Part I: Basics and Motivation

- How to properly process an analog signal with the aid of a digital filter?
- Why to perform the sampling rate conversion directly in the digital domain?
- Needs for the sampling rate conversion directly the digital domain as well as the main benefits from the FIR and IIR filter implementation points of view.
- Two basic types of sampling rate conversion, namely, decimation and interpolation.
- The basic ideas behind decimation and interpolation by an integer factor. What is the role of the digital filter in such operations?
- What about decimation and interpolation by a ratio of two integers?
- Three different cases to state the criteria for the digital filter being involved in decimation and interpolation. Why and when to use one of these three options?
- What are the main benefits of using partly digital anti-aliasing filters?

Part II: Design and Implementation of Efficient Decimators and Interpolators

- There are two traditional techniques for efficiently implementing linear-phase FIR filters for decimation and interpolation purposes, namely the "the direct-form structures exploiting the coefficient symmetry" and the conventional polyphase structures. When comparing these structures with each other, what are the benefits and drawback?
- Why traditional IIR filters are not so useful for decimation and interpolation purposes?
- Why to use multistage decimators and interpolators whenever the overall sampling rate conversion factor can be factorized as a product of integers? Benefits and drawbacks of the multistage implementations in comparison with the one-stage implementations. **It is worth pointing out that the one-stage implementation means that the decimation and interpolation is performed with the aid of one filter, whereas a single-stage equivalent means transforming the multistage implementation to a form that simply corresponds to a one-stage implementation!**
- No need to read special "optimized" decimator and interpolator designs! The lecturer of the course just wanted to include these more sophisticated designs for his own purpose.
- The key ideas of using *N*th-band recursive digital filters for decimation and interpolation purposes. What are half-band and *N*th-band recursive filters? Basic definitions and their use in multirate signal processing.
- The key ideas of using *N*th-band FIR digital filters for decimation and interpolation purposes. What are various half-band and *N*th-band FIR filters? Basic definitions and their use in multirate signal processing.
- Totally forget Part II. H!

Part III: Polynomial-Based Interpolation for DSP Applications

- What is the Farrow (modified Farrow) structure?
- Why is the hybrid analog/digital structure to be mimicked very useful to end up with the structure that is efficiently implementable?

- Why to use analog reconstruction filters which are not at all implementable in practice for developing the modified Farrow structure or what are the conditions for the artificial reconstruction filter to make the resulting digital system to become very efficiently implementable?
- What are the basic parameters to control the location of the sample occurring at an arbitrary sampling instant?

Part IV: Design of FIR Filters Using Multirate and Complementary Filtering

- How to efficiently implement narrow transition-band linear-phase FIR filters using this approach?
- What are the basic benefits in comparison with conventional linear-phase FIR filter designs?

Part V: Multirate Filter Banks

- How to construct analysis-synthesis filter banks with a processing unit in between.
- Key difference between analysis-synthesis filter banks and transmultiplexers (synthesis-analysis filter banks).
- Conditions for constructing alias-free FIR and IIR two-channel filter banks.
- When is the input-output transfer function, in addition to being alias-free, a pure delay for FIR two-channel filter bank?
- Ability to distinguish between the following two-channel FIR filter banks:
  (a) NPR conventional quadrature mirror filter (QMF) banks with linear-phase filters.
  (b) NPR low-delay QMF banks with non linear-phase filters.
  (c) PR orthogonal banks with linear-phase filters.
  (d) Low-delay PR orthogonal banks with nonlinear-phase filters.
  (e) NPR orthogonal banks with linear-phase filters.
  (f) Low-delay NPR orthogonal banks with nonlinear-phase filters.
- Two-channel IIR filter banks.
- Tree-structured filter banks and their construction based on the use of two-channel filter banks.
- Why are cosine-modulated (or modified DFT) filter banks in cases with many channels superior to tree-structured banks?
- Octave filter banks and their construction based on the use of two-channel filter banks.
- The structures for frequency-selective octave filter banks and discrete-time wavelet banks are the same. What is the key difference?