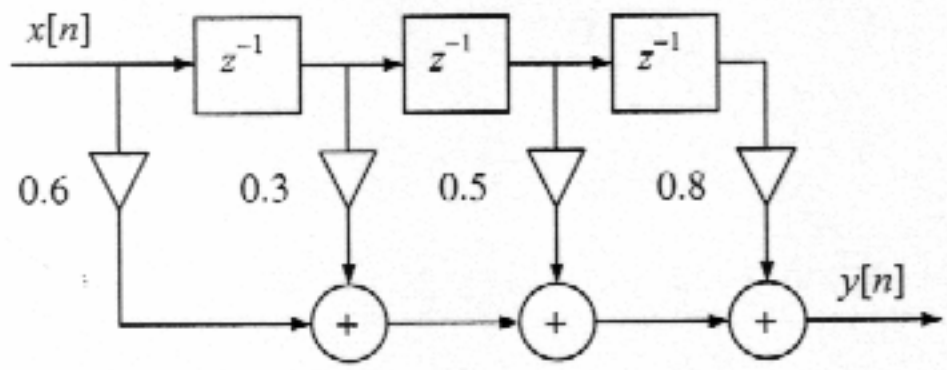
801063 DIGITAL LINEAR FILTERING I

Final Examination: **05.04.2004**

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

1. Explain shortly (using formulas and/or words) the meanings of the following terms:
   (a) Minimax error (1pt)
   (b) Direct-form II structure (1pt)
   (c) Type III linear-phase FIR filters (1pt)
   (d) Bilinear transform (1pt)
   (e) Rounding and truncation (1pt)
   (f) Filter scaling (1pt)

2. (a) What is a linear digital filter? (2pt)
   (b) A discrete system is given by the following figure:



   What is the impulse response, the transfer function, and the frequency response of this system? Is this system stable? (2pt)
   (c) The frequency response of a system is given by $H(e^{j\omega})=2.33\,e^{-j1.5\omega-j\pi/4}$. What is the phase and the group delay of this system? (2pt)

3. (a) Describe the basic steps in Remez algorithm. (3pt)
   (b) It is desired to design a lowpass FIR filter by windowing. The maximum allowed passband and stopband ripples are $\delta_p=0.003$ and $\delta_s=0.001$. Which fixed widow or windows can be used for designing such a filter? Give an explanation. (2pt)
   (c) Explain how to generate a transposed structure. (1pt)

4. Design a Butterworth digital filter with the aid of the bilinear transformation to satisfy following design criteria: $\omega_p=0.45\pi$, $\omega_s=0.75\pi$, $A_p=3$dB, and $A_s=25$dB. (6pt)
   For estimating the minimum order of a Butterworth filter satisfying the given criteria following expression is valid: $N \geq \dfrac{\log_{10}\left[(A^2-1)/\varepsilon^2\right]}{2\cdot\log_{10}(\Omega_s)}$

5. (a) Digital filters are implemented using finite word lengths for both the data and the filter coefficients. Name and describe three scaling methods that can be used in such designs. (3pt)
   (b) What are the main errors caused by the use of finite word lengths for both the data and the filter coefficients. (2)
   (c) Explain limit cycle (1)