

SGN-2056 DIGITAL LINEAR FILTERING II

Final Examination 12.5.2011 by Tapio Saramäki

NO literature in the examination, short, compact, and pithy answers are preferred. **The Faculty's calculator is allowed to be used. No need to return the exam questions.**

1. A lowpass-highpass complementary IIR filter pair can be implemented using two allpass filters. Give the block diagram for the realization. Sketch typical phase responses for both allpass sections and explain how to generate the passband and stopband. What are the limitations for the orders of the allpass subfilters? Repeat the above for the corresponding bandstop-bandpass complementary filter pair. Why is it beneficial to implement IIR filters as a parallel connection of two allpass filters?
2. What makes periodic FIR filters, whose transfer function is obtained from the conventional transfer function by replacing each unit delay by multiple delays, useful in designing high-order filters with a very narrow transition band? Give the basic principle for one design scheme based on the use of transfer functions of this kind.
3. Several techniques for designing linear-phase direct-form FIR filters have been considered in our course. What are the benefits and drawbacks of these techniques? Compare them with each other.
4. Answer to one of the following two questions:
 - (a) Explain briefly how to design minimum-phase FIR filters with the aid of linear-phase FIR filters.
 - (b) In our course, a simple technique has been proposed for designing half-band FIR filters. Explain briefly this technique.
5. What are the most commonly used scaling norms for fixed-point arithmetic (basic definitions)? How do they differ from each other in terms of the probability of overflows and output noise variance due to the multiplication roundoff errors. It is desired to realize a sixth-order elliptic filter using three second-order direct-form II blocks. How to share the poles and zeros between the blocks in such a way that after scaling the output noise variance becomes small. What are the critical points for scaling for two's complement arithmetic in the overall structure. How to scale our filter?