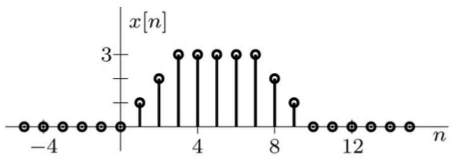
ENGR 4333/5333: Digital Signal Processing

HW 3: Ch 4

1) The signal $x[n]$ is shown in Figure below, sketch the signals

a) $x[3-n]$ **b)** $x[3n]$ **c)** $x[1-2n]$ **d)** $x\left[\frac{n+1}{4}\right]$

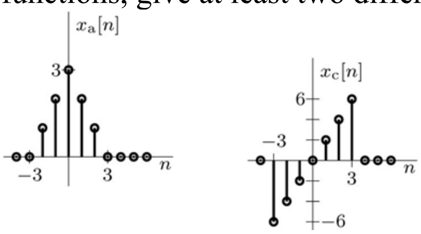


2) What values θ cause the DT sinusoid $\cos(\Omega n + \theta)$ to be a simple shifted version of $\cos(\Omega n)$?

3) Sketch the signals

a) $u[n-2] - u[n-6]$ **b)** $n(u[n] - u[n-7])$ **c)** $(n-2)(u[n-2] - u[n-6])$

4) Describe each of the signals in Figures below by a single expression valid for all n. Using only ramp and step functions, give at least two different expressions to describe each signal.



5) The following signals are in the form $e^{\lambda n}$. Express them in the form γ^n.

(a) $e^{-0.5n}$ **(b)** $e^{+0.5n}$ **(c)** $e^{-j\pi n}$ **(d)** $e^{-(1+j\pi)n}$ **(e)** $e^{(1-j\pi/3)n}$

In each case, show the locations of λ and γ in the complex plane. Verify that the exponential is growing if γ lies outside the unit circle (λ in the RHP), is decaying if γ lies within the unit circle (λ in the LHP), and has a constant envelope if γ lies on the unit circle (λ on the imaginary axis).

6) A continuous-time sinusoid $\cos(\omega_0 t)$ is sampled at a rate $F_s = 100$ Hz. The sampled signal is found to be $\cos(0.6\pi n)$. If there is more than one possible value for ω_0, find the general expression for ω_0, and determine the three smallest values of $|\omega_0|$.

7) Samples of a continuous-time sinusoid $\cos(100\pi t)$ are found to be $\cos(\pi n)$. Find the sampling frequency F_s. Explain whether there is only one possible value for F_s. If there is more than one possible value, find the general expression for the sampling frequency, and determine the three largest possible values.

8) Express the following exponentials in the form $e^{j(\Omega n+\theta)}$, where $-\pi \le \Omega < \pi$:

(a) $e^{j(8.2\pi n+\theta)}$ **(b)** $e^{j4\pi n}$ **(c)** $e^{-j1.95n}$ **(d)** $e^{-j10.7\pi n}$

Repeat the problem if Ω is required to be in the range $0 \le \Omega < 2\pi$.

9) Consider a signal $x(t) = 10\cos(2000\pi t) + \sqrt{2}\sin(3000\pi t) + 2\cos(5000\pi t + \pi/4)$.

(a) Assuming that $x(t)$ is sampled at a rate of 4000 Hz, find the resulting sampled signal $x[n]$, expressed in terms of apparent frequencies. Does this sampling rate cause any aliasing? Explain.

(b) Determine the maximum sampling interval T that can be used to sample the signal $x(t)$ without aliasing.