80558 MULTIRATE SIGNAL PROCESSING

Final Examination 2.3.2001

NO literature in the examination, short, compact, and pithy answers are preferred.

ANSWER TO SIX OUT OF THE FOLLOWING SEVEN QUESTIONS!!

1. How to modify direct-form FIR filter structures exploiting the coefficient symmetry for effectively implementing linear-phase FIR filter decimators and interpolators. How to implement linear-phase FIR decimators and interpolators using the polyphase structures? Compare the above-mentioned two alternative structures. Elliptic filters are not so useful for decimation amd interpolation purposes. Why?

2. What are half-band and Nth-band FIR and IIR filters? Basic definitions and their use in multirate signal processing.

3. What is the Farrow structure? Recall that it mimics the following system. First, a continuous-time signal is generated from the existing discrete-time samples with the aid of the ideal digital-to-analog converter and a reconstruction filter. Then, new output samples at arbitrary points are obtained by re-sampling this continuous-time signal. What are the conditions for the reconstruction filter to make the overall system implementable using the Farrow structure? What are the basic control parameters for this structure for generating an output sample at an arbitrary time instant?

4. How to effectively implement narrow transition-band linear-phase FIR filters using multirate and complementary filtering? What are the basic benefits compared to the direct implementation of an FIR filter?

5. Consider a two-channel system which consists of analysis and synthesis banks of two FIR filters. When is the input-output relation alias-free? When is the overall transfer function from the input to the output a pure delay?

6. How to construct a tree-structured multirate filter bank using two-channel filter banks? Why is it beneficial in many applications to design and implement a multichannel filter bank using a cosine modulation, instead of a tree-structured filter bank?

7. How to construct an octave filter bank using a two-channel filter bank as a building block? The structures for frequency-selective octave filter banks and discrete-time wavelet filter banks are the same. What is the main difference?