homework 4 Matlab

P5.10 Plot the DTFT magnitude and angle of each of the following sequences using the DFT as a computation tool. Make an educated guess about the length N so that your plots are meaningful.

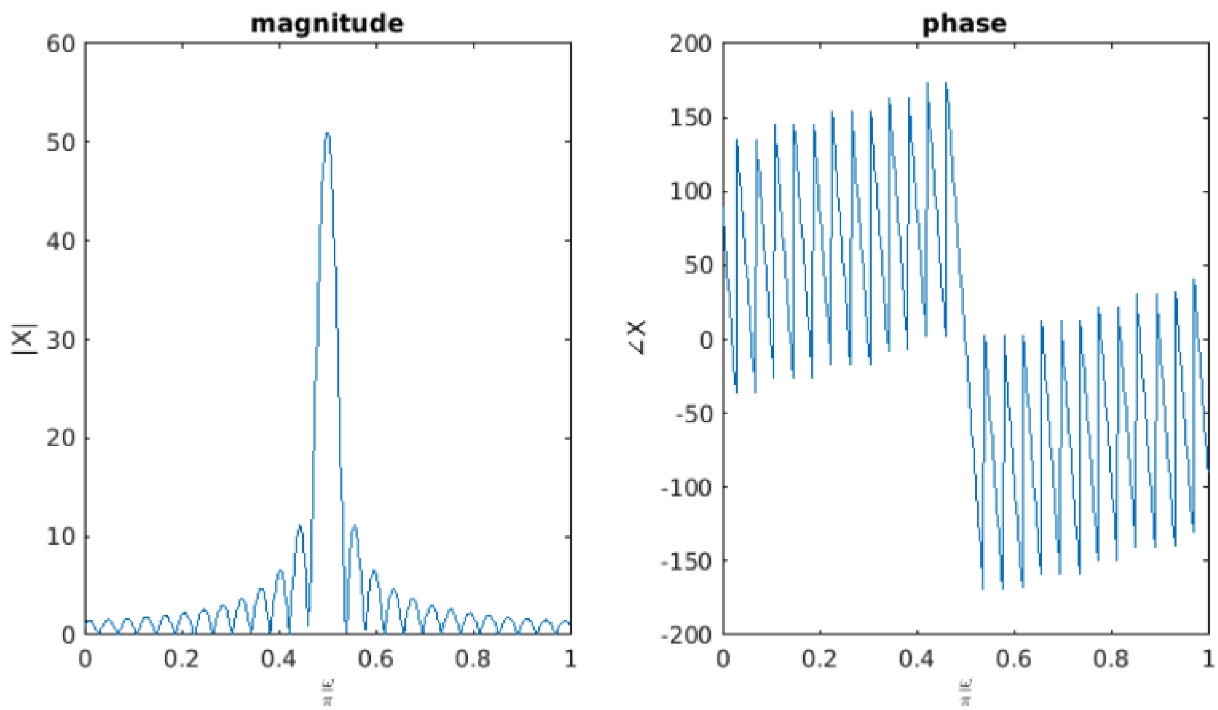
3. $x(n) = [\cos(0.5\pi n) + j\sin(0.5\pi n)][u(n) - u(n-51)]$.
4. $x(n) = \{1, 2, 3, \underset{\uparrow}{4}, 3, 2, 1\}$.

5.10.3

```
function [Xk] = dft(xn,N)
% Computes Discrete Fourier Transform
% -----------------------------------
% [Xk] = dft(xn,N)
% Xk = DFT coeff. array over 0 <= k <= N-1
% xn = N-point finite-duration sequence
% N = LengthofDFT
%
n = (0:1:N-1);          % row vector for n
k = (0:1:N-1);          % row vecor for k
WN = exp(-1j*2*pi/N);   % Wn factor
nk = n'*k;              % creates a N by N matrix of nk values
WNnk = WN .^ nk;        % DFT matrix
Xk = xn * WNnk;         % row vector for DFT coefficients
```

```
% P5.10
n = 0:1:1000;
N = length(n);
k = 0:1:N-1;
w = k*2*pi/N;
u = (n >= 0)-(n >= 51);
x = (cos(0.5*pi*n)+1j*sin(0.5*pi*n)).*u;
dft_result = dft(x,N);
x_axis = w/pi;
x_axis_limit = [0,1];
magnitude = abs(dft_result);
phase = angle(dft_result)*180/pi;

% magnitude
subplot(1,2,1);
plot(x_axis,magnitude);
```

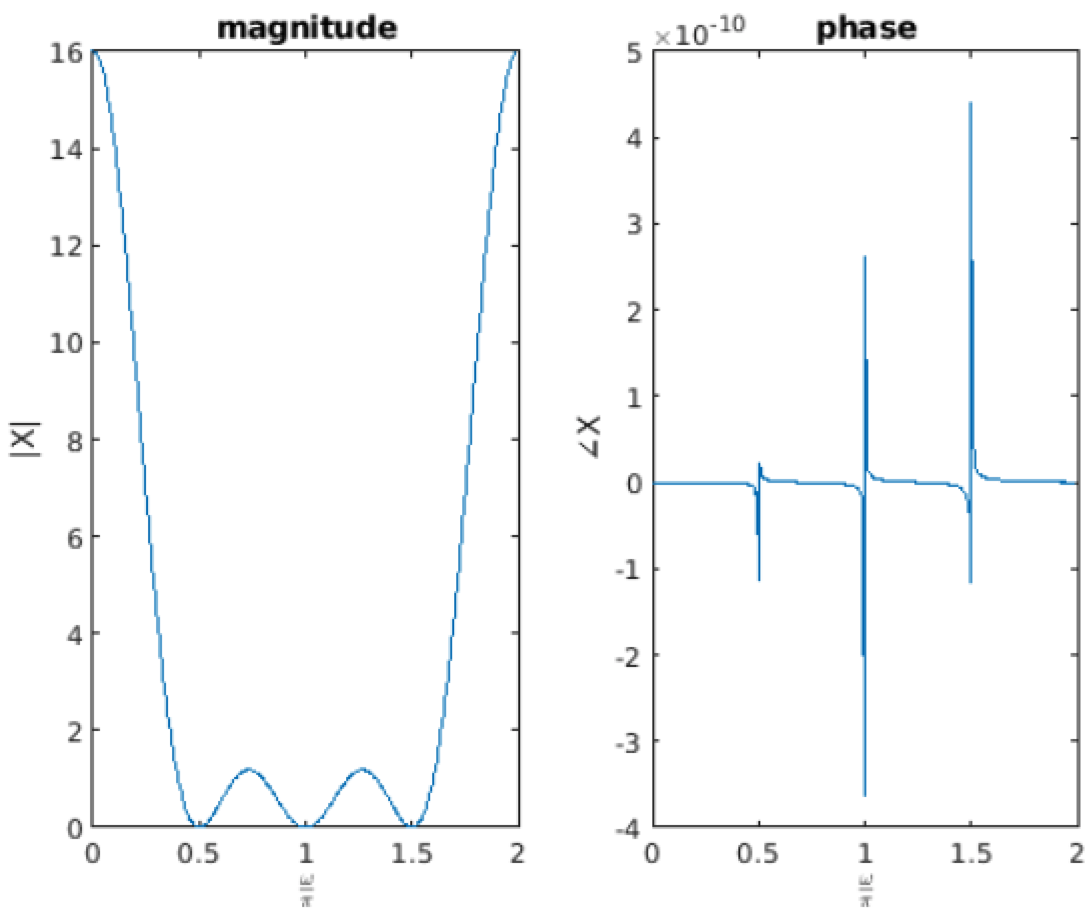
```
xlabel('$\frac{\omega}{\pi}$','Interpreter','latex');
xlim(x_axis_limit);
ylabel('|X|');
title('magnitude');

% phase
subplot(1,2,2);
plot(x_axis,phase);
xlabel('$\frac{\omega}{\pi}$','Interpreter','latex');
xlim(x_axis_limit);
ylabel('\angleX');
title('phase')
```



5.10.4

```
% P5.38
n = 0:1:500;
N = length(n);
x = [1 2 3 4 3 2 1];
x = [x zeros(1,N-7)];
k = 0:1:N-1;
w = k*2*pi/N;
dft_result = dft(x,N).*exp(-1j*w*-3);
magnitude = abs(dft_result);
phase = angle(dft_result)*180/pi;
```

```
x_axis = w/pi;

subplot(1,2,1);
plot(x_axis,magnitude);
xlabel('$\frac{\omega}{\pi}$','Interpreter','latex');
ylabel('|X|');
title('magnitude');

subplot(1,2,2);
plot(x_axis,phase);
xlabel('$\frac{\omega}{\pi}$','Interpreter','latex');
ylabel('\angleX');
title('phase');
```



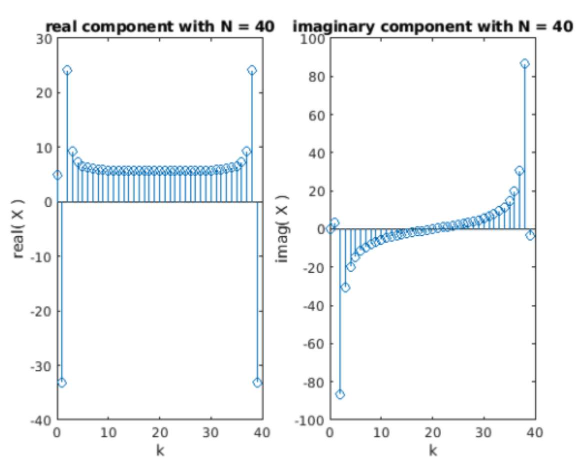
P5.38 An analog signal $x_a(t) = 2\sin(4\pi t) + 5\cos(8\pi t)$ is sampled at $t = 0.01n$ for $n = 0, 1, \ldots, N-1$ to obtain an N-point sequence $x(n)$. An N-point DFT is used to obtain an estimate of the magnitude spectrum of $x_a(t)$.

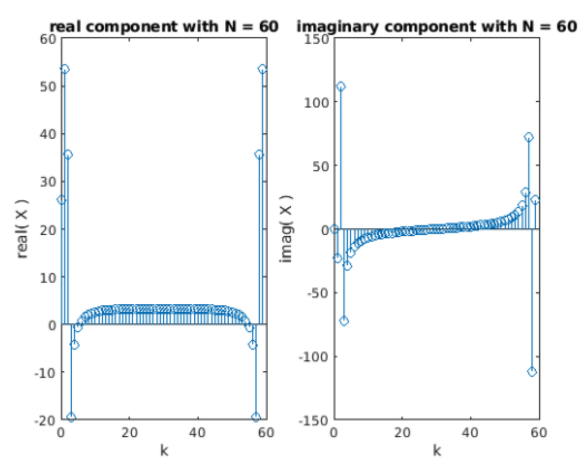
1. From the following values of N, choose the one that will provide the accurate estimate of the spectrum of $x_a(t)$. Plot the real and imaginary parts of the DFT spectrum $X(k)$.
   (a) $N = 40$, (b) $N = 50$, (c) $N = 60$.

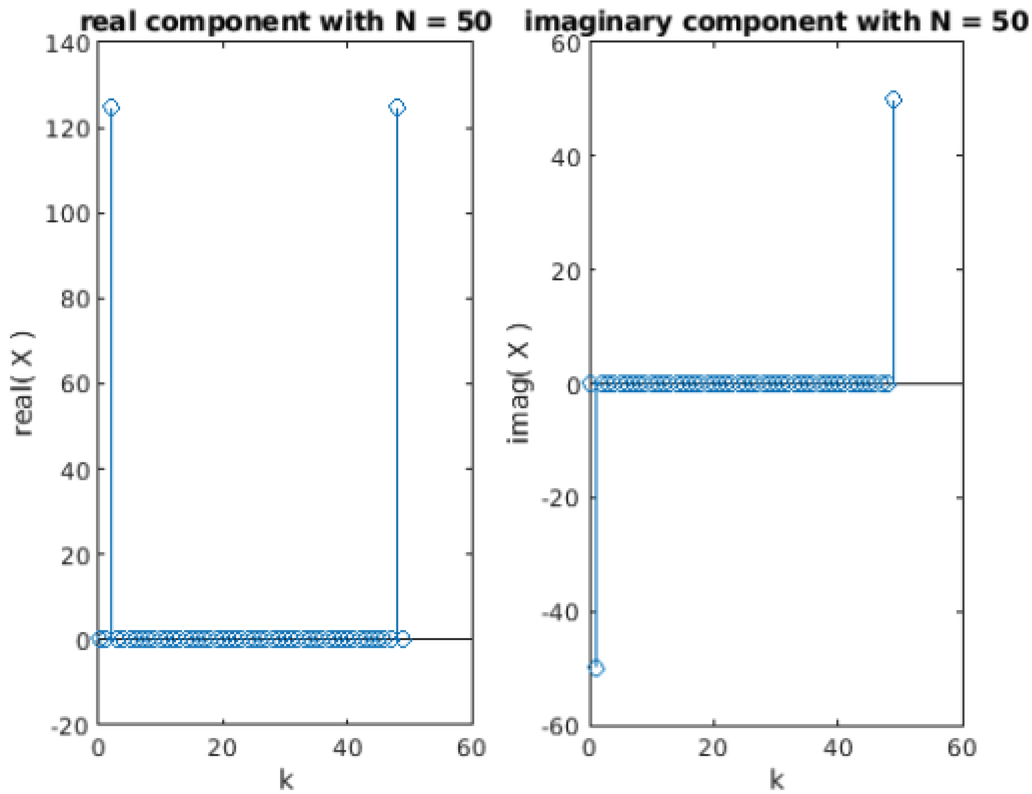
2. From the following values of N, choose the one that will provide the least amount of leakage in the spectrum of $x_a(t)$. Plot the real and imaginary parts of the DFT spectrum $X(k)$. (a) $N = 90$, (b) $N = 95$, (c) $N = 99$.

5.38.1

```
% P5.38.1
N = 50;
n = 0:1:N-1;
t = 0.01.*n;
x = (2.*sin(4.*pi.*t)) + (5.*cos(8.*pi.*t));

dft_result = fft(x,N);

subplot(1,2,1);
stem(n,real(dft_result));
xlabel('k');
ylabel('real( X )');
title('real component with N = 50');

subplot(1,2,2);
stem(n,imag(dft_result));
xlabel('k');
ylabel('imag( X )');
title('imaginary component N = 50')
```





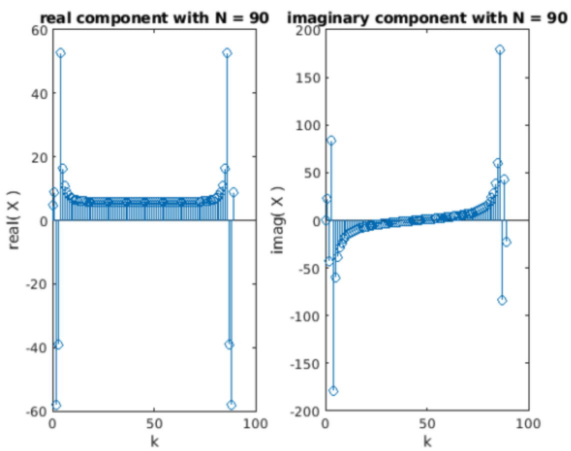


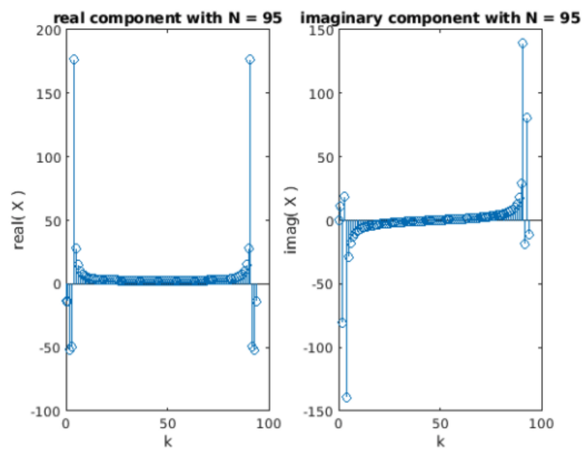
When $N = 50$ we get the best imaginary and real results because we get complete cycles of the $\sin$ and $\cos$.

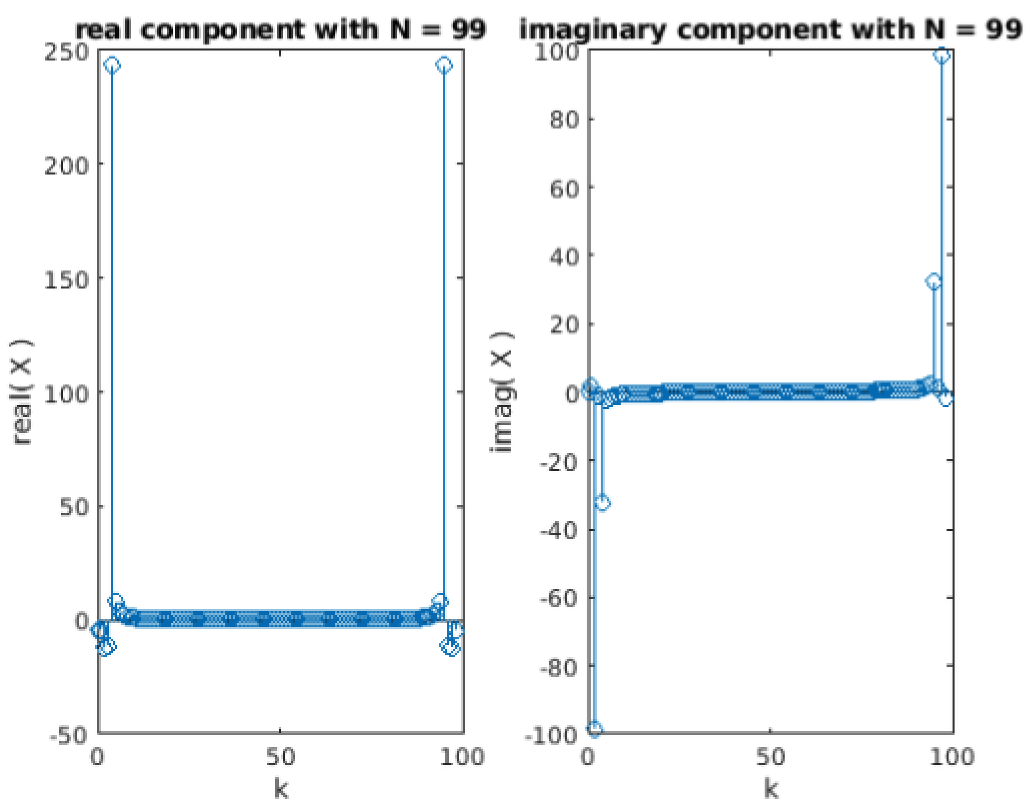
5.38.2

```
% P5.38.2
N = 99;
n = 0:1:N-1;
t = 0.01.*n;
x = (2.*sin(4.*pi.*t)) + (5.*cos(8.*pi.*t));

dft_result = fft(x,N);

subplot(1,2,1);
stem(n,real(dft_result));
xlabel('k');
ylabel('real( X )');
title('real component with N = 99');
```

```
subplot(1,2,2);
stem(n,imag(dft_result));
xlabel('k');
ylabel('imag( X )');
title('imaginary component with N = 99')
```







When $N = 99$ we get the best imaginary and real results because we get complete cycles of the $\sin$ and $\cos$ wich gives the least leakage.