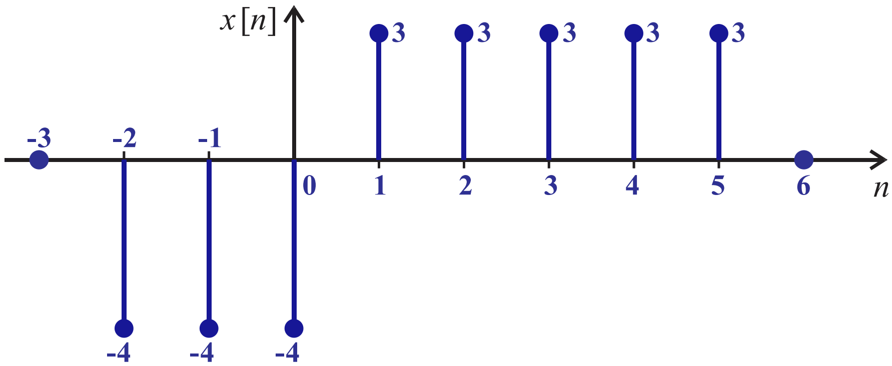
Use the DFT with $N = 12$ to approximate the DTFT of the signal $x[n]$ shown below. Plot the amplitude and phase spectrum (rad) of the exact DTFT and DFT approximation for $0 \le \Omega \le 2\pi$. Use solid lines for the exact DTFT and dots for the DFT approximation to the DTFT on the plots. Repeat for $N = 32$.



From DTFT_A.docx

$$x[n] = -4\,p_3[n+1] + 3\,p_5[n-3]$$

use Table 4.1 DTFT pair for a rectangular pulse of length $L = 2q+1$

$$p_{2q+1}[n] \leftrightarrow \frac{\sin[(q+\frac{1}{2})\Omega]}{\sin(\Omega/2)}$$

use Table 4.2 DTFT properties:

linearity $\quad a\,x[n] \leftrightarrow a\,X(\Omega)$

time-shift $\quad x[n-q] \leftrightarrow X(\Omega)\,e^{-jq\Omega}$

For $p_3[\;]$, $L = 2(1)+1$ $\;(q=1)$ w/ $q=-1$ shift

For $p_5[\;]$, $L = 2(2)+1$ $\;(q=2)$ w/ $q=3$ shift

$$X(\Omega) = -4\,\frac{\sin[(1+\frac{1}{2})\Omega]}{\sin(\Omega/2)}\,e^{+j(1)\Omega} + 3\,\frac{\sin[(2+\frac{1}{2})\Omega]}{\sin(\Omega/2)}\,e^{-j3\Omega}$$

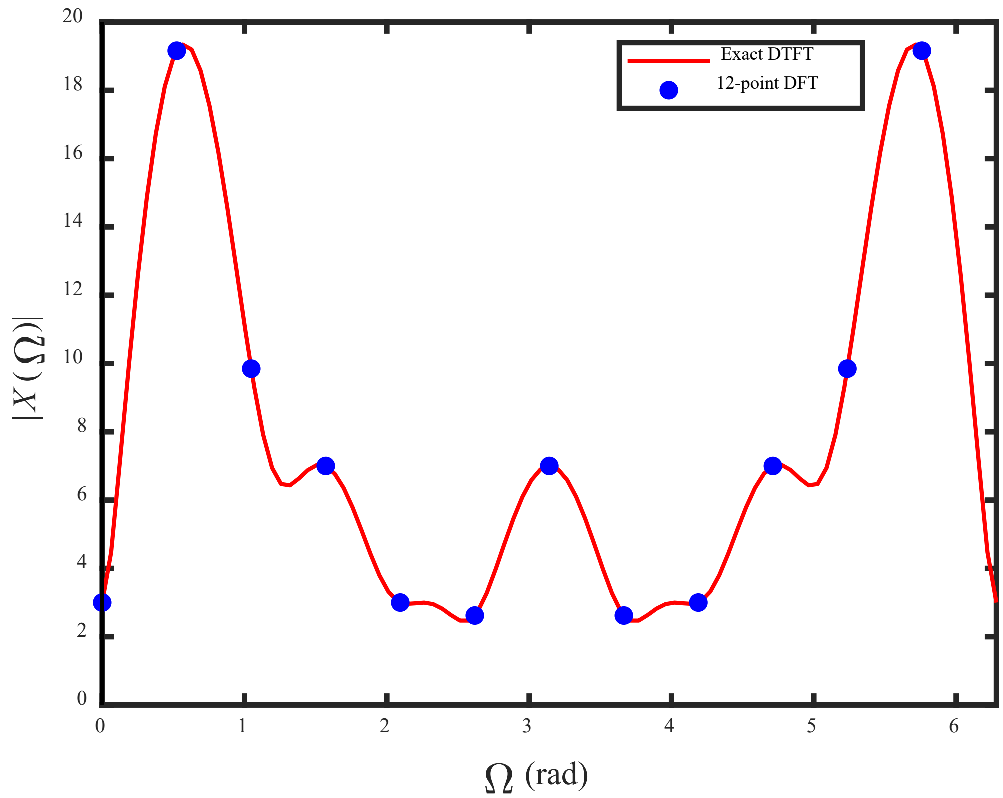
$$X(\Omega) = -4\,\frac{\sin(1.5\Omega)}{\sin(0.5\Omega)}\,e^{j\Omega} + 3\,\frac{\sin(2.5\Omega)}{\sin(0.5\Omega)}\,e^{-j3\Omega}$$

$$-\infty < \Omega < \infty$$

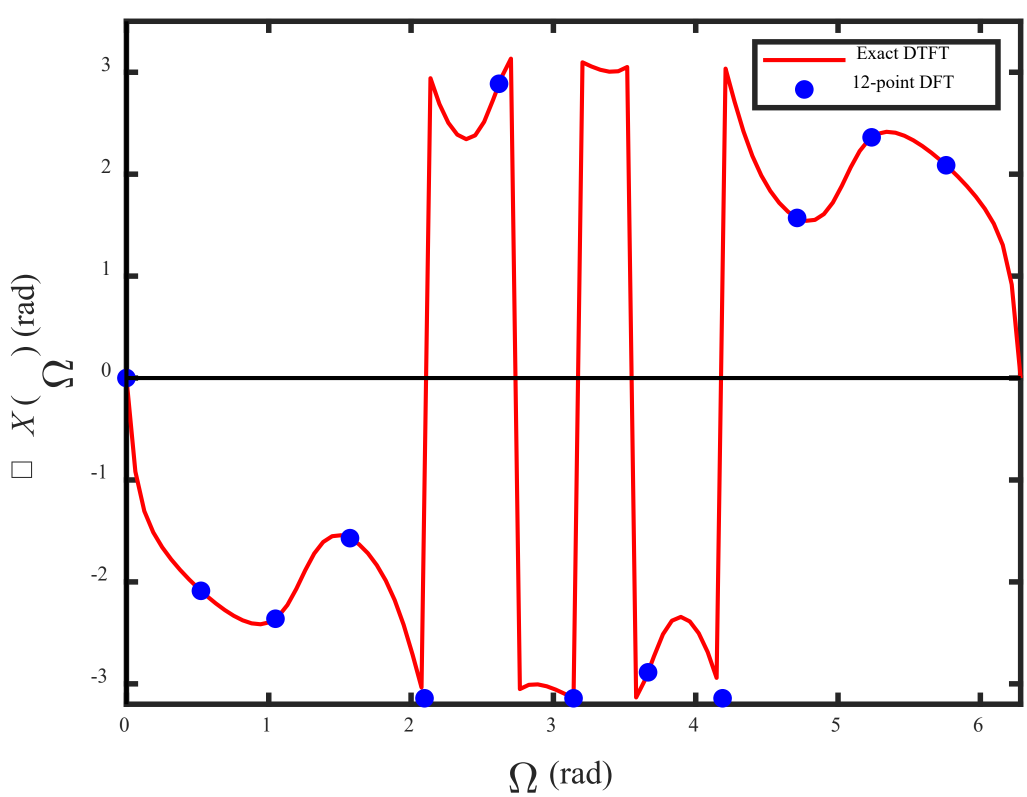
```
% Chapter 4 problem 4.16 (chap4_4_16.m)
% Plot DTFT magnitude and phase spectrum of
% x[n] = 2p5[n-2] - 2p3[n-6]
% and compare with N-point DFT of same signal.
%
clear;clc;close all;
% Exact DTFT expression
Omega = 0+eps : pi/50 : 2*pi;  % Define frequency vector to avoid 0
X1 =  2*exp(-j*2*Omega).*sin(2.5*Omega)./sin(0.5*Omega);
X2 = -2*exp(-j*6*Omega).*sin(1.5*Omega)./sin(0.5*Omega);
X = X1 + X2;
Xmag=abs(X); Xang=angle(X)*180/pi; % DTFT spectrum
% Define input signal w/ zero padding
N = input('Input length of DFT to calculate ');
x = [2,2,2,2,2,-2,-2,-2,zeros(1,N-8)];
% N-point DFT expression & corresponding frequencies
Xk = dft(x); k = 0:1:N-1; Omegak = 2*pi*k/N;
Xkmag=abs(Xk); Xkang=angle(Xk)*180/pi; % DFT line spectra
% Plot amplitude and phase spectrum
plot(Omega,Xmag,'r-',Omegak,Xkmag,'b.',[0 0],[0 15],'k-'),
axis([0 2*pi 0 15]),
xlabel('\Omega (radians)','fontsize',16,'fontname','times'),
ylabel('|{\itX}(\Omega)|','fontsize',16,'fontname','times'),
title('DTFT spectrum for {\itx}[{\itn}] = 2p_5[n-2]-2p_3[n-6]',...
    'fontsize',16,'fontname','times'),
legend(' Exact DTFT',[' ',num2str(N),'-point DFT'])
figure,
plot(Omega,Xang,'r-',Omegak,Xkang,'b.',[0 2*pi],[0 0],'k-',...
    [0 0],[-200 250],'k-'),
axis([0 2*pi -200 250]),
xlabel('\Omega (radians)','fontsize',16,'fontname','times'),
ylabel('\angle {\itX}(\Omega) (deg)','fontsize',16,'fontname','times'),
title('DTFT spectrum for {\itx}[{\itn}] = 2p_5[n-2]-2p_3[n-6]',...
    'fontsize',16,'fontname','times'),
legend(' Exact DTFT',[' ',num2str(N),'-point DFT'])
set(findobj('type','line'),'linewidth',1.5,'markersize',18)
set(findobj('type','axes'),'linewidth',2,'fontname','times')
set(findobj('type','axes'),'fontsize',12)
```

N = 12

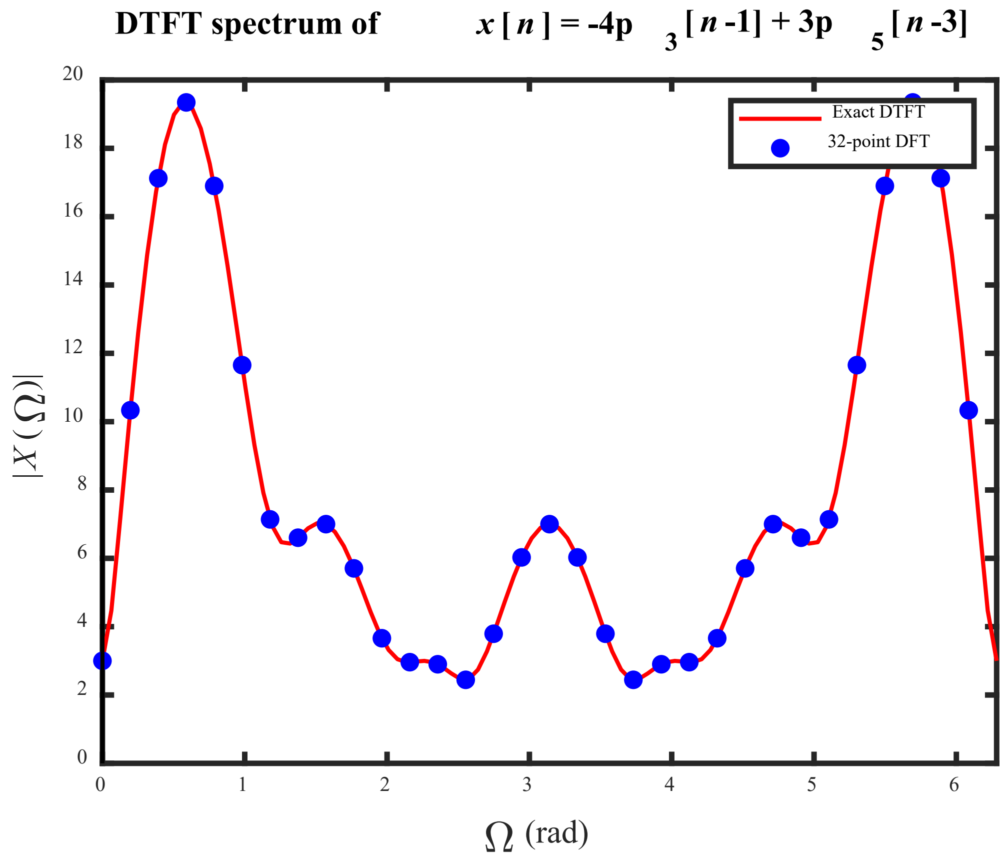
DTFT spectrum of $x[n] = -4p_3[n-1] + 3p_5[n-3]$

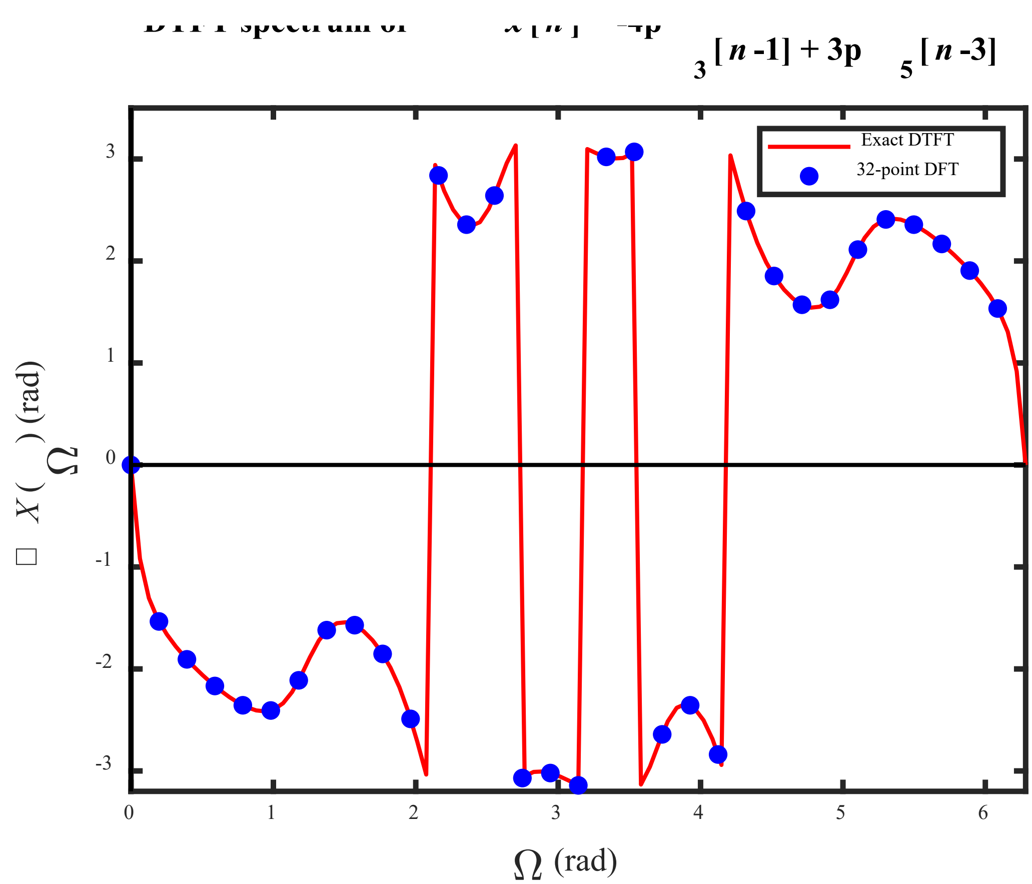


DTFT spectrum of $x[n] = -4p_3[n-1] + 3p_5[n-3]$



N = 32


DTFT spectrum of x [n] = -4p 3 [n -1] + 3p 5 [n -3]
Exact DTFT
32-point DFT
|X (Ω)|
Ω (rad)
20
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6


3 [n -1] + 3p 5 [n -3]
Exact DTFT
32-point DFT
X (Ω) (rad)
Ω (rad)
3
2
1
0
-1
-2
-3
0
1
2
3
4
5
6