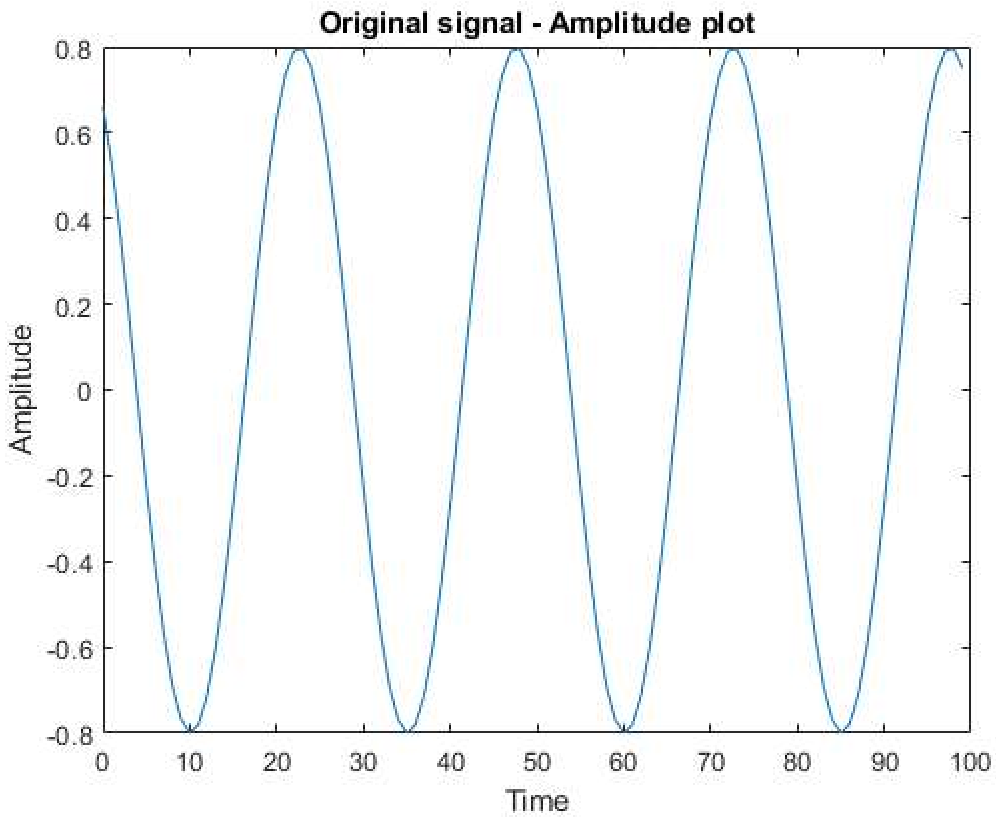
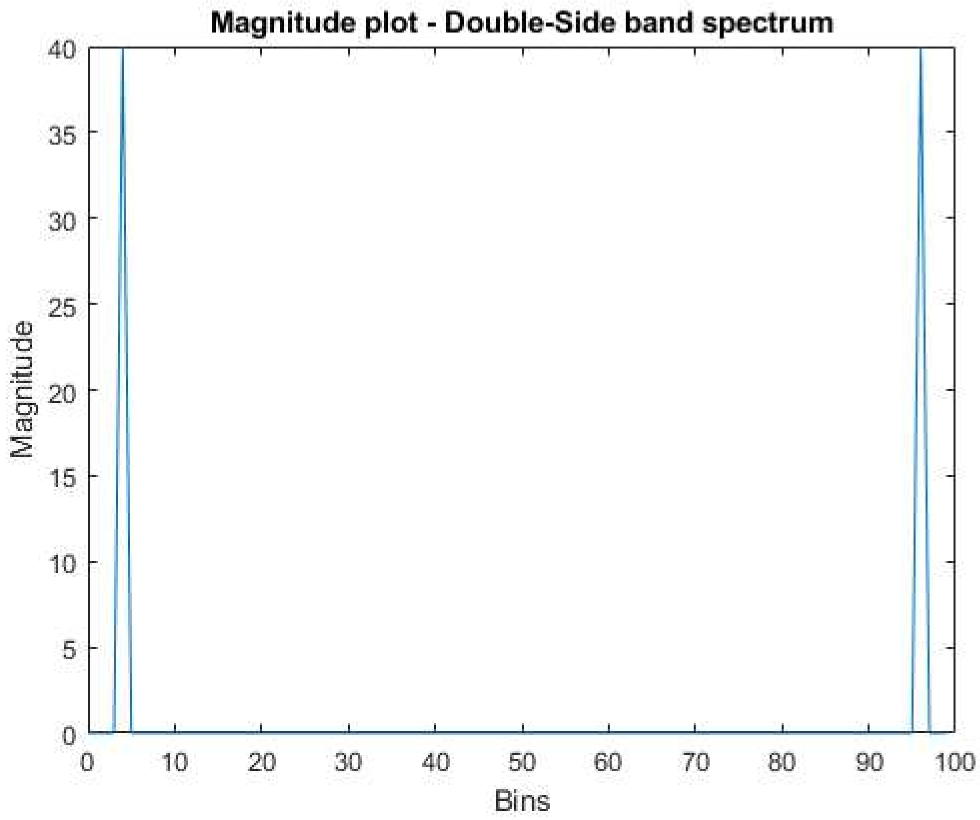
Contents

How to compute the DFT of a simple sinusoid signal using MATLAB

```
% Remove all global variables from the current workspace
clear;
% Clear all input & output from the command window display
clc;

% DFT (Discrete Fourier Transform)
% FFT (Fast Fourier Transform) - fast algorithm that computes DFT

% For a sampling frequency (fs) of 100 and a length of a signal to analyze
% is 1sec, the signal is 100 samples long or 100 bins
% fs/2 = 50Hz
% In this example 50 DFT bins corresponds to 50Hz so 4Hz corresponds to 4bins

fs = 100;   % Sampling frequency = 100Hz
f1 = 4;     % Sinusoidal Frequency = 4Hz
T = 1/fs;   % Sampling interval
A = 0.8;    % Amplitude = 0.8
P = 0.6;    % Phase = 0.6

% For a duration of 1sec there are 4 cycles present
t = 0 : T : 1 - T;           % Time vector
x1 = A*cos(2*pi*f1*t + P);  % Single sinusoid signal
%figure(1)

% Length of x1
L = length(x1);              % Length of signal, 100

plot(t*100,x1);
title('Original signal - Amplitude plot');
xlabel('Time');
ylabel('Amplitude');
```

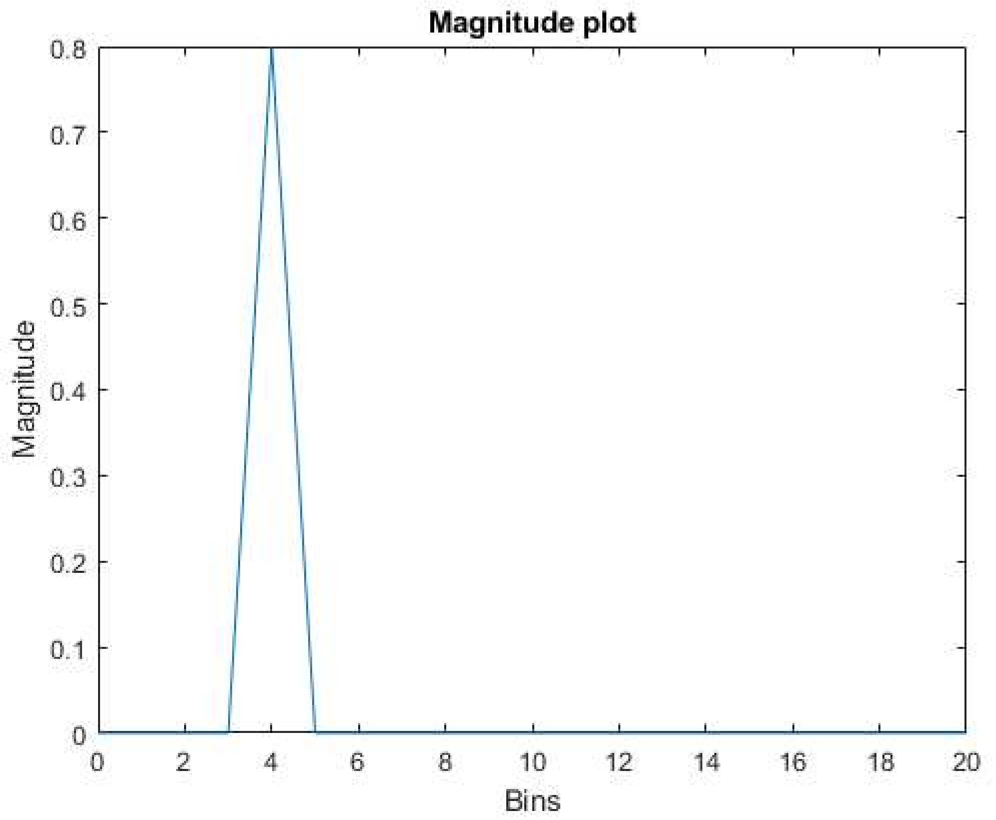



```
% Using here capital X1 for frequency content & lower case x1 for time domain content.
% Compute the DFT of x1 using a Fast Fourier transform (FFT) algorithm.
% X1 is a sequence of complex numbers returned by the FFT function
X1 = fft(x1);     % Compute DFT of x1

% Double-Side Band spectrum
plot((0:length(X1)-1),abs(X1));
title('Magnitude plot - Double-Side band spectrum');
xlabel('Bins');
ylabel('Magnitude');

% Plot the portions of a plot x-axis to be able to zoom into the frequencies of interest (if required)
% xlim([0,20]);
% xlim([80,100]);
```



Compute the single-side band (SSB) spectrum, normalize it with the signal length & plot it's Magnitude response

```
% If we take the spectrum associated with positive frequencies only
% and multiply it by 2, we will get the SSB spectrum

SSB = X1(1:L/2);
SSB(2:end) = 2*SSB(2:end);
f = (0:L/2-1)*(fs/L);
P1 = abs(SSB/L);

plot(f,P1);          % Normalizing the spectrum with signal length
title('Magnitude plot');
xlabel('Bins');
ylabel('Magnitude');

% Plot a portion of a plot x-axis 0->20 to be able to zoom into the frequency of interest
xlim([0,20]);
```



How to deduce the Magnitude & Phase information of the DFT

```
% To get the Magnitude of the DFT
%   5 here refers to bin no. 4 due to MATLAB indexing issues
%   MATLAB indexes start at no.1 whereas mathematically we normally start at 0
% FFT Magnitude = [A*L]/2 = [0.8*100]/2 = 40
%   where L is the length of the signal being analysed
m = abs(X1(5))                  % Magnitude @bin no. 4, 40

% Actual original amplitude of sinusoid signal
% Normalising magnitude into amplitude
a = (abs(X1(5))/L)*2            % Amplitude, [40/100]*2 = 0.8

% Phase of sinusoid signal
p = angle(X1(5))                % Phase, 0.6
```

```
m =

    40


a =

    0.8000


p =

    0.6000
```

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