Digital Signal Processing

http://kom.aau.dk/~zt/cources/DSP_E/

Exercises of Lecture 4 (MM4)

Exercise 4.1. If the sequence $x[n] = \cos(\frac{n\pi}{4}), -\infty < n < \infty$

is obtained by sampling the analog (continuous) signal $x_c(t) = \cos(\Omega_0 t), -\infty < t < \infty$ at a sampling rate of 1000 samples/s, what are two possible values of Ω_0 that could have resulted in the sequence $x[n]$?

Exercise 4.2. The input signal, $x_c(t)$, given by $X_c(j\Omega) = 0, |\Omega| \geq 2\pi\ x10^4$

is subjected to a sampling system, using sampling period T, and having output $x[n]$:

$$x[n] = x_c(nT_s).$$

The signal $x[n]$ is then subjected to a digital filter, having impulse response $h[n]$, and generating the output $y[n] = T\sum_{k=-\infty}^{n} x[k]$.

a) What is the maximum allowable value of T if aliasing is to be avoided ? (so that x_c can be recovered from $x[n]$) ?

b) What is $h[n]$?

Exercise 4.3. A system interpolates a sequence $x[n]$ by a factor of *L* (upsampling and filtering by a filter having impule response $h[n]$.). Suppose that the filter is given by:

$h[n] = h[-n]$ and $h[n] = 0,\ for |n| > (RL-1)$ where R and L are integers; i.e. the impulse response is symmetric and of length (2RL-1) samples.

a) How much delay must de inserted to make the system causal ?

b) What conditions must be satisfied by $h[n]$ in order that

$$y[n] = x[n/L],\ for n = 0, \pm L, \pm 2L, \pm 3L, ...$$

Exercise 4.4 Consider the sampling and reconstruction system given below where $x(t)$ is given by the formula $x(t) = 10\cos(20\pi t - \pi/4) - 5\cos(50\pi t)$

a) What condition must be satisfied by the sampling rate to ensure $y(t) = x(t)$?

b) How should f_S be chosen, so that $y(t) = A + 10\cos(20\pi t - \pi/4)$?

c) What is the value of the constant A ?

Thanks Borge Lindberg for providing the exercises and solutions.