ECEn 487 - Introduction to Digital Signal Processing

Winter 2013

Quiz 11

1. Suppose I have a signal $x[n] = \sin(2\pi n/7)$. I take a 16-point DFT of $x[n]$ hoping to resolve the DTFT of this signal, but it doesn't quite look like I think it would (impulses).

   a) (1 pt) What kind of window must you be assuming for this problem?

   Rectangular

   b) (2 pt) If $v[n] = x[n]w[n]$, what is $V(e^{j\omega})$ in terms of W, the DTFT of the window?

   $$V(e^{j\omega}) = \frac{1}{2j}\left(W\left(e^{j(\omega-\frac{2\pi}{7})}\right)\right) + \frac{1}{2j}\left(W\left(e^{j(\omega+\frac{2\pi}{7})}\right)\right)$$

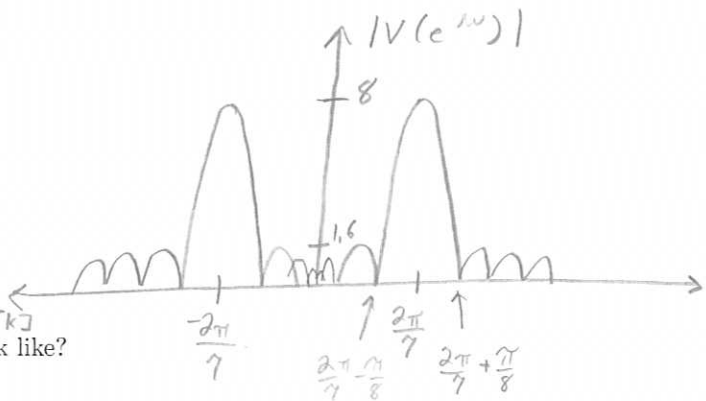
   c) The window has a nice DTFT, $W\left(e^{j\omega}\right) = e^{-j\omega(L-1)/2}\frac{\sin(\omega L/2)}{\sin(\omega/2)}$. (1 pt) Draw $\left|V\left(e^{j\omega}\right)\right|$ and indicate the maximum heights of the main lobes (1 pt), the null locations around the side lobes (1 pt), and the approximate height of the side lobes (1 pt) (Hint: 13 dB ≈ 0.2).

   $W(e^{j\omega}) = e^{-j\omega 15/2}\frac{\sin(8\omega)}{\sin(\omega/2)}$

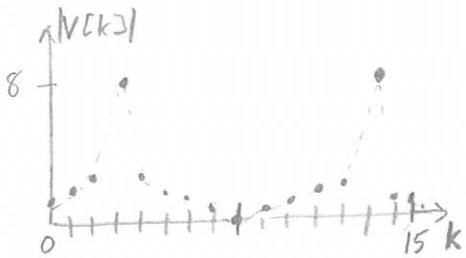
   $W(e^{j0}) = \frac{\cos(8\omega)(8)}{\cos(\omega/2)(1/2)}\Big|_{\omega=0} = 16$

   $8\omega = \pi$

   $\omega = \pi/8$

   d) (1 pt) What will the 16-point DFT look like?

   e) (2 pt) Suppose I take my $v[n]$ and pass it through a Hilbert Transformer to get $y[n]$. Suppose I find $z[n] = v[n] + jy[n]$. What will $\left|Z\left(e^{j\omega}\right)\right|$ look like?