Digital version

ENGS252 Signals and Systems - Homework 2

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Problem 1

Evaluate the summation.

$$\sum_{n=0}^{\infty} \delta(n+1)(0.5)^n = 0$$

Since the impulse function is only 1 at the point 0, and 0 elsewhere, and in our case $n+1$ is never 0.

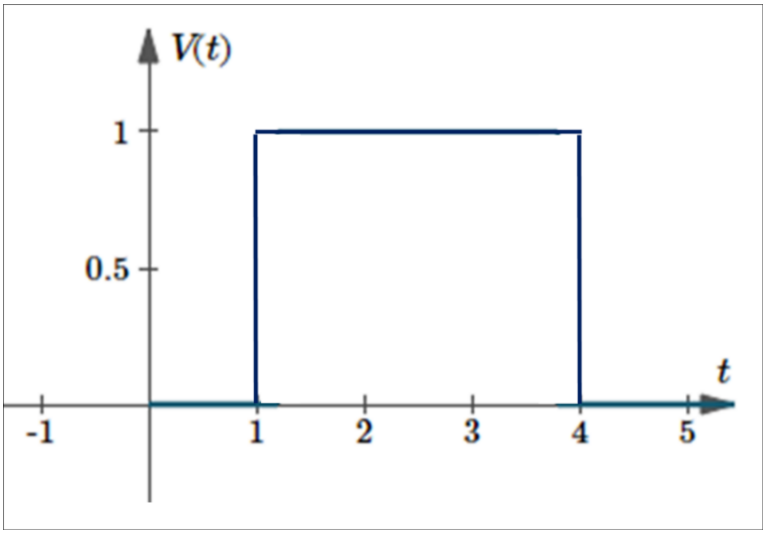
Problem 2

Express the signal in terms of scaled and shifted impulses. $x(0) = 5$, $x(-1) = 3$, $x(2) = -7$, $x(-3) = -4$, and $x(n) = 0$ otherwise.

$$x(n) = 5\delta(n) + 3\delta(n+1) - 7\delta(n-2) - 4\delta(n+3)$$

Problem 3

Express the signal in terms of scaled and shifted unit step signals.



$$V(t) = u(t-1) - u(t-4)$$

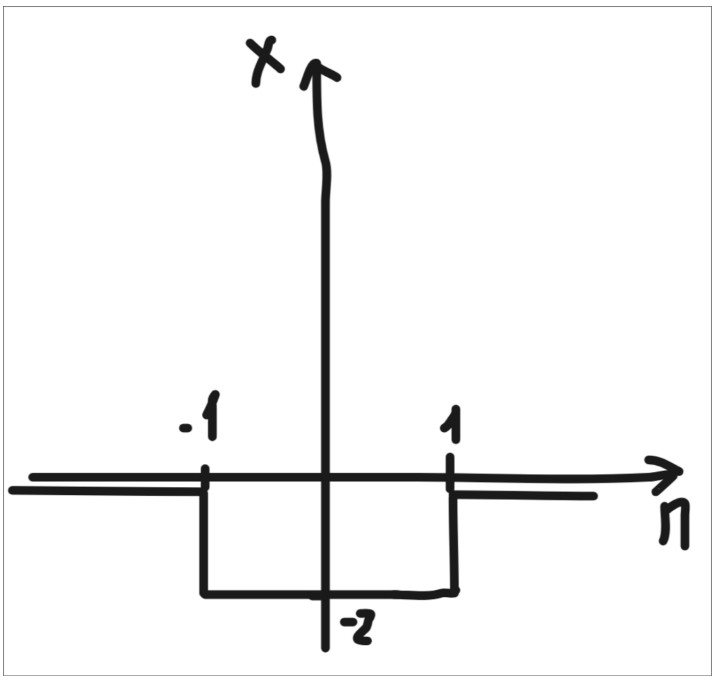
Problem 4

Draw the graph of the discrete signal given a linear combination of scaled and shifted unit-step signals.

a) $x[n] = (2u(-n-2) - 2u(-n+1))$

Consider the three intervals:

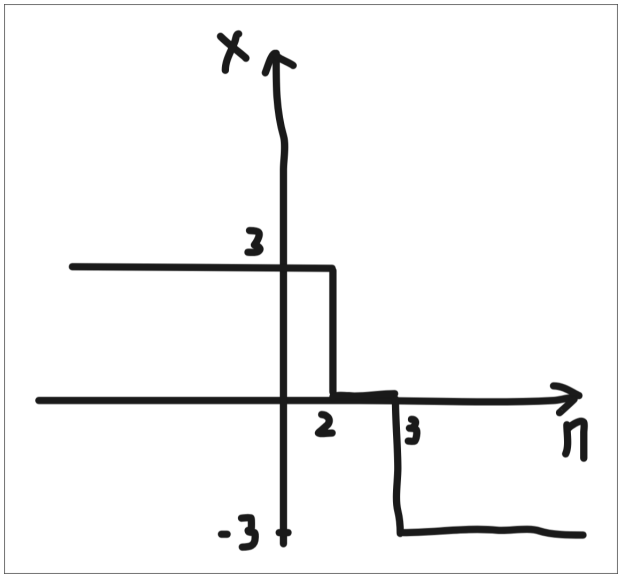
$$\begin{cases} x[n] = 0, n \leq -2 \\ x[n] = -2, n \in (-2, 1] \\ x[n] = 0, n > 1 \end{cases} \implies x[n] = \begin{cases} -2, n \in [-1, 1] \\ 0, \text{else} \end{cases}$$



b) $x[n] = (-3u(n-2) + 3u(-n+3))$

Consider the three intervals:

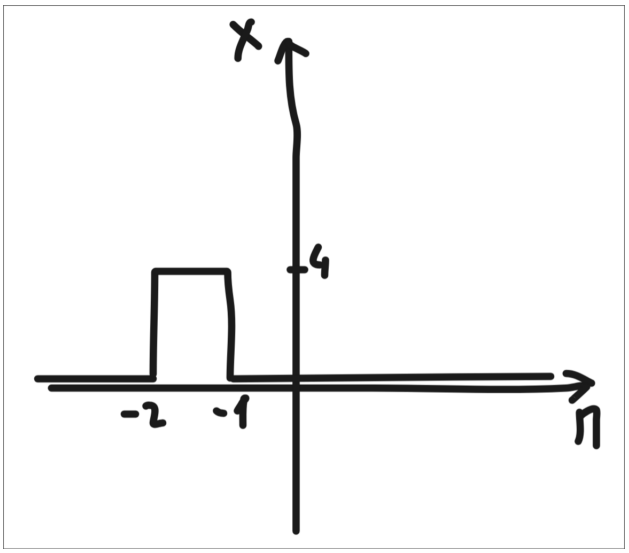
$$\begin{cases} x[n] = 3, n < 2 \\ x[n] = 0, n \in [2, 3] \\ x[n] = -3, n > 3 \end{cases}$$



c) $x[n] = (4u(n+2) - 4u(n))$

Consider the three intervals:

$$\begin{cases} x[n] = 0, n < -2 \\ x[n] = 4, n \in [-2, 0) \\ x[n] = 0, n \geq 0 \end{cases} \implies x[n] = \begin{cases} 4, n \in [-2, -1] \\ 0, \text{else} \end{cases}$$



Problem 5

Is $x[n]$ an energy signal, a power signal, or neither? If it is an energy signal, find its energy. If it is a power signal, find its average power.

a) $x[n] = 2 \cdot (0.8)^n u[n]$

Energy signal, since finite energy.

$$E = \sum_{n=-\infty}^{\infty} |2 \cdot (0.8)^n u[n]|^2 = 4 \sum_{n=0}^{\infty} (0.64)^n = \frac{4}{1 - 0.64} = \frac{100}{8} \approx 11.1$$

b) $x[n] = 2 \sin\left[\frac{\pi n}{2} - \frac{\pi}{3}\right]$

Power signal, since infnite energy.

$$P = \lim_{n \to \infty} \frac{1}{4} \sum_{n=0}^{3} \left| 2 \sin\left[\frac{\pi n}{2} - \frac{\pi}{3}\right] \right|^2 = \frac{3}{4} + \frac{1}{4} + \frac{3}{4} + \frac{1}{4} = 2$$

c) $x[n] = 2$

Power signal, since infinite energy.

$$P = 2^2 = 4$$

d) $x(t) = 2 \sin\left(\frac{\pi t}{5} + \frac{\pi}{6}\right)$

Power signal, since infnite energy.

$$P = \frac{1}{10} \int_0^{10} \left(2 \sin\left(\frac{\pi t}{5} + \frac{\pi}{6}\right)\right)^2 \mathrm{d}t = 2$$

Problem 6

Decompose the signal $x[n]$ into its even and odd components. Find the samples of the signal and its components (even/odd) for $n = -3, -2, -1, 0, 1, 2, 3$. Sum the samples of the components and verify that they are the same as those of the given signal.

a) $x[n] = (-0.8)^n u[n]$

The original samples are: $\{0, 0, 0, 1, -0.8, 0.64, -0.512\}$.

$$x_{\text{even}}[n] = \frac{x[n] + x[-n]}{2}$$

The even samples are: $\{-0.256, 0.32, -0.4, 1, -0.4, 0.32, -0.256\}$.

$$x_{\text{odd}}[n] = \frac{x[n] - x[-n]}{2}$$

The odd samples are: $\{0.256, -0.32, 0.4, 0, -0.4, 0.32, -0.256\}$.

$$x[n] = x_{\text{even}}[n] + x_{\text{odd}}[n]$$

The combined samples are: $\{0, 0, 0, 1, -0.8, 0.64, -0.512\}$. Same as the original.

b) $x[n] = 2\sin\left[\frac{\pi n}{4} - \frac{\pi}{3}\right]$

The original samples are: $\{\frac{\sqrt{6}-\sqrt{2}}{2}, -1, \frac{-\sqrt{6}-\sqrt{2}}{2}, -\sqrt{3}, \frac{-\sqrt{6}+\sqrt{2}}{2}, 1, \frac{\sqrt{6}+\sqrt{2}}{2}\}$.

$$x_{\text{even}}[n] = \frac{x[n] + x[-n]}{2}$$

The even samples are: $\{\frac{\sqrt{6}}{2}, 0, -\frac{\sqrt{6}}{2}, -\sqrt{3}, -\frac{\sqrt{6}}{2}, 0, \frac{\sqrt{6}}{2}\}$.

$$x_{\text{odd}}[n] = \frac{x[n] - x[-n]}{2}$$

The odd samples are: $\{-\frac{\sqrt{2}}{2}, -1, -\frac{\sqrt{2}}{2}, 0, \frac{\sqrt{2}}{2}, 1, \frac{\sqrt{2}}{2}\}$.

$$x[n] = x_{\text{even}}[n] + x_{\text{odd}}[n]$$

The combined samples are: $\{\frac{\sqrt{6}-\sqrt{2}}{2}, -1, \frac{-\sqrt{6}-\sqrt{2}}{2}, -\sqrt{3}, \frac{-\sqrt{6}+\sqrt{2}}{2}, 1, \frac{\sqrt{6}+\sqrt{2}}{2}\}$. Smae as the original.