\rm)');
grid on;
title('Message Signal and Spectrum');

subplot(212);
plot(omega/(2*pi),abs(X));
l=get(gca,'children');set(l,'linewidth',1.5)
set(gca,'FontName','arial');set(gca,'FontSize',14);
xlabel('Frequency \omega/2\pi (Hz)');
ylabel('|\itX\rm(\itj\rm\omega)|');
grid on;

fc = 50;
omegac = 2*pi*fc;
y=x.*cos(omegac*t);
[Y,omega2]=CTFT_approx(y,t);
figure(2);
subplot(211);
plot(t,y);
l=get(gca,'children');set(l,'linewidth',1.5)
set(gca,'FontName','arial');set(gca,'FontSize',14);
xlabel('Time \itt\rm (s)');
ylabel('\ity\rm(\itt\rm)');
grid on;
title('Modulated Signal and Spectrum');

subplot(212);
plot(omega/(2*pi),abs(Y));
l=get(gca,'children');set(l,'linewidth',1.5)
set(gca,'FontName','arial');set(gca,'FontSize',14);
xlabel('Frequency \omega/2\pi (Hz)');
ylabel('|\itY\rm(\itj\rm\omega)|');
grid on;

v=1/2*x*cos(phi)+1/2*x.*cos(2*omegac*t+phi);
[V,omega3]=CTFT_approx(v,t);
figure(3);
subplot(211);
```

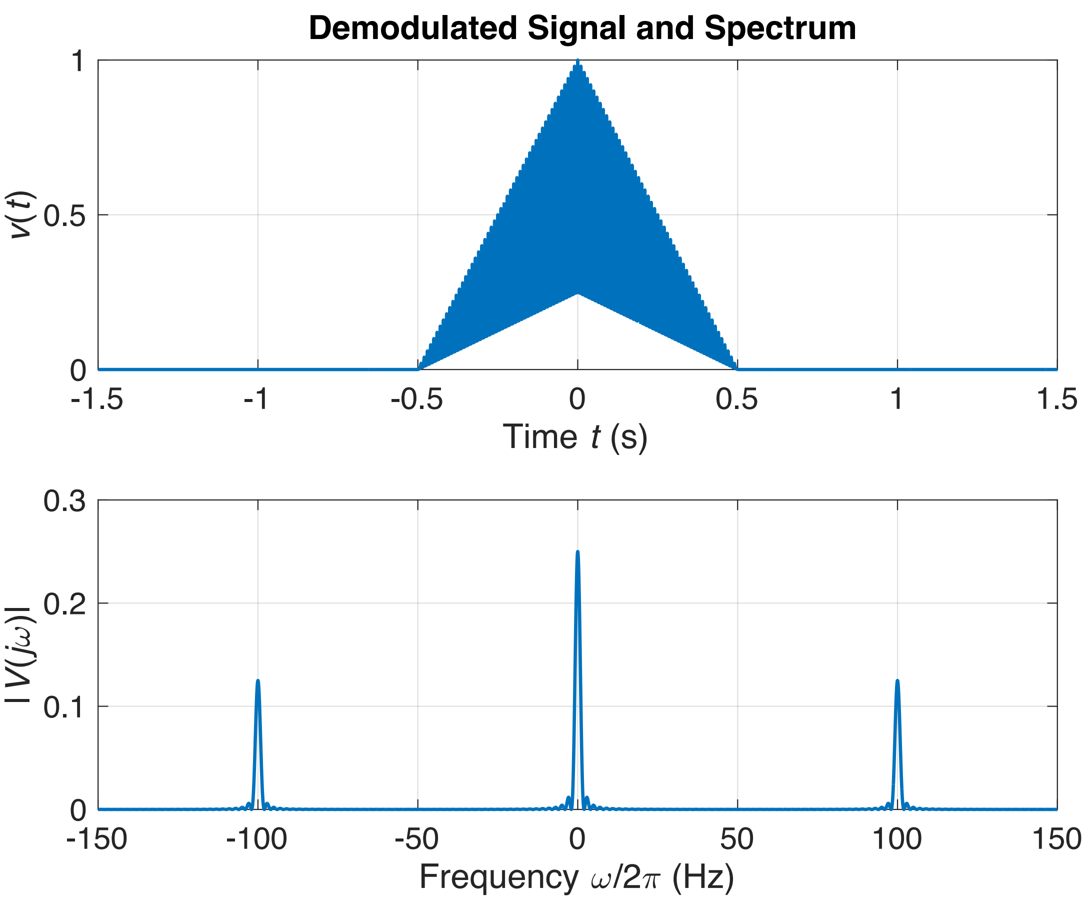
```
plot(t,v);
l=get(gca,'children');set(l,'linewidth',1.5)
set(gca,'FontName','arial');set(gca,'FontSize',14);
xlabel('Time \itt\rm (s)');
ylabel('\itv\rm(\itt\rm)');
grid on;
title('Demodulated Signal and Spectrum');

subplot(212);
plot(omega3/(2*pi),abs(V));
l=get(gca,'children');set(l,'linewidth',1.5)
set(gca,'FontName','arial');set(gca,'FontSize',14);
xlabel('Frequency \omega/2\pi (Hz)');
ylabel('|\itV\rm(\itj\rm\omega)|');
grid on;

fn=5;omegan=2*pi*fn;
hlpf=hsolpfcd(t,omegan);
[H,omega4]=CTFT_approx(hlpf,t);
magnitude=abs(H);
phase=angle(H);
figure(4);
subplot(311)
plot(t,hlpf);
l=get(gca,'children');set(l,'linewidth',1.5)
set(gca,'FontName','arial');set(gca,'FontSize',14);
xlabel('Time \itt\rm (s)');
ylabel('\ith\rm(\itt\rm)');
grid on;
title('Impulse Response of LPF');
subplot(312);
plot(omega4/(2*pi),magnitude);
l=get(gca,'children');set(l,'linewidth',1.5)
set(gca,'FontName','arial');set(gca,'FontSize',14);
xlabel('Frequency \omega/2\pi (Hz)');
ylabel('|\itH\rm(\itj\rm\omega)|');
grid on;

subplot(313);
plot(omega4/(2*pi),phase);
l=get(gca,'children');set(l,'linewidth',1.5)
set(gca,'FontName','arial');set(gca,'FontSize',14);
xlabel('Frequency \omega/2\pi (Hz)');
ylabel('<\itH\rm(\itj\rm\omega)');
grid on;

tw=-2*tmax:deltat:2*tmax;
w=deltat*conv(v,hlpf);
[W,omega9]=CTFT_approx(w,tw);

figure(5);
subplot(211);
plot(tw,w);
l=get(gca,'children');set(l,'linewidth',1.5)
set(gca,'FontName','arial');set(gca,'FontSize',14);
xlabel('Time \ittw\rm (s)');
ylabel('\itw\rm(\itt\rm)');
%ylim([0,0.5])
xlim([-1.5,1.5])
```

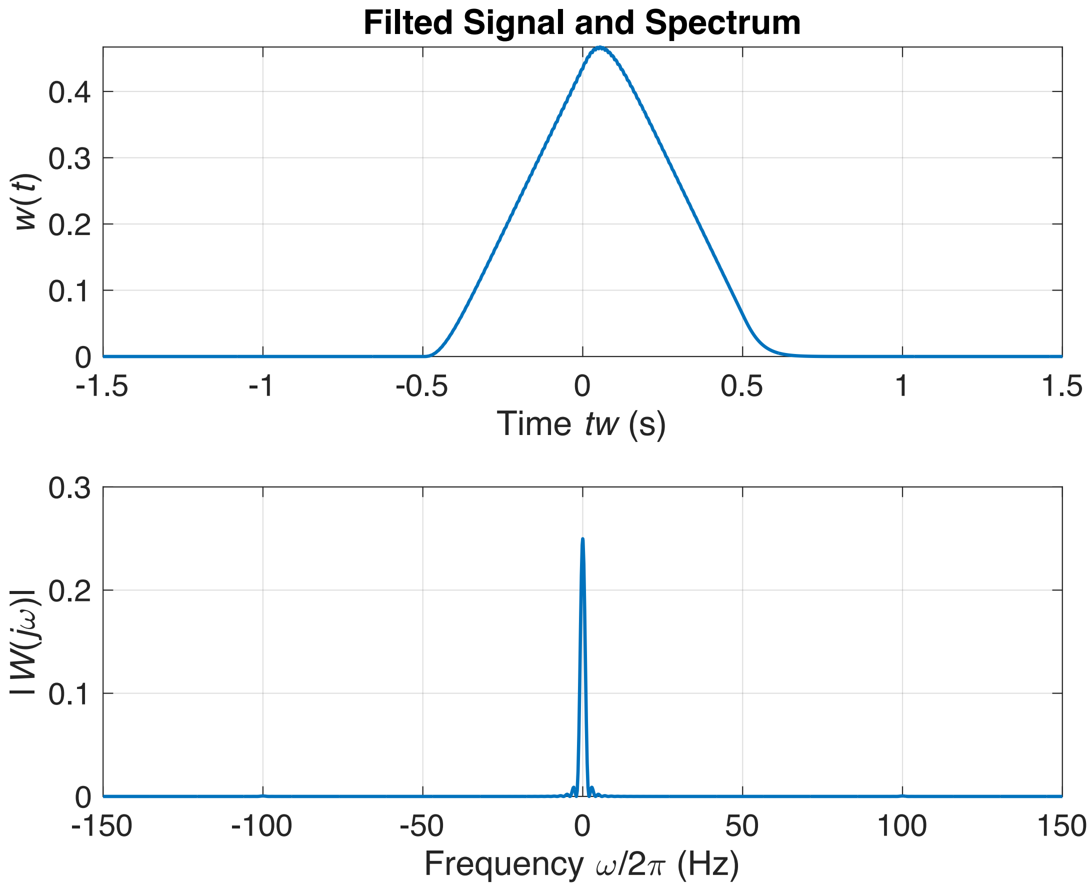
```
grid on;
title('Filted Signal and Spectrum');

subplot(212);
plot(omega9/(2*pi),abs(W));
l=get(gca,'children');set(l,'linewidth',1.5)
set(gca,'FontName','arial');set(gca,'FontSize',14);
xlabel('Frequency \omega/2\pi (Hz)');
ylabel('|\itW\rm(\itj\rm\omega)|');
%ylim([0,0.5])
grid on;
```


Message Signal and Spectrum
x(t)
Time t (s)
|X(jω)|
Frequency ω/2π (Hz)


Modulated Signal and Spectrum
y(t)
Time t (s)
|Y(jω)|
Frequency ω/2π (Hz)


Impulse Response of LPF
h(t)
10
5
0
-1.5
-1
-0.5
0
0.5
1
1.5
Time t (s)
|H(jω)|
1
0.5
0
-150
-100
-50
0
50
100
150
Frequency ω/2π (Hz)
<H(jω)
2
0
-2
-150
-100
-50
0
50
100
150
Frequency ω/2π (Hz)

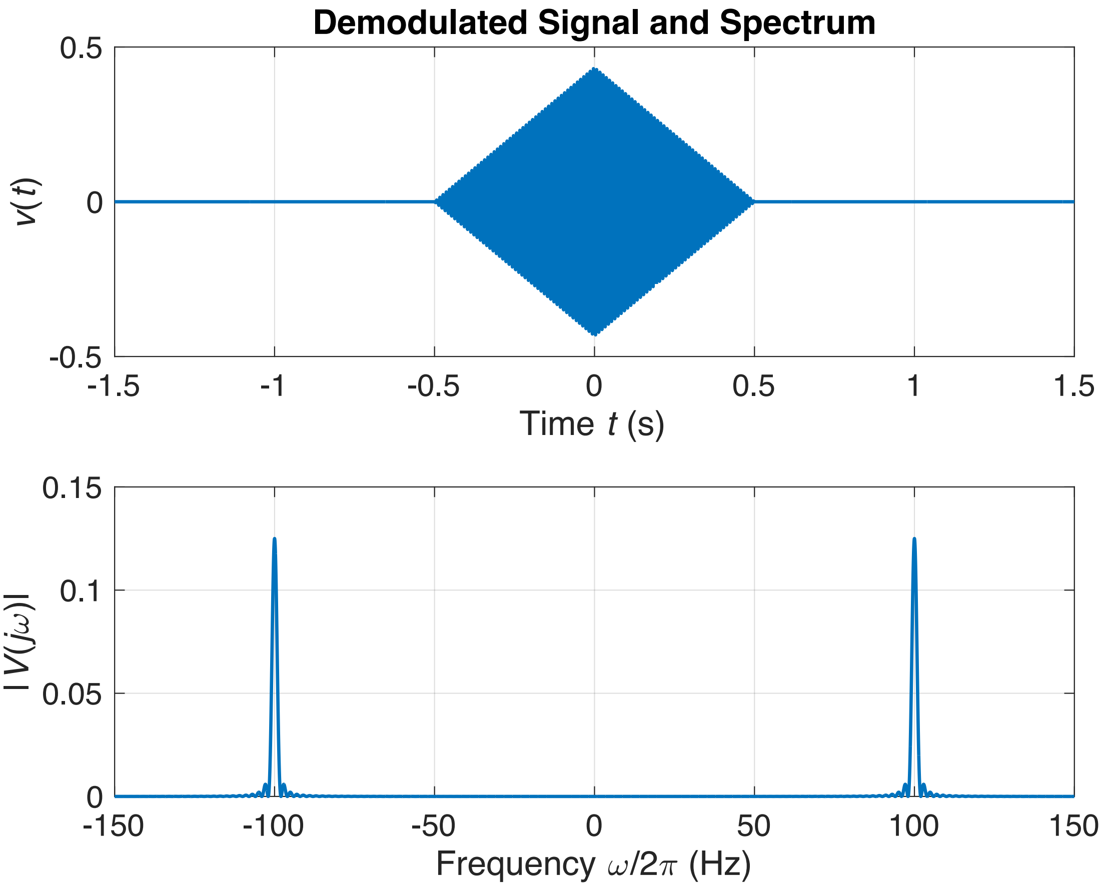

Demodulated Signal and Spectrum
v(t)
1
0.5
0
-1.5
-1
-0.5
0
0.5
1
1.5
Time t (s)
|V(jω)|
0.3
0.2
0.1
0
-150
-100
-50
0
50
100
150
Frequency ω/2π (Hz)

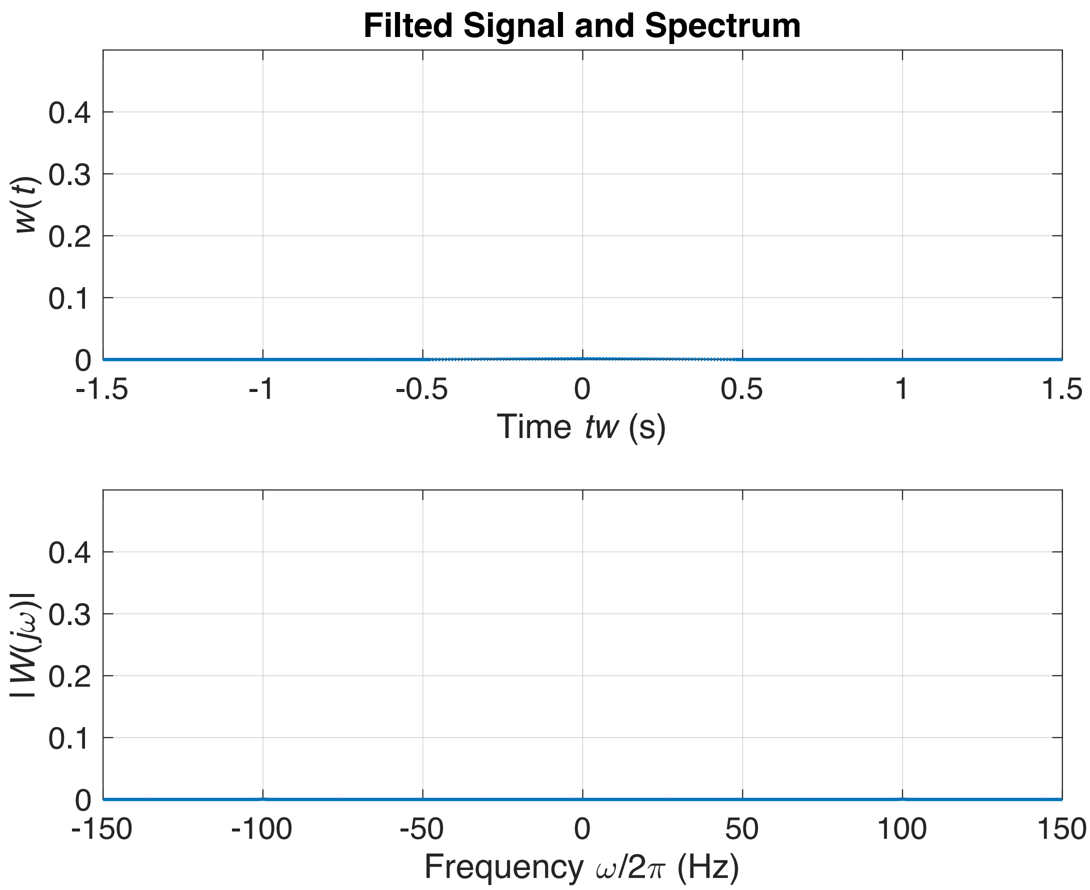


5.
The filtered signal w(t) has 1. Small leakage of the 2 wc component; 2. Amplitude distortion; 3. Time delay. Possible improvement: reduce the LPF cut off frequency; use a higher order filter with a higher cut-off frequency.

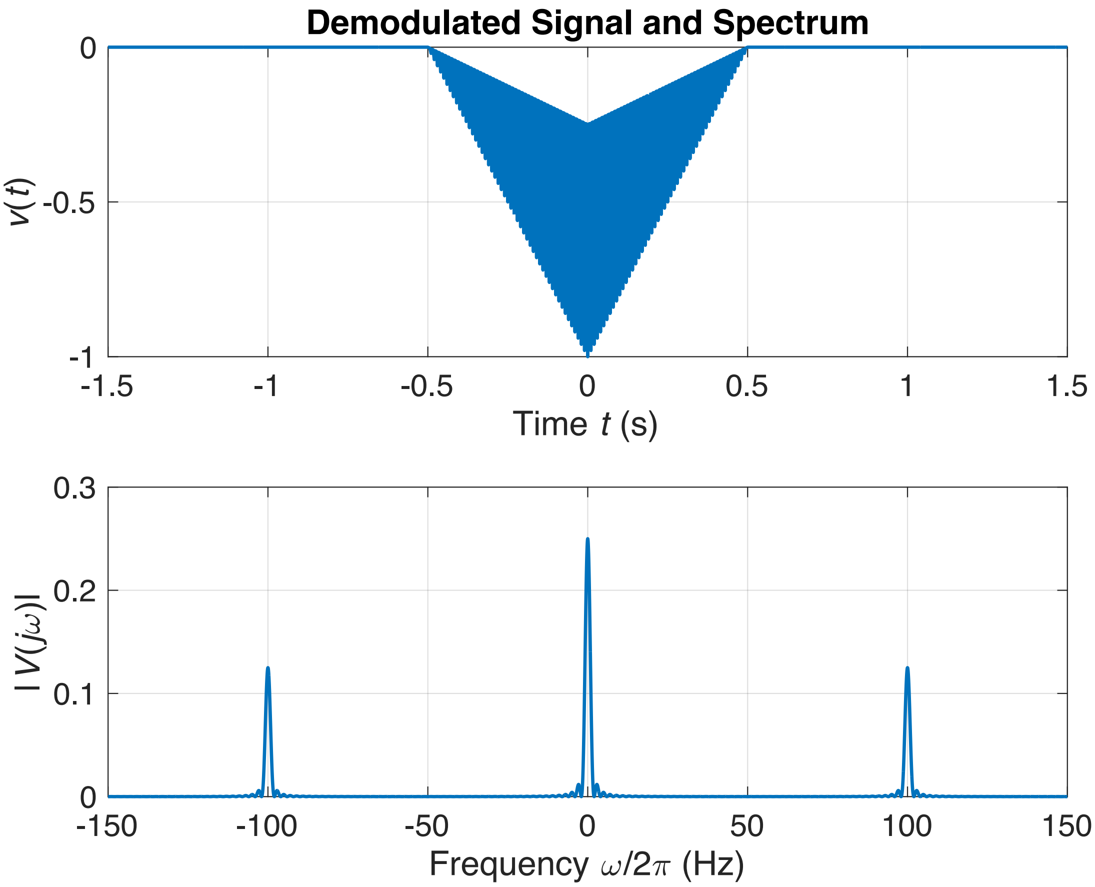
6.
Phase offsets of phi=0, pi/2, and pi yield lowpass filter outputs w(t) = ½ x(t), 0, and -1/2 x(t). Phase of ½ pi is worst since no signal is recovered.

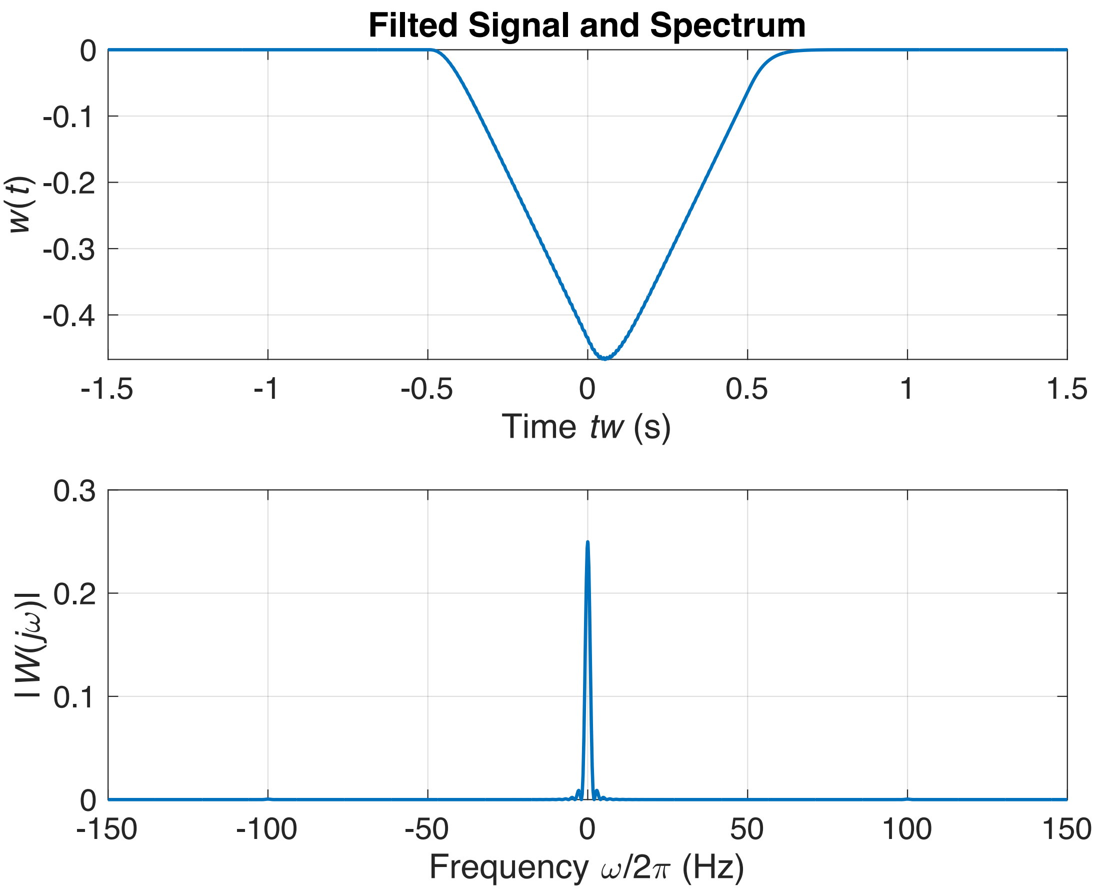
7.
Phi=1/2*pi:


Demodulated Signal and Spectrum
0.5
0
-0.5
-1.5
-1
-0.5
0
0.5
1
1.5
Time t (s)
v(t)
0.15
0.1
0.05
0
-150
-100
-50
0
50
100
150
Frequency ω/2π (Hz)
| V(jω)|


Filted Signal and Spectrum
0.4
0.3
0.2
0.1
0
-1.5
-1
-0.5
0
0.5
1
1.5
Time tw (s)
w(t)
0.4
0.3
0.2
0.1
0
-150
-100
-50
0
50
100
150
Frequency ω/2π (Hz)
| W(jω)|

Phi = pi:


Demodulated Signal and Spectrum
v(t)
0
-0.5
-1
-1.5
-1
-0.5
0
0.5
1
1.5
Time t (s)
| V(jω)|
0.3
0.2
0.1
0
-150
-100
-50
0
50
100
150
Frequency ω/2π (Hz)


Filted Signal and Spectrum
w(t)
0
-0.1
-0.2
-0.3
-0.4
-1.5
-1
-0.5
0
0.5
1
1.5
Time tw (s)
| W(jω)|
0.3
0.2
0.1
0
-150
-100
-50
0
50
100
150
Frequency ω/2π (Hz)