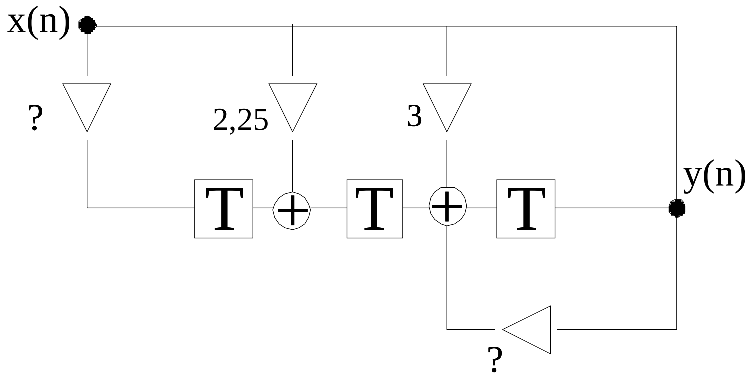
Digital Signal Processing: Foundations

1. Difference Equations and z-Transformation

1.1. For the following digital filter, construct the difference equation.



1.2.Transform the difference equation into z-space, and hence construct the transfer function H(z). Draw a scetch of the poles and zeros of H(z) in the z-plane.

1.3.What is the steady state result for H(z)? What is the initial response part of H(z)?

1.4.The filter is now used. Prior to usage, all values are zero. Now, a series of values x[n] is given to the filter as follows:
[0,2,0,-2,0]
What are the filter outputs y[n]?

2. MATLAB Computer experiments

If you need some more information about a Matlab function, type: *help function*

2.1. Type the coefficients of the difference equation from 1.1. into Matlab
b=[b1,b2,...]
a=[a1,a2,...]
and plot the poles and zeros with the matlab functions *b_zeros=roots(b)* and *zplane(?)*.

2.2.Compute the impulse response of your system with the special function *impz(?)*.

2.3.Check your outputs y[n] for the series given in 1.4. with a Matlab result. Use the function *filter(?)*.

2.4.

2.5.Continue the series in 1.3. periodically, i.e. [0,2,0,-2,0,2,0,-2,....] for 10 times. Use something like
for i=1:?:?
g(i:i+?)=[0,2,0,-2];

end
What is the frequency? Pass a long series of this nature to the filter. What is the steady state of the output after some time?

2.6. From 1.3., let Matlab perform an inverse z-Transformation of the steady state and the initial response part of H(z). Doing so, you receive a linear superposition of two outputs y[n]. The steady state output resembles a (hypothetical) situation where the periodic signal was present at the input since infinite long times. The „initial“ output part corrects for the hypothetical steady state part in such a way that the real situation (zero inputs in the past, then since t=0 the series under 2.3.) is modelled. Looking at this „initial“ output part, draw a scetch of the decay of this distortion of the steady state.