SGN-2056 DIGITAL LINEAR FILTERING II

Final Examination: **30.01.2009**

NO literature in the examination. Short, compact, and concise answers are preferred.

1. Explain shortly (using formulas and/or words) the meanings of the following terms:
   (a) IIR filter (1pt)
   (b) Bandstop filter (1pt)
   (c) Minimum-phase filter (1pt)
   (d) Linear programming (1pt)
   (e) Wideband filter (1pt)
   (f) Rounding in two's complementary arithmetic (1pt)

2. (a) Describe the method for designing linear-phase FIR filters in the least-mean-square sense? (3pt)
   (b) What is a Half-band filter? Describe the design method discussed in the course and show how the half-filter can be efficiently implemented. (3pt)

3. (a) Describe the basic structure for designing linear-phase FIR filters by using the frequency-response masking approach. Explain briefly why this structure is beneficial for designing filters. Show how the desired filter transfer function is generated. (5pt)
   (b) A lowpass filter with $\omega_p = 0.7\pi$ and $\omega_s = 0.9\pi$ is designed. Let the transfer function of this lowpass filter be denoted by $F(z)$. Draw the transfer function of filter $F(z)$ and filter $F(z^L)$ for $L=4$? (1pt)

4. (a) Give the block diagram for implementing a lowpass-highpass complementary IIR filter pair by using two allpass filters. Describe how the filters' passbands and stopbands are generated by sketching typical phase responses. What are the limitations for the orders of the allpass filters? (4pt)
   (b) Describe how approximately linear phase IIR filters can be generated by replacing one allpass filter with a delay z^{-M_1} ? (2pt)

5. (a) What are the most commonly used scaling norms for fixed point arithmetic? How do they differ from each other in terms of the probability of overflows and output noise variance due to the multiplication roundoff errors? (3pt)
   (b) How to pair (share) poles and zeros in an N^{th} order IIR filter between the first and second order blocks in such a way that after scaling the output noise variance becomes small? You can show this by means of an example for $N=6$. (2pt)
   (c) What is the signal to noise ratio due to rounding or truncation? (1 pt)