PROBLEM:

Suppose that a MATLAB function has been written to calculate a sum of discrete-time sinusoids:

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

If the following MATLAB command is used to make an output sound:

```
soundsc( makedcos(pi*linspace(0,0.8,3),[-1,j,1-j],4000), 8000 )
```

(a) Draw a plot of the discrete-time spectrum (vs. $\hat{\omega}$) of the discrete-time signal defined by this MATLAB operation.

(b) Draw a plot of the continuous-time spectrum (vs. f in Hz) of the analog output signal defined by the `soundsc()` function.

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

SOLUTION

(a) The soundsc function calls makedcos which defines the frequencies to be:

$$\hat{\omega} = \pi * [0, 0.4, 0.8] = [0, 0.4\pi, 0.8\pi]$$

Note: linspace(0,0.8,3) generates a length-3 vector starting at 0, ending at 0.8.

The complex amplitudes are:

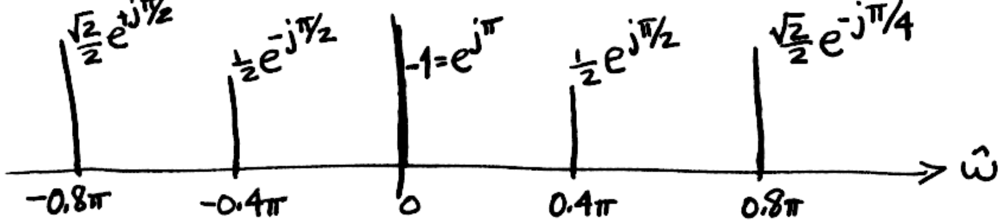
$$Z = [-1, j, 1-j]$$

Thus x[n] can be written as the following <u>MATH</u> expression

$$x[n] = \Re e\left\{ -1e^{j0} + \underbrace{j}_{e^{j\pi/2}} e^{j0.4\pi n} + \underbrace{(1-j)}_{\sqrt{2}e^{-j\pi/4}} e^{j0.8\pi n} \right\}$$

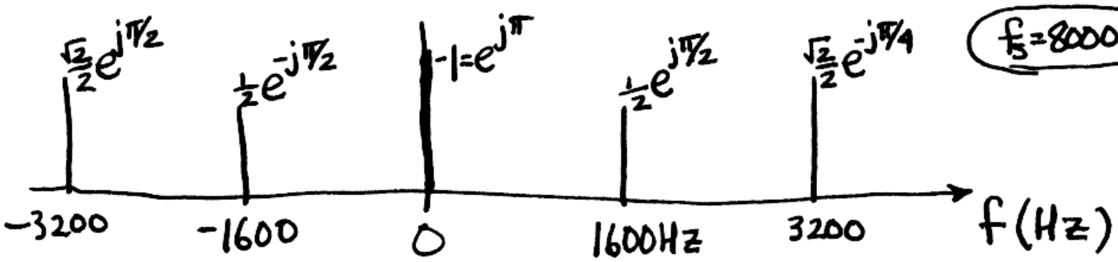
$$x[n] = -1 + \cos(0.4\pi n + \pi/2) + \sqrt{2}\cos(0.8\pi n - \pi/4)$$

Now it should be easy to draw the "digital" spectrum



(b) To convert the spectrum to analog use $f = \frac{\hat{\omega}}{2\pi} f_s$

$f_s = 8000$



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