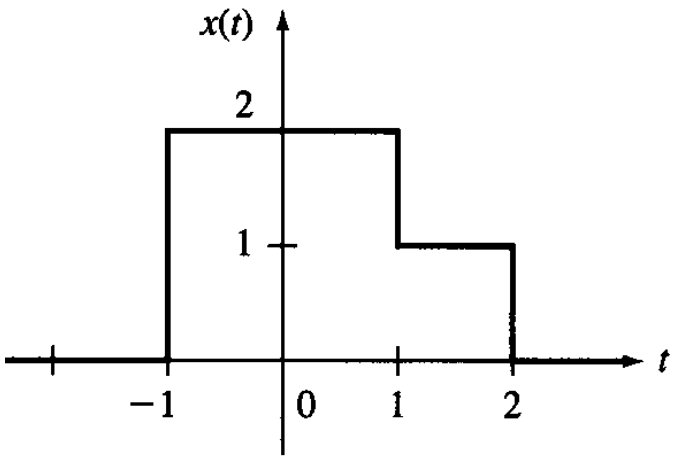
3.19 By first expressing $x(t)$ in terms of rectangular pulse functions and triangular pulse functions, compute the Fourier transform of the signals in Figure P3.19. Plot the magnitude and phase of the Fourier transform.



(b)

- Using Matlab, plot magnitude and phase for $-10 \le \omega \le 10$ rad/s.

Method 1

$$x(t) = 2p_2(t) + p_1(t-1.5)$$

From Tables 3.1 & 3.2 of the text, use

$p_\tau(t) \longleftrightarrow \tau \operatorname{sinc}\frac{\tau\omega}{2\pi}$ Transform pair

$a\,x(t) \longleftrightarrow a\,X(\omega)$ Linearity property

$x(t-c) \longleftrightarrow X(\omega)e^{-j\omega c}$ Time-shift property

to get $X(\omega) = 2(2)\operatorname{sinc}\left(\frac{2\omega}{2\pi}\right) + (1)\operatorname{sinc}\left(\frac{1\omega}{2\pi}\right)e^{-j\omega 1.5}$

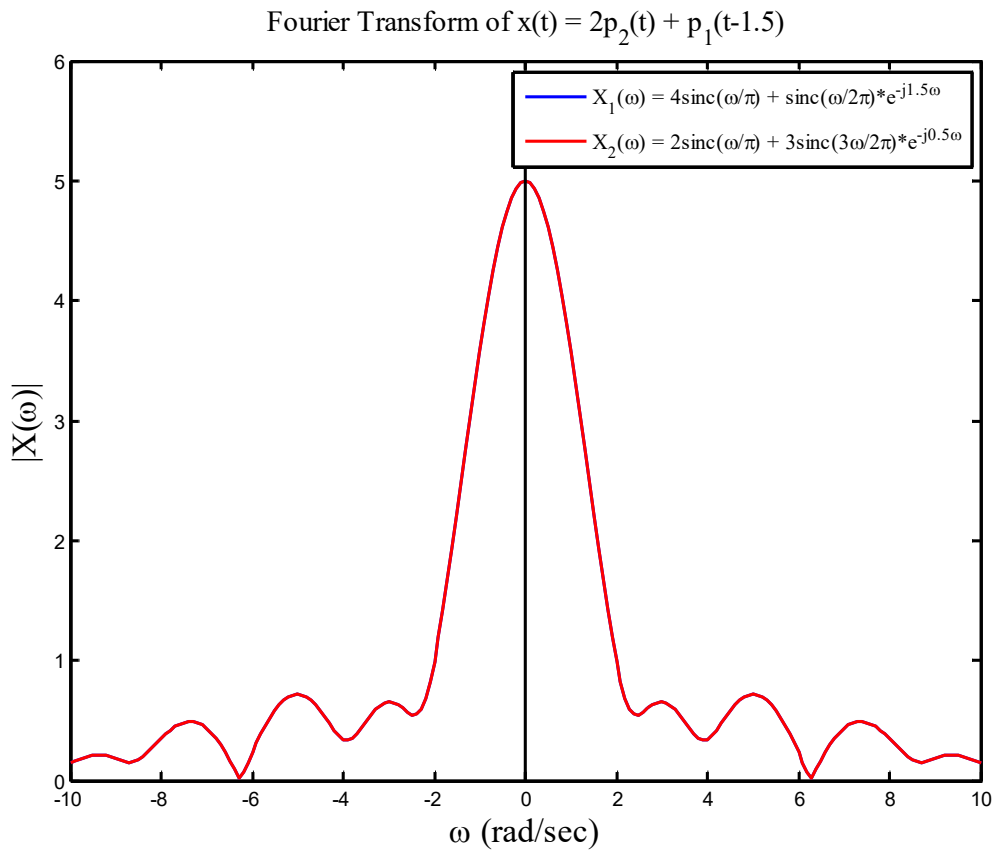
$$X(\omega) = 4\operatorname{sinc}\left(\frac{\omega}{\pi}\right) + \operatorname{sinc}\left(\frac{\omega}{2\pi}\right)e^{-j1.5\omega} \quad -\infty < \omega < \infty$$

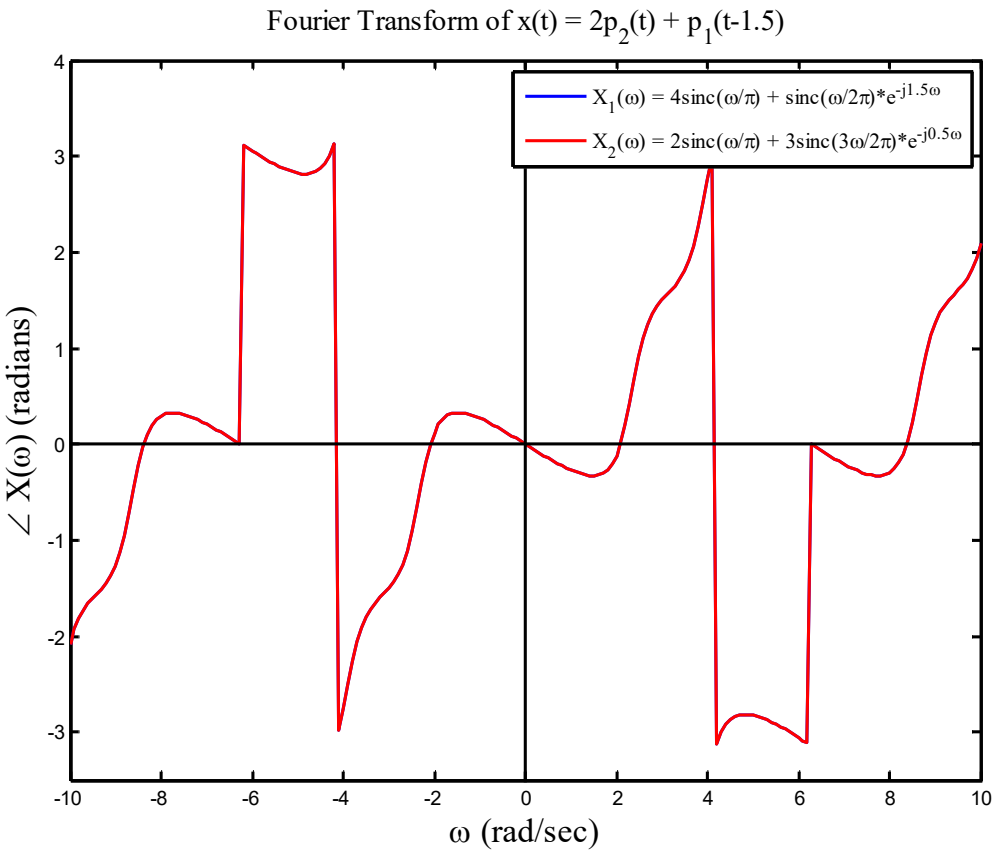
Method 2

$$x(t) = p_3(t-1/2) + p_2(t)$$

$$X(\omega) = 2\operatorname{sinc}\left(\frac{\omega}{\pi}\right) + 3\operatorname{sinc}\left(\frac{3\omega}{2\pi}\right)e^{-j0.5\omega} \quad -\infty < \omega < \infty$$

```
% Chapter 3 Fourier transform (chap3_3_19b.m)
%
% Plot the magnitude & phase of the Fourier transform
% X1(w) = 4sinc(w/pi) + sinc(w/2pi)*exp(-j1.5w)
% X2(w) = 2sinc(w/pi) + 3sinc(3w/2/pi)*exp(-j0.5w)
%
clear;clc;close all;
% Compute X(w) for plotting
w = -10:0.1:10;
X1 =4*sinc(w/pi) + sinc(w/2/pi).*exp(-j*1.5*w);
X2 =2*sinc(w/pi) + 3*sinc(3*w/2/pi).*exp(-j*0.5*w);
plot(w,abs(X1),'b-',w,abs(X2),'r-',[0 0],[0,6],'k-'),
axis([-10 10 0 6]),
title('Fourier Transform of x(t) = 2p_2(t) + p_1(t-1.5)',...
    'fontsize',14,'fontname','times');
legend('X_1(\omega)=4sinc(\omega/\pi)+sinc(\omega/2\pi)*e^{-j1.5\omega}',...
    'X_2(\omega)=2sinc(\omega/\pi)+3sinc(3\omega/2\pi)*e^{-j0.5\omega}');
xlabel('\omega (rad/sec)','fontsize',16,'fontname','times')
ylabel('|X(\omega)|','fontsize',16,'fontname','times')
figure,
plot(w,angle(X1),'b-',w,angle(X2),'r-',[-10 10],[0,0],'k-',...
[0 0],[-4,4],'k-'),
axis([-10 10 -3.5 4]),
title('Fourier Transform of x(t) = 2p_2(t) + p_1(t-1.5)',...
    'fontsize',14,'fontname','times');
legend('X_1(\omega) = 4sinc(\omega/\pi) + sinc(\omega/2\pi)*e^{-j1.5\omega}',...
    'X_2(\omega) = 2sinc(\omega/\pi) + 3sinc(3\omega/2\pi)*e^{-j0.5\omega}');
xlabel('\omega (rad/sec)','fontsize',16,'fontname','times')
ylabel('\angle X(\omega) (radians)','fontsize',16,'fontname','times')
set(findobj('type','text'),'fontname','times')
set(findobj('type','line'),'linewidth',1.5)
set(findobj('type','line'),'markersize',18)
set(findobj('type','axes'),'linewidth',2)
```





Plots reveals that both solutions are the same!