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Examination, Systems and Signals EITF75

Maximum grade is 3. For higher grades, you need to take an oral exam as well. Send your solutions (e.g. photos) by email to fredrik.rusek@eit.lth.se no later than 17.00 Thursday 16/4. If you are interested in an oral exam, then mention that in the email. Oral exams will be held via Zoom in the week starting with Monday 20/4.

If you don't pass the written exam, you cannot take the oral exam. Grading will be finished by Monday morning 19/4.

Passing score (tentatively): 15p.

Problem 1 (10p)

For the difference equation $y(n) + \frac{2}{3}y(n-1) = 2x(n) + x(n-1)$, find

1. The system transfer function $H(z)$
2. The pole-zero diagram corresponding to the difference equation
3. The impulse response $h(n)$
4. The Discrete-time Fourier transform of the impulse response $H(f)$
5. The output for the input signal $x(n) = [1\ \ 1\ \ -1\ \ 1]$
6. The steady state response to the input $x(n) = u(n)$ (a step)
7. The transient response to the input $x(n) = u(n)$

Problem 2 (5p)

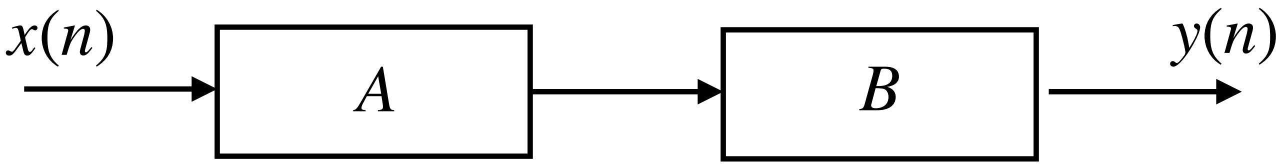
Consider a system described by the difference equation $y(n) - \sum_{k=1}^{\infty} y(n-k) = x(n)$. Is the system BIBO stable? You may assume that the system is at rest.

Hint: It is not meant that you should try to solve for all the poles/zeros.

Problem 3 (5p)

For a general 4th order difference equation, we need to solve a fourth order equation to establish the pole/zero structure. This is in general hard to do without a computer.

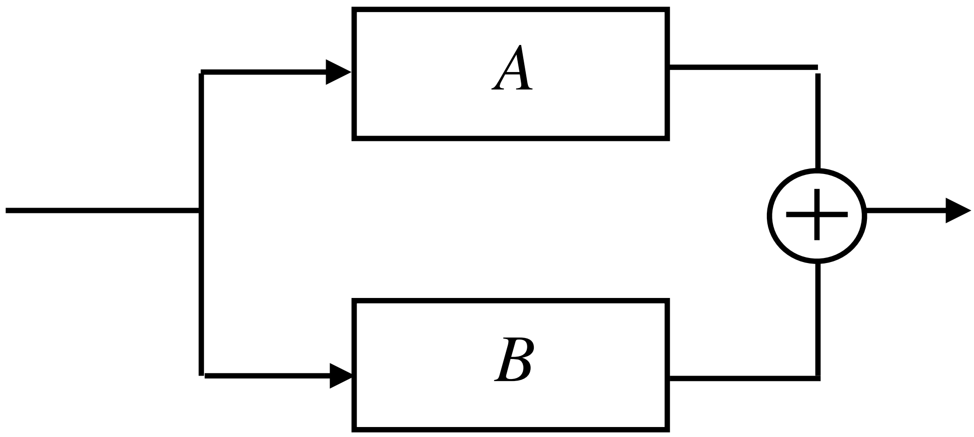
Now consider the following serially cascaded system, where both A and B can be described by second order difference equations.



1. Can an arbitrary 4th order difference equation be described as a serially cascaded system of two 2nd order systems A and B? Explain.

2. Provided with the 2nd order difference equations describing A and B, how does one proceed to establish the pole-zero structure of the overall 4th order system?

Repeat subproblem 1 for the parallel cascaded system below.



Problem 4 (5p)

This problem deals with sampling of time-continuous signals with a sampling frequency of F_s samples per second.

For $X_1(f)$ and $X_2(f)$ shown below sketch the spectra of the signals after sampling for

1. $F_s = 10000\,Hz$
2. $F_s = 25000\,Hz$
3. $F_s = 50000\,Hz$

4. For $X_1(f)$ and $F_s = 25000\,Hz$, determine the output signal in the time-domain.
5. For $X_2(f)$ and $F_s = 10000\,Hz$, determine the output signal in the time-domain.

Remark: Your solutions should take amplitude into account. (I.e., not only the shape of the spectra matters).