

## 5<sup>th</sup> Exercise in Digital Information Processing

1. The transfer function  $H(z)$  of a system has exactly two poles at  $z_{\infty 1} = 1/2$  and at  $z_{\infty 2} = 1 + j$ . Choose the zeros such that the system is an all-pass filter. Expand the numerator and denominator and check the all-pass properties of the resulting polynomials.
2. Sampling (An analog signal  $f(t)$  is transformed into a discrete series  $f[n]$ .)
  - What is the appropriate formula to describe sampling? Why?
  - What is the appropriate formula to describe a sampled signal  $f[n]$  in frequency domain?
  - What is discrete with respect to the sampled signal  $f[n]$ ?
3. Given is the function  $x(t)$ .
  - Sample  $x(t)$  with frequency  $f_a$  and transform the result into frequency domain.
  - Plot the resulting spectrum  $Y_a[f]$ . Using your graph show the minimal sampling frequency  $f_s$  with which perfect reconstruction of  $x(t)$  is still possible.
4. Given is the function  $x(t) = \cos(2\pi t)$ . The sampling frequency is  $f_a = 3/2$ . Plot the spectrum of  $x(t)$  before and after sampling and after reconstruction. Give the formula for the reconstructed function  $x(t)$  in time domain.