ELEC 466 : DIGITAL SIGNAL PROCESSING
1995/96 WINTER SESSION TERM 2

Assignment 3 - The z-Transform

Due January 30, 1996

Question 1

A *median filter* is often used to remove noise from signals. The output of a median filter is the median of the $2N+1$ most recent input values[1].

(a) Is a median filter a linear system?

(b) Is a median filter a time-invariant system?

For each part above, if an answer is 'yes' explain why. If an answer is 'no' give a counter-example. Find the impulse response of a median filter for which $N = 1$.

Question 2

Prove that

$$a^n x(n) \rightleftharpoons X\left(\frac{z}{a}\right)$$

Question 3

(a) What is the z-transform of the sequence $\{0.5, 1.5, 2.5\}$?

(b) What is the transfer function of a system whose impulse response is $\{0, 1, 3, 5\}$?

Question 4

(a) Find the poles and zeroes of

$$H(z) = \frac{z - 0.05}{(z - 1.55)(z + 0.55j)}$$

[1] By definition half of the values will be greater than or equal to the median and half will be less than or equal to the median.

(b) Use Matlab to plot $|H(z)|$ for $-2 < \mathrm{Re}\{z\} < 2$ and $-2 < \mathrm{Im}\{z\} < 2$ with increments of 0.1 in $\mathrm{Re}\{z\}$ and $\mathrm{Im}\{z\}$.

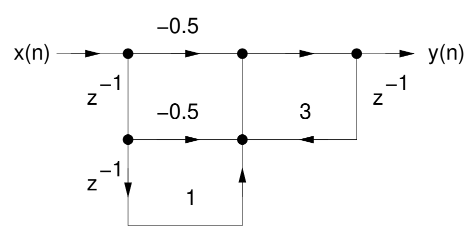
Hand in a printout of your plot and the commands you used to generate it.

Hints:

- *Use the Unix command* `script` *to record the commands you used (type* `man script` *for more information).*
- *The command* `x=[-2:0.1:2];` *generates a vector with values from -2 to 2 with steps of 0.1.*
- *Use the* `meshdom()` *and* `mesh()` *functions.*
- *The operators* `.+`, `.*`, `./` *etc. do the element-by-element operations on vectors or matrices (*`*` *and* `/` *do the vector or matrix operations).*

Question 5

(a) Find the transfer function of the system described by the following signal flow graph:



(b) Is this an FIR filter? Is it an IIR filter?

(c) Use basic Matlab operators (not the `freqz` function) to compute and plot the magnitude of the frequency response of the system above in dB over the range $-3 < \omega < 3$ in steps of 0.1 radian.

Hand in a printout of your plot and the commands you used to generate it.