Feedback — DSP Exercises: Spectra

You submitted this homework on **Wed 3 Apr 2013 2:10 PM CDT -0500**. You got a score of **0.33** out of **7.00**. You can attempt again, if you'd like.

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.

You entered:

Preview Help

Your Answer	Score	Explanation
✘	0.00	Could not parse student submission
Total	0.00 / 1.00	

Question Explanation

The DTFT equals $e^{-j2\pi f}+e^{-j2\pi 7f}$.

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`.

You entered:

Preview Help

Your Answer	Score	Explanation
✘	0.00	Could not parse student submission
Total	0.00 / 1.00	

Question Explanation

The DFT equals $e^{-j2\pi k/8} + e^{-j2\pi 7k/8}$. This can be simplified by noting that $e^{j2\pi 8k/8} = 1$. Multiplying the last term by this quantity, we obtain the equivalent expression $e^{-j2\pi k/8} + e^{+j2\pi k/8} = 2\cos\left(\frac{2\pi k}{8}\right)$.

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?

Your Answer	Score	Explanation
$\delta(n-1) + \delta(n-7)$ and $\delta(n-1) + \delta(n+1)$ are different signals. She made a mistake.		
$\delta(n-1) + \delta(n-7)$ and $\delta(n-1) + \delta(n+1)$ are the same signals once they are made periodic. She is correct.		
She must have used the wrong formula for the DFT.		
Total	0.00 / 1.00	

Question Explanation

Because the DFT is a sampled version of the DTFT, the signal must be finite duration **and** will be periodic, the period being the length of the DFT. So, making $\delta(n-1)+\delta(n+1)$ periodic with period 8 (repeating it every 8 samples) and making $\delta(n-1)+\delta(n-7)$ periodic with period 8 results in the *same* signal. This example shows you that it is important to understand the periodicity imposed on the signal in the time domain by 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.

Your Answer		Score	Explanation
$\frac{1}{a+j\pi f}$	✘	0.00	Not periodic
$\cos(2\pi fT)$	✘	0.00	f must be dimensionless. Assuming T has units of time, this cannot be an answer.
$e^{-j2\pi 2f}$	✔	0.17	This is the DTFT of $\delta(n-2)$.
$\frac{\sin 2\pi f}{\pi f}$	✘	0.00	Not periodic.
$\frac{\sin 2\pi f}{\sin \pi f}$	✘	0.00	Periodic, but **not** a period of 1.
$e^{-j\pi f}\frac{\sin 2\pi f}{\sin \pi f}$	✔	0.17	Periodic with a period of 1. This is the DTFT of $\delta(n)+\delta(n-1)$.
Total		0.33 / 1.00	

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?

Your Answer	Score	Explanation
$\frac{1}{2}\left(1 + \cos\frac{2\pi n}{N}\right)$		
$\sin\frac{2\pi n}{N}$		
$\frac{1}{2}\left(1 - \cos\frac{2\pi n}{N}\right)$		
$\frac{1}{2}\left(1 + \sin\frac{2\pi n}{N}\right)$		
Total	0.00 / 1.00	

Question Explanation

Window functions must be positive. The formula is
$\text{hanning}(n) = \frac{1}{2}\left(1 - \cos\frac{2\pi n}{N}\right)$.

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?

Your Answer	Score	Explanation
About 8 milliseconds longer.		
64 times the original time.		

The additional time depends on the speed of my compute.

8 times the original time.

Total	0.00 / 1.00	

Question Explanation

Since the DFT has complexity $O(N^2)$, it will take 64 times longer to compute the spectrum.

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?

Your Answer	Score	Explanation
A little more than 8 times longer.		
It will take the same amount of time since the FFT is so efficient.		
Depends on how fast my computer is.		
A factor of 64 times longer.		
Total	0.00 / 1.00	

Question Explanation

Since the FFT has complexity $O(N \log_2 N)$, the computational time will increase by a factor of $\frac{8N \log_2 8N}{N \log_2 N} = 8\left(1 + \frac{\log_2 8}{\log_2 N}\right) = 8\left(1 + \frac{3}{10}\right) = 10.4$.