ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
School of Computer and Communication Sciences

**Handout 5** Introduction to Communication Systems
Homework 3 October 2, 2008

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PROBLEM 1. The signal $\bar{x}(n) = \cos(\pi n/4)$ has been obtained by sampling a continuous-time signal $x(t) = \cos(2\pi f t)$ using a sampling frequency of 1000 Hz.

1. Find two values of $f$ that could have given the signal $\bar{x}(n)$.
2. Which is the signal $y(t)$ that one would reconstruct by applying the ideal interpolator to the signal $\bar{x}(n)$?

PROBLEM 2. Consider the points $P_0 = (0, 1)$, $P_1 = (1, 0.8)$, $P_2 = (2, 2)$, $P_3 = (3, 4)$.

1. Draw the points and the result of piecewise-constant (zero-order hold).
2. Draw the points and the result of linear interpolation.

PROBLEM 3.
1. Consider the signal $x(t) = \sin(25\pi t)+\cos(50\pi t)$. What are the sampling frequencies which avoid the problem of aliasing? If one sampled at the sampling frequency of 40 Hz and used an ideal interpolator to reconstruct the signal, what would the reconstructed signal $y(t)$ be?
2. Consider the signal $x(t) = \sin(25\pi t) - \cos(50\pi t)$. What are the sampling frequencies which avoid the problem of aliasing?
3. Consider the signal $x(t) = \sin(25\pi t)\cos(50\pi t)$. What are the sampling frequencies which avoid the problem of aliasing?

PROBLEM 4. Assume that you are watching a movie wherein there is a horse-carriage going to your right. Assume that the wheel of the horse-carriage has 4 spokes and a radius of 0.5 meters. Assume that we only watch the wheels of the horse-carriage and not the horse. The motion of the wheel is a continuous signal in time, but when you watch the movie, your brain samples the movie signal at 12 frames per second. In other words the sampling frequency is 12Hz.

1. What is the motion of the wheel perceived when the horse-carriage is moving at a speed of $3\pi$ meters per second?
2. What is the motion of the wheel perceived when the horse-carriage is rotating at $9\pi/4$ meters per second ?