DSP Exercises: Spectra

The **due date** for this homework is **Sun 14 Apr 2013 8:00 PM EDT**.

Question 1

What is the DTFT (discrete-time Fourier transform) of the signal $\delta(n-1)+\delta(n-7)$?

Type your answer as an expression involving complex exponentials.

Preview

Question 2

What is the **length-8** DFT of the signal $\delta(n-1)+\delta(n-7)$?

Type your answer as an expression involving complex exponentials and k.

Preview

Question 3

A colleague wants to check the answer provided for the length-8 DFT of the signal $\delta(n-1)+\delta(n-7)$. She computes the inverse DFT of the answer and obtains $\delta(n-1)+\delta(n+1)$. She checks her calculations and finds nothing wrong. Did she find the inverse DFT correctly?

- $\delta(n-1)+\delta(n-7)$ and $\delta(n-1)+\delta(n+1)$ are the same signals once they are made periodic. She is correct.
- $\delta(n-1)+\delta(n-7)$ and $\delta(n-1)+\delta(n+1)$ are different signals. She made a mistake.
- She must have used the wrong formula for the DFT.

Question 4

You have been asked to grade answers for the DTFT of a variety of signals for a *large* number of students. *Without knowing what the signal was in each case*, which of the following answers **cannot** be correct?

Check **all** that cannot possibly be right.

- $\frac{1}{a+j\pi f}$
- $\cos(2\pi fT)$
- $e^{-j2\pi 2f}$
- $\frac{\sin 2\pi f}{\pi f}$
- $\frac{\sin 2\pi f}{\sin \pi f}$
- $e^{-j\pi f}\,\frac{\sin 2\pi f}{\sin \pi f}$

Question 5

In computing the spectrogram, we need to "window" the signal. A typical window is the Hanning window, which corresponds to one cycle of a sinusoid over the window's duration. Taking N to be the duration and the signal is defined for $n=0,\ldots,N-1$, what is the formula for the Hanning window?

- $\frac{1}{2}\left(1-\cos\frac{2\pi n}{N}\right)$

- $\sin \frac{2\pi n}{N}$
- $\frac{1}{2}\left(1+\sin \frac{2\pi n}{N}\right)$
- $\frac{1}{2}\left(1+\cos \frac{2\pi n}{N}\right)$

Question 6

My boss wants me to calculate the spectrum of a length 1024 signal. When I finally receive the data, I discover it is 8 times longer than he says (the length is actually 8192).

If I use the DFT, how much longer will it take to calculate spectrum than to calculate the spectrum of the length 1024 signal?

- About 8 milliseconds longer.
- The additional time depends on the speed of my compute.
- 64 times the original time.
- 8 times the original time.

Question 7

My boss wants me to calculate the spectrum of a length 1024 signal. When I finally receive the data, I discover it is 8 times longer than he says (the length is actually 8192).

If I use the FFT, how much longer will the calculation take?

- It will take the same amount of time since the FFT is so efficient.
- A little more than 8 times longer.
- A factor of 64 times longer.
- Depends on how fast my computer is.

☐ In accordance with the Honor Code, I certify that my answers here are my own work.

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