L.EEC025 - FUNDAMENTALS OF SIGNAL PROCESSING

Academic year 2023-2024, week 8
TP (Recitation) exercises

Topics: The influence of zeros and poles on the frequency response magnitude

Exercise 1

Consider a causal discrete-time system that is described by the difference equation:
$y[n] = x[n] + Cx[n-2] - Dy[n-2]$, where C and D are constants.

Write a Matlab command file that executes the following functions:

-initializes C=0.0 and D=0.64

-initializes NT=30 and NF=512

Executes a 'while' cycle where, at each iteration:

- **a)** Represents in `subplot(2,2,1)` the first NT samples of the impulse response of the system (add labels),
- **b)** represents in `subplot(2,2,3)` the zero-pole diagram of the system (add labels),
- **c)** represents in `subplot(2,2,4)` the absolute value of the frequency response of the system (linear scale) using NF points for the *whole* unit circumference of the Z plane (add labels),
- **d)** increments C by 1/50 and inserts a `pause`.

The 'while' cycle must execute while $C \leq 2$.

NOTE: at each iteration, you should observe the three figures simultaneously.

Interpret the behavior of the system from iteration to iteration, from the point of view of poles, or zeros, determining the shape of the frequency response magnitude as peaks, or valleys.

Relate the special cases when C=0.64, and C=1.5625. Why are these cases special ?

Problem 2

A first-order discrete-time system has a pole at α , and a zero at $1/\alpha^*$, with $|\alpha| < 1$.

- **a)** Admitting that α is located on the first quadrant of the Z-plane, represent the zero and pole of the discrete-time system.
- **b)** Show graphically that the absolute value of the frequency response of our first-order discrete-time system does not depend on ω (i.e., it consists of an all-pass filter).