

Foundations of Audio Signal Processing

Exercise sheet 9

To be uploaded in eCampus till: 22-12-2018 22:00 (strict deadline)

Exercise 9.1

[2 + 2 + 2 = 6 points]

The signal f defined by $f(t) := \text{sinc}(t)$ is to be sampled.

- (a) Draw illustrations of:
 - (i) the signal f to be sampled,
 - (ii) the T -sampled signal $f_T := (\mathbb{Z} \ni n \mapsto f(n \cdot T))$ for $T \in \{1, \frac{1}{2}, 2\}$. Which sampling rate is thus used in each of the three cases?
- (b) Is f bandlimited? If so, find the smallest Ω such that f is still Ω -bandlimited.
- (c) Is the continuous signal f reconstructible from the sampled signal f_T for $T \in \{1, \frac{1}{2}, 2\}$, according to the sampling theorem? Why?

Exercise 9.2

[3 + 3 = 6 points]

Investigate whether the following operators are time-invariant:

- (a) upsampling
- (b) frequency-shift operator.

Prove your claim.

Exercise 9.3

[8 points]

Implement in Matlab a uniform scalar quantizer based on what was explained in the lecture. It should output a quantized version of the input signal using a specified number of bits/sample and an amplitude range ($\pm x_{max}$). Additionally visualize the quantization error.