

Thus with  $N = 1000$ , the index 2/2

$k = 150$  corresponding to  $f = 3000$  Hz

For  $k = 800$ , we need to be careful.

Because  $X(e^{j\omega})$  is periodic,

$$X(e^{j\omega}) = X(e^{j(\omega + 2\pi)})$$

$k = 800$  corresponds to the  
frequency

$$\omega_k = \frac{2\pi}{N}k = \frac{2\pi}{N}(k - N) = -200 \frac{2\pi}{N}$$

With  $N = 1000$  this is  $\omega_k = -0.4\pi$ . In  
analog freq., this corresponds to  $\Omega_k = -8000\pi$

or  $f_k = -4000$  Hz.

4b)

The spacing between spectral  
samples is

$$\Delta f = \frac{20.000}{N} = \frac{20000}{1000} = 20 \text{ Hz}$$