

DSP Midterm Exam

Monday, May 24, 2021

Question 1: T or F, Multiple Choice, and Short Answer (Estimated time: 5-10 minutes)

1. **T or F:** The time index n for DT signals usually has units of seconds.
2. **T or F:** DT signals are typically plotted as a series of lollipops.
3. **T or F:** A DT frequency of π is considered a high frequency.
4. **T or F:** A DT frequency of 2π is considered a low frequency.
5. **T or F:** The DTFT of a DT signal is periodic with a period of 2π .
6. The DTFT of a rectangle is a:
 - (a) Sine wave
 - (b) Periodic sinc
 - (c) Rectangle
 - (d) None of the above
7. The DTFT of a single impulse is:
 - (a) A single impulse
 - (b) A constant
 - (c) Infinite
 - (d) None of the above
8. A DT signal is given as follows:

$$x(n) = (3\delta(n) - 5\delta(n-1) + 3\delta(n-2))u(n+1)$$

The value of $x(n)$ at $n = 3$ is:

- (a) 0
- (b) 0.25
- (c) 0.5
- (d) 1
- (e) None of the above

9. A DT signal $x(n]$ is given as follows:

$$x(n) = 101$$

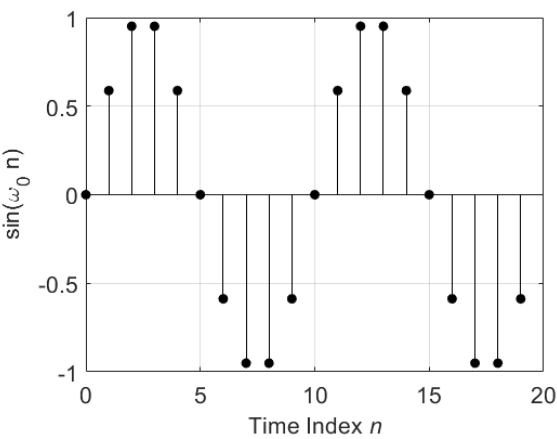
The length of $x(n]$ is:

- (a) 0
 - (b) 1
 - (c) 101
 - (d) ∞
 - (e) None of the above
10. A DT signal $x(n]$ is given as follows:

$$x(n) = \text{rect}_5(n)$$

We want to create a new signal $y(n]$ that is identical to $x(n]$ but is centered about $n = 0$ (i.e., we want a rectangle that is symmetric about time zero). To create $y(n]$, we should use:

- (a) $y(n) = x(2n)$
 - (b) $y(n) = x(n + 2)$
 - (c) $y(n) = x(n - 2)$
 - (d) $y(n) = x(n + 2) + x(n - 2)$
 - (e) None of the above
11. Two cycles of a DT sine wave $\sin(\omega_0 n)$ are shown in the following plot:



The value of ω_0 is:

- (a) $1/5$
- (b) $\pi/5$
- (c) 5
- (d) 5π
- (e) None of the above

12. Two DT signals, $x_1(n)$ and $x_2(n)$, are given as follows:

$$x_1(n) = \delta(n + 1) + \delta(n - 1)$$

$$x_2(n) = \delta(n) - \delta(n - 1)$$

In the space provided below, sketch the convolution of these two signals. You must show your work to receive credit.

13. A DT signal $x(n)$ is given as follows:

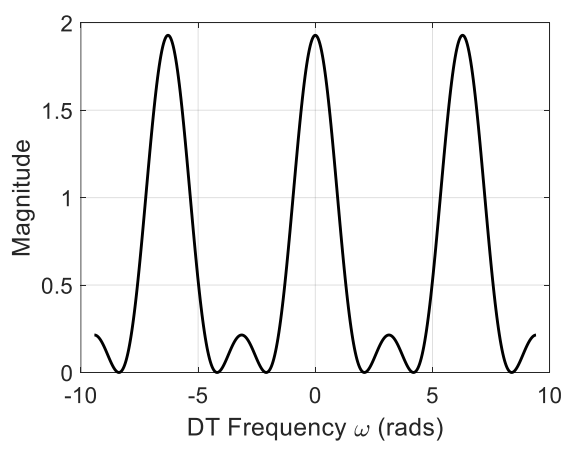
$$x(n) = \delta(n + 2) + 2\delta(n) + \delta(n - 2)$$

Which of the following is the DTFT $X(e^{j\omega})$ of this signal?

- (a) $e^{j2\omega} + 2 + e^{-j2\omega}$
- (b) $2e^{j\omega} + 2 + 2e^{-j\omega}$
- (c) $\delta(2\omega) + 2\delta(\omega) + \delta(-2\omega)$
- (d) $2\delta(\omega) + \delta(2\omega) - 2\delta(\omega)$
- (e) None of the above

14. In simple terms, describe the key difference between the DTFT of $\text{rect}_3(n)$ and the DTFT of $\text{rect}_3(n + 1)$:

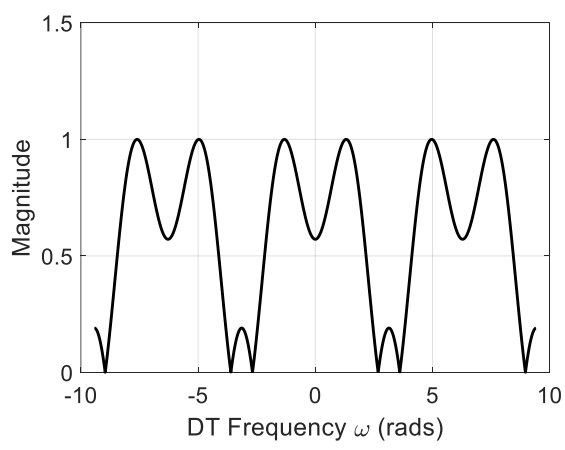
15. A DT signal $x(n]$ has a magnitude spectrum as shown below (showing the range -3π to $+3\pi$):



The magnitude spectrum of $x[n - 2]$ would look like:

<p>(a)</p> <p>This plot shows the original magnitude spectrum of $x[n]$ with peaks at $\omega = -6, 0, 6$ and nulls at $\omega = -9, -3, 3, 9$. It is identical to the original spectrum.</p>	<p>(b)</p> <p>This plot shows a magnitude spectrum with peaks at $\omega = -9, -3, 3, 9$ (magnitude 2) and nulls at $\omega = -6, 0, 6$. This represents a time shift of 1 sample.</p>
<p>(c)</p> <p>This plot shows a magnitude spectrum with peaks at $\omega = -9, -3, 3, 9$ (magnitude 2) and nulls at $\omega = -6, 0, 6$. This represents a time shift of 1 sample.</p>	<p>(d)</p> <p>This plot shows a magnitude spectrum with peaks at $\omega = -6, 0, 6$ (magnitude 2) and nulls at $\omega = -9, -3, 3, 9$. It is identical to the original spectrum.</p>
<p>(e) None of the above</p>	

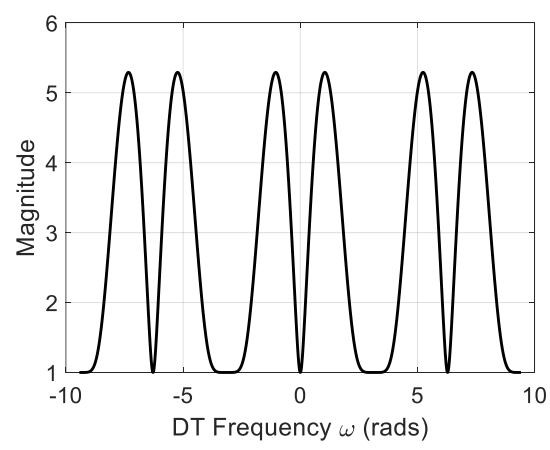
16. A DT signal $x(n]$ has a magnitude spectrum as shown below (showing the range -3π to $+3\pi$):



The magnitude spectrum of $-1.5x[n]$ would look like:

<p>(a)</p> <p>This plot is identical to the original magnitude spectrum of $x[n]$. It has a period of 2π with a peak magnitude of 1.0 at $\omega = 0$ and nulls at $\omega = \pm\pi$.</p>	<p>(b)</p> <p>This plot shows a periodic magnitude spectrum with a period of 2π. The peaks occur at $\omega = \pm\pi$ (approximately ± 3.14) with a magnitude of 1.5. The main lobe at $\omega = 0$ has a magnitude of approximately 0.6. There are nulls at $\omega = \pm\pi/2$ (approximately ± 1.57).</p>
<p>(c)</p> <p>This plot is identical to the original magnitude spectrum of $x[n]$. It has a period of 2π with a peak magnitude of 1.0 at $\omega = 0$ and nulls at $\omega = \pm\pi$.</p>	<p>(d)</p> <p>This plot shows a periodic magnitude spectrum with a period of 2π. The peaks occur at $\omega = 0$ with a magnitude of 1.5. The side lobes at $\omega = \pm\pi$ have a magnitude of approximately 0.6. There are nulls at $\omega = \pm\pi/2$ (approximately ± 1.57).</p>
<p>(e) None of the above</p>	

17. A DT signal $x(n]$ has a magnitude spectrum as shown below (showing the range -3π to $+3\pi$):



The magnitude spectrum of $\cos(\pi n) x(n]$ would look like:

<p>(a)</p> <p>This option shows a magnitude spectrum identical to the original signal $x[n]$, with six peaks at $\omega = -9, -6, -3, 0, 3, 6$ radians, each reaching a magnitude of approximately 5.3.</p>	<p>(b)</p> <p>This option shows a magnitude spectrum with twelve peaks at $\omega = -9, -7.5, -6, -4.5, -3, -1.5, 0, 1.5, 3, 4.5, 6, 7.5$ radians. Each peak reaches a maximum magnitude of approximately 5.3.</p>
<p>(c)</p> <p>This option shows a magnitude spectrum with six peaks at $\omega = -9, -6, -3, 0, 3, 6$ radians. The peaks are narrower and taller than in the original spectrum, reaching a maximum magnitude of approximately 5.3.</p>	<p>(d)</p> <p>This option shows a magnitude spectrum with six peaks at $\omega = -9, -6, -3, 0, 3, 6$ radians. The peaks are narrower and taller than in the original spectrum, reaching a maximum magnitude of approximately 2.5.</p>
<p>(e) None of the above</p>	