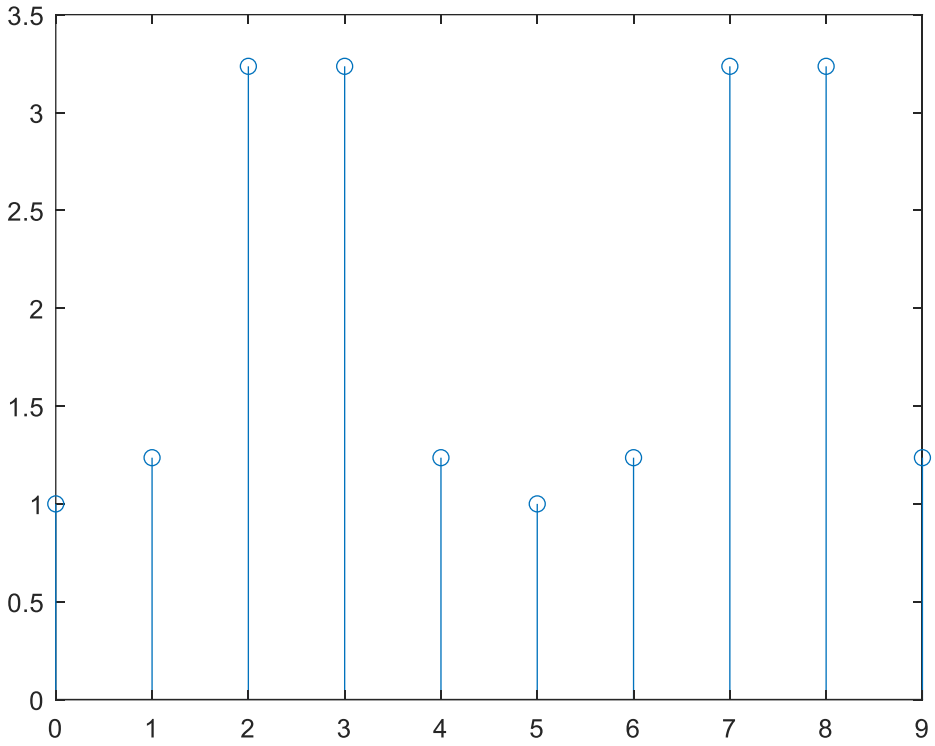
DFT example, finite-length sinusoid

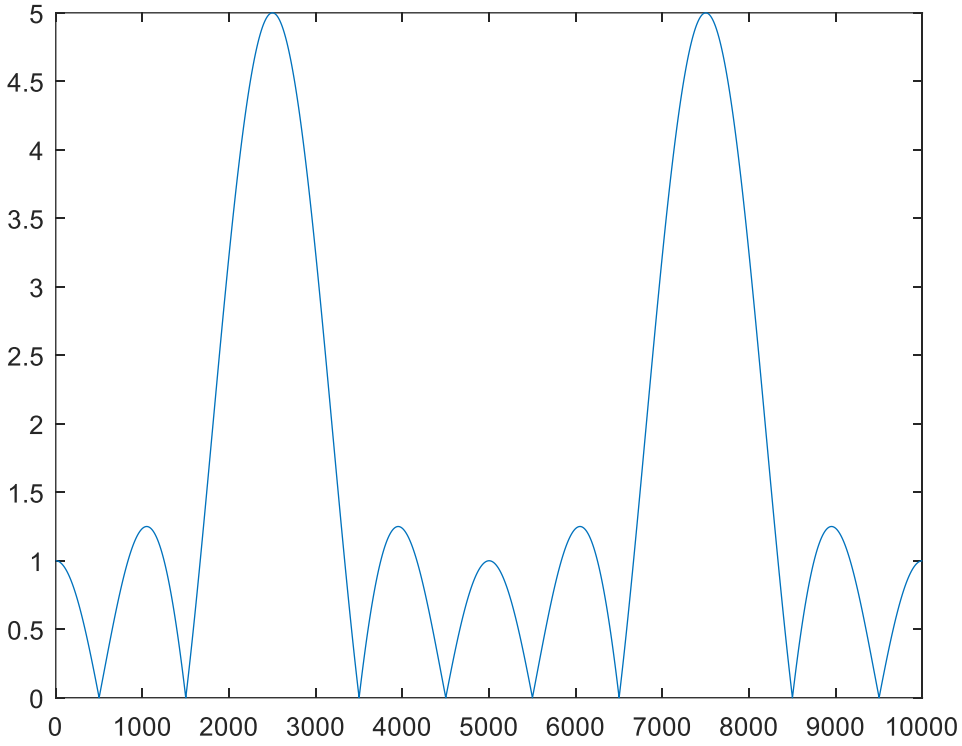
```
N = 10;
 n = 0:N-1;
 x = cos(2*pi*0.25*n);
 X = fft(x);
 k= 0:N-1;
 figure(1), stem(k , abs(X) )
```



Notice that we don't get the two tall impulses we would expect from a single sinusoid. This is because it is a finite-length signal. We can zero-pad to increase the number of frequency samples.

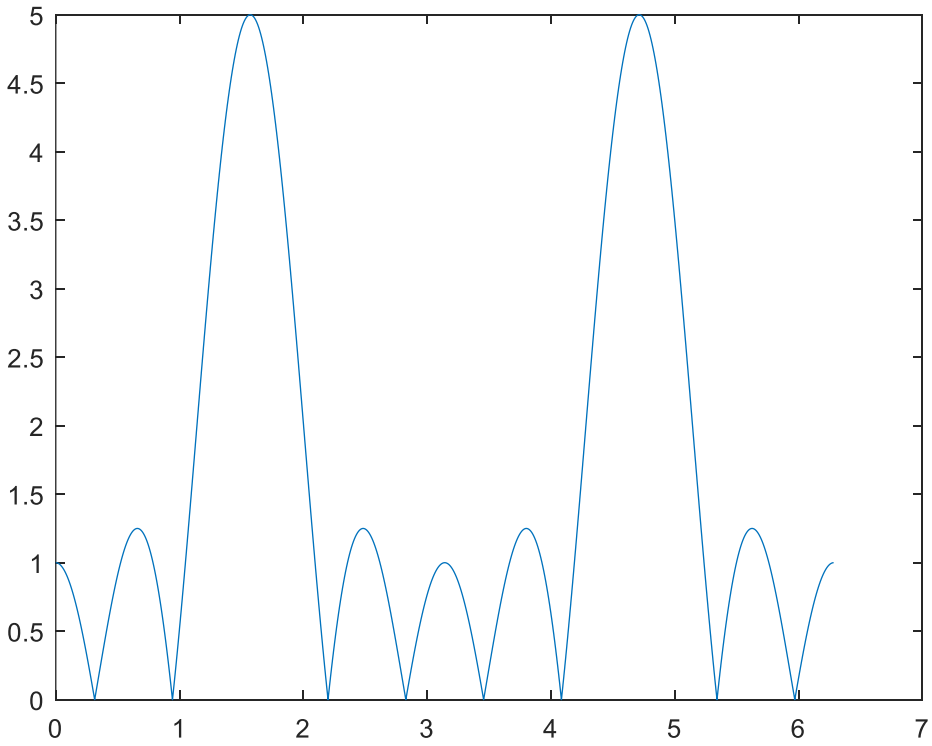
```
NFFT = 10000;
X = fft(x, NFFT);
k = 0:NFFT-1;
```

figure(2), plot(k, abs(X))



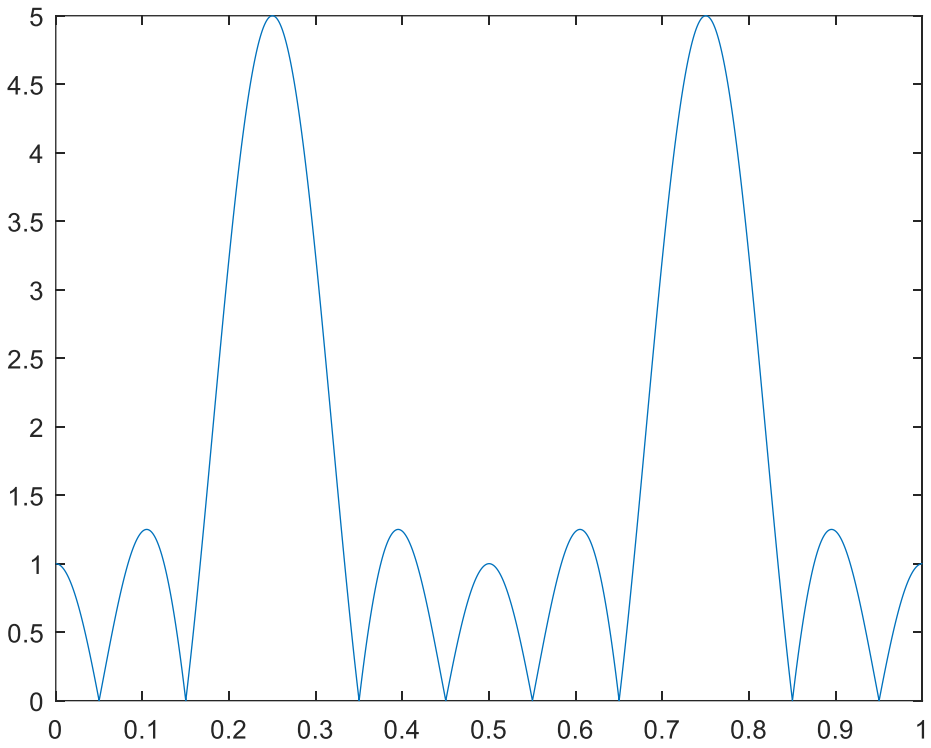
This is plotted versus k on the horizontal axis. It would be more useful to plot versus frequency.

```
wk = 2*pi/NFFT*k;

figure(3), plot(wk , abs(X) )
```



Notice the horizontal axis labels go from 0 to 2*pi. A better choice is the normalized Hz frequency, fk.

```
fk = wk /(2*pi);

figure(4), plot(fk , abs(X) )
```



Now we can see the peak occurs at the 0.25 we used when we created the sinusoid. Also notice all the smaller peaks. They are caused by the finite length window of observation. They are called ***sidelobes***. The tall wide peaks are called ***mainlobes***.