CENG 384 - Signals and Systems for Computer Engineers
Spring 2020
Written Assignment 1

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1. (a) $z + 3\overline{z} = j - 1$
$x + jy + 3(x - jy) = j - 1$
$4x - 2jy = j - 1$
$x = \dfrac{-1}{4}$, $y = \dfrac{-1}{2}$
$|z|^2 = x^2 + y^2$
$|z|^2 = \dfrac{1}{16} + \dfrac{1}{4} = \dfrac{5}{16}$

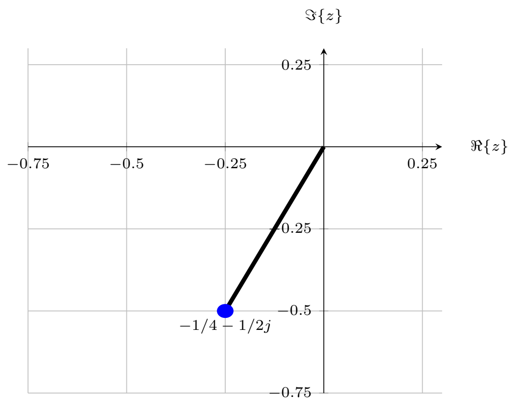


Figure 1: z on the complex plane.

(b) $z = a + jb$
$a = r\cos\theta$, $b = r\sin\theta$
$z = r\cos\theta + jr\sin\theta$
$z^2 = r^2(\cos^2\theta - \sin^2\theta) + j2r^2\cos\theta\sin\theta$
$\cos^2\theta - \sin^2\theta = 0$
$\theta = \pi/4$
$r^2\sin 2\theta = 25$
$r = 5$
$z = 5e^{j(\pi/4 + \pi k)}$
$z_0 = 5e^{j\frac{\pi}{4}}$ for k=0
$z_1 = 5e^{j\frac{5\pi}{4}}$ for k=1

(c) $z = \dfrac{(1+j)(1-\sqrt{3}j)}{1-j} = \dfrac{(1+j)(1+j)(1-\sqrt{3}j)}{(1-j)(1+j)}$ multiplying both numerator and denominator with $(1+j)$
$z = \dfrac{2j \cdot (1-\sqrt{3}j)}{2}$
$z = \sqrt{3} + j$
$r = \sqrt{3+1} = 2$
$\theta = \tan^{-1}(\dfrac{1}{\sqrt{3}}) = \pi/6$

(d) $j = e^{j\pi/2}$
$z = je^{-j\pi/2} = e^{j\pi/2}e^{-j\pi/2} = e^0 = 1$

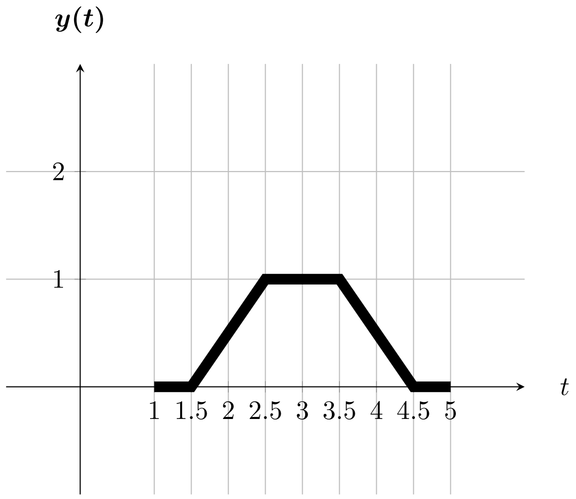


Figure 2: t vs. $y(t)$.

2.

3. (a)

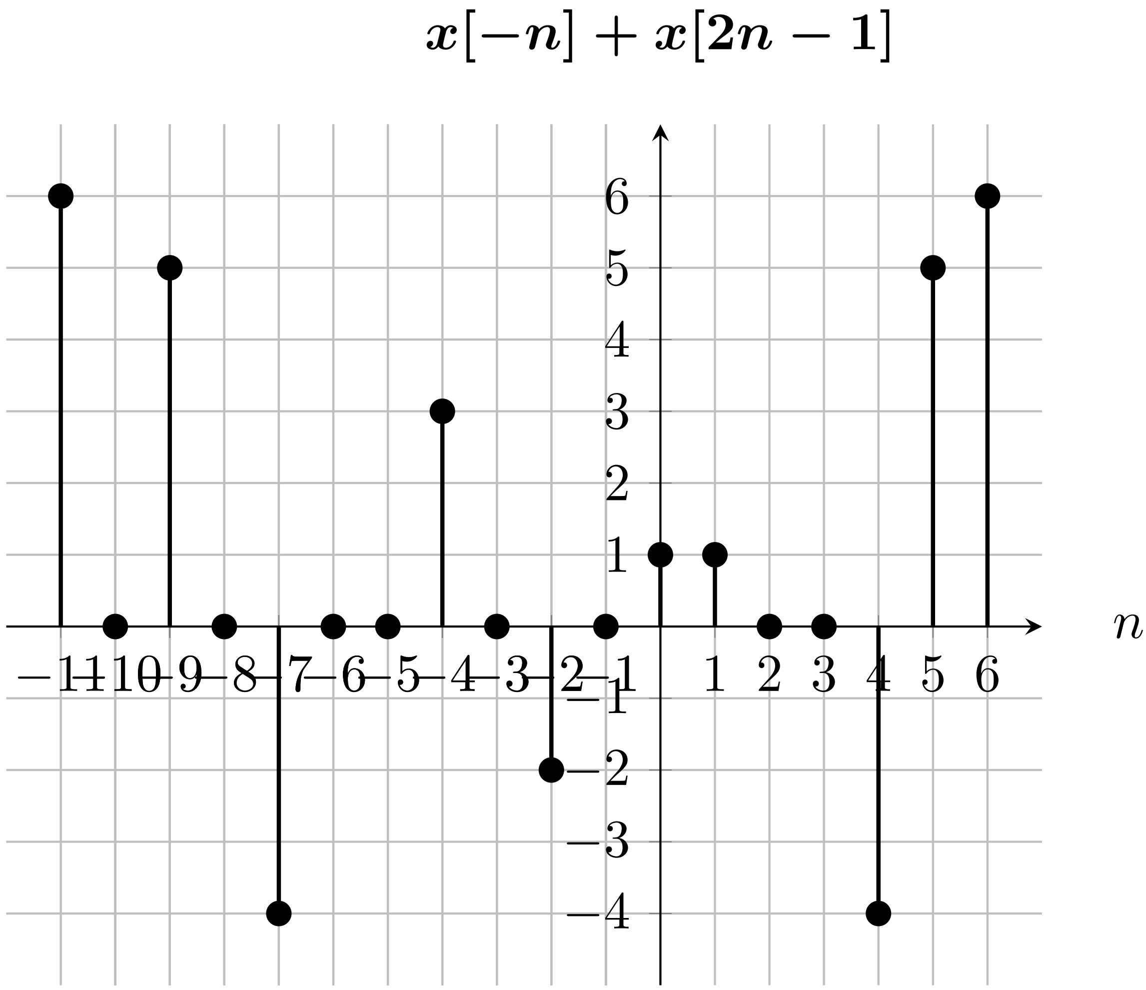


Figure 3: n vs. $x[-n] + x[2n-1]$.

(b) $x[-n]+x[2n-1] = 6\delta[n+11]+5\delta[n+9]-4\delta[n+7]+3\delta[n+4]-2\delta[n+2]+\delta[n]+\delta[n-1]-4\delta[n-4]+5\delta[n-5]+6\delta[n-6]$

4. (a) i. $7\sin[\frac{5\pi}{8}n - \frac{2\pi}{3}] = 7\sin[\frac{5\pi}{8}(n - \frac{16}{15})]$

$$N_0 = \frac{2\pi}{\Omega_0}k$$

$$N_0 = \frac{2\pi \cdot 8}{5\pi}k = 16k$$

$$k = 5,\ N_0 = 16$$

ii. $2\cos[\frac{2\pi}{3}n]$

$$N_0 = \frac{2\pi \cdot 3}{2\pi}k = 3k$$

$$k = 1,\ N_0 = 3$$

The fundamental period of the signal is the least common magnitude of the component of the compound signal. $LCM(16, 3) = 48$. So the period of $x[n]$ is 48.

(b) $x[n] = 3\cos[5(n - \frac{3\pi}{20})]$

$$N_0 = \frac{2\pi}{\Omega_0}k$$

$$\Omega_0 = 5$$

$$N_0 = \frac{2\pi}{5}k$$

This signal $x[n]$ is not periodic because, there is no integer k value that makes this signal periodic.

(c) $x(t) = 4\sin(5\pi t - \frac{3\pi}{5}) = 4\sin(5\pi(t - \frac{3}{25}))$

$$\omega_0 = 5\pi$$

$$T_0 = \frac{2\pi}{\omega_0}$$

$$T_0 = \frac{2\pi}{5\pi} = \frac{2}{5}$$

(d) $j = e^{j\frac{\pi}{2}}$

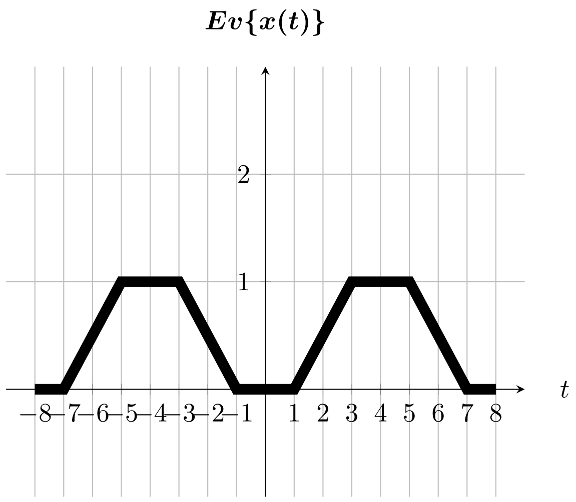
$$x(t) = je^{j2t} = e^{j\frac{\pi}{2}}e^{j2t} = e^{j(\frac{\pi}{2}+2t)} = e^{2j(t+\frac{\pi}{4})}$$

$$\omega_0 = 2,\ T_0 = \frac{2\pi}{\omega_0},$$

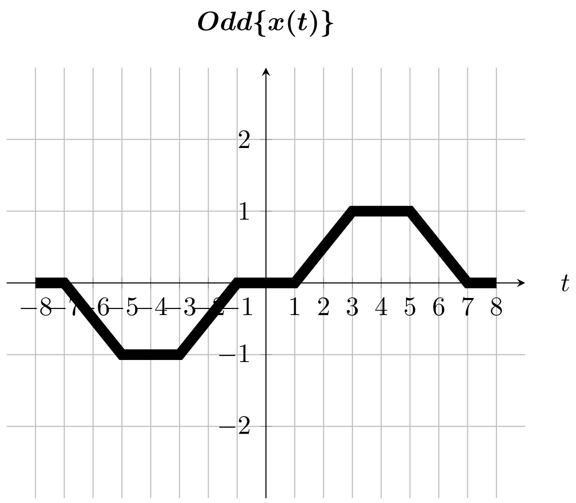
$$T_0 = \frac{2\pi}{2} = \pi$$

5. Even signals are symmetric with respect to the vertical axis. Signal in the figure is defined at just positive t values. It's not symmetric with respect to vertical axis. So it is not even.
Odd signals are symmetric with respect to the origin. The signal in the figure is defined in only I quadrant. Signal in the figure is not symmetric with respect to the origin. So it is not odd.

Even decomposition of x(t):



Odd decomposition of x(t):



6. (a) $x(t) = u(t-1) - 3u(t-3) + 4u(t-4)$

(b)