SGN-2106 MULTIRATE SIGNAL PROCESSING

- Lectures: Tapio Saramäki, ts@cs.tut.fi, Preliminary plan: (1) Four hours during the first period: Wednesday 12-14,TB214; What about Monday for the second two-hour lecture?; (2) Four hours during the second period in the same manner but only for three-and-a-half weeks?; The very original plan was to have two hours during one overall period.
- Exercises: Two hours during the second period. Let us decide when to have those two hours!

PURPOSE OF THE COURCE

- Multirate digital signal processing (DSP) is one of the most crucial subtopics when applying DSP to practical applications.
- Multirate DSP is nowadays utilized in several areas including among others sampling rate conversions; filter synthesis; signal, image and video compressions; signal analysis and enhancement as well as several applications in intrumentation, speech and audion signal processing, biomedical engineering, and communications.
- The purpose of this course is to show how multirate DSP can be exploited in the above-mentioned applica-

tions and how to design effective DSP algorithms based on the use of multirate DSP.

CONTENTS

HOW TO PASS THE COURSE?

- Final examination.
- Three homeworks will be given out of which two must be done. For the remaining homework, extra points will be given which are added to the points obtained from the final examination.
- Note that the homeworks are given in the end of this pile.
- **How to return the homeworks?** There is a mailbox for this purpose on the fourth floor.

COURSE MATERIAL

- Lecture notes and copies of some articles

HOMEWORK 1: Design of a two-channel filter bank

In the lecture notes we designed a perfect-reconstruction two-channel filter bank based on the use of a separable half-band filter. The orders of the filters were $M = 63$. Do the same for $M = 33$. The band edges remain the same. Use the file bankexa.m in SUN's in the directory /home/ts/matlab/multirate as a starting point.

What to return? Matlab commands required to desig the above filters (command 'diary' may help, useless iterations can be edited away), the amplitude and impulse responses for the filters in the analysis and synthesis banks.

HOMEWORK 2: Two-stage FIR decimator

Synthesize a two-stage conventional FIR filter decimator with the sampling rate conversion ratio $D = 20$, passband edge $= (f_s/2)/40$, stopband edge $= (f_s/2)/20$, passband ripple for the amplitude response $= 0.01$, and stopband ripple for the amplitude response $= 0.001$.

Factorize $D = 20 = D_1 D_2$ to minimize the number of multiplications per input sample.

What to return? Matlab commands as well as the responses and coefficients of the subfilters.

HOMEWORK 3: Design of an FIR filter using multirate and complementary filtering

It is desired to synthesize a linear-phase lowpass FIR filter with edges at $\pi/3 \pm 0.005\pi$ and passband and stopband ripples of 0.001. Design the filter using multirate and complementary filtering such that the sampling rate of the termination filter is $f_s/16$ where f_s is the input and output sampling rate of the overall system. In order to solve the problem properly, read Part IV of the lecture notes.

What to return? Overall filter structure as well as the responses for the subfilters.