



Exercises sheet 2
Continuous Signals Sampling

1. State under what conditions a continuous signal $x_c(t)$ can be represented by a discrete signal $x[n]$ obtained by sampling $x_c(t)$.
2. Consider the continuous signal $x_c(t) = \cos(4000\pi t)$, which was sampled with a sampling period $T_s = 1/6000$ s.
 - a. What is the angular frequency of the signal Ω_0
 - b. What is the digital angular frequency of the signal w_0
 - c. What is the angular frequency of sampling Ω_s
 - d. Was the sampling theorem fulfilled?
 - e. What is the expression of the resulting sampled signal $x[n]$?
3. The continuous signal $x_c(t) = \sin(2\pi * 100t)$ was sampled with the sampling period $T_s = 1/400$ s. What is the expression of the resulting discrete signal $x[n]$?
4. The signal discrete sequence $x[n] = \cos(\pi n/4)$, $-\infty < n < +\infty$, was obtained per sampling the follow signal:

$$x_c(t) = \cos(\Omega_0 t) \quad -\infty < t < +\infty$$

At the sampling frequency 1000 samples/s. What are the possible positive values of Ω_0 that may have resulted in $x[n]$?

5. The continuous signal $x_c(t) = \cos(4000\pi t)$ was sampled with a sampling period T_a and it results in the follow discrete signal:

$$x[n] = \cos\left(\frac{\pi n}{3}\right)$$

- a. Determine a consistent T_a .
 - b. It is the T_a 's choice of the previous paragraph unique? If so, explain why, otherwise determine another value for T_a also consistent.
6. Consider the follow discrete signals $x_1(t)$ e $x_2(t)$ such that:

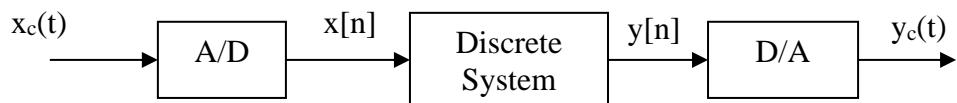
$$|\Omega| > \Omega_1 \Rightarrow X_1(j\Omega) = 0$$

$$|\Omega| > \Omega_2 \Rightarrow X_2(j\Omega) = 0$$

$$\Omega_2 > \Omega_1$$

Determine the minimum sampling frequency required to represent $x(t)$ in the cases:

- a. $x(t) = x_1(t) + x_2(t)$
 - b. $x(t) = x_1(t) \cdot x_2(t)$
7. Consider the system of the figure with the discrete system being an ideal low pass filter with a cutoff frequency $\pi/8$ rad.



- a. If $x_c(t)$ is limited to the frequency of 5 kHz, what is the maximum value of T_a to avoid aliasing in the A / D converter?
- b. If $1/T_a = 10$ kHz what should be the effective cutoff frequency of the filter?