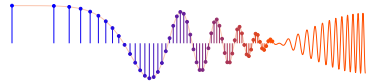

PROBLEM:

Suppose that a MATLAB function has been written to calculate a sum of discrete-time sinusoids, e.g., something similar to the function that was written for the lab. Here is the actual function:

```
function  xn = makedcos(omegahat,XX,Length)
xn = real( exp( j*(0:Length-1)'*omegahat(:)' ) * XX(:));
```

(a) Write an equation for $x[n]$, the discrete-time signal that is created by this MATLAB function, when the following function call is used:

```
xn = makedcos(pi*[0,0.25,0.75,1.75],[1,1-1i,-7i,2i],200001)
```

Your equation should be in terms of cosine functions. To do this you must figure out how the matrix multiplications and `exp( )` in the MATLAB statement defining `xn` work. (For this part, ignore the fact that the total length of the signal `xn` is finite.)

(b) Draw a plot of the discrete-time spectrum (vs. $\hat{\omega}$) of the discrete-time signal defined by this MATLAB operation. Make sure that you include all the spectrum components in the $-\pi$ to $+\pi$ interval.

McClellan, Schafer and Yoder, *Signal Processing First*, ISBN 0-13-065562-7.
Prentice Hall, Upper Saddle River, NJ 07458.

SOLUTION

a) $x[n] = \mathrm{Re}\left(\sum_{i=1}^{4} (XX)_i \, e^{j\pi\hat{\omega}_i n} \right) \; ; \quad n = 0 \text{ -- } 200000$

$= 1 + \mathrm{Re}\left[(1-j)\, e^{j\frac{\pi n}{4}}\right] + \mathrm{Re}\left[(-7j)\, e^{j\frac{3\pi}{4}n}\right] + \mathrm{Re}\left[(2j)\, e^{j\frac{7\pi}{4}n}\right]$

$e^{j\frac{7\pi}{4}n} = e^{-j\frac{\pi}{4}n}$

$\mathrm{Re}\left[-2j\, e^{j\frac{\pi}{4}n}\right]$

$= 1 + \mathrm{Re}\left((1-3j)\, e^{j\frac{\pi}{4}n}\right) + \mathrm{Re}\left((-7j)\, e^{j\frac{3\pi}{4}n}\right)$

$= 1 + \sqrt{10}\cos\left(\frac{\pi}{4}n + \varphi\right) + 7\cos\left(\frac{3\pi}{4}n - \frac{\pi}{2}\right)$

$\tan\varphi = -3 \; ; \quad -\frac{\pi}{2} < \varphi < 0 \rightarrow \varphi = -1.249$

(b)