DSP – Laboratorio N°1 – 2021-1

The interference perceived in a communicational system needs to be modeled. There are 2 possible models, each represented by a block diagram. In both cases, the input $x(t)$ is the transmitted signal, and the output $y(t)$ is the received signal. The discrepancy between the time duration of $y(t)$ and $x(t)$ is the so-called intersymbol interference. For simplicity, both signals are discretized as $x[n]$ and $y[n]$.

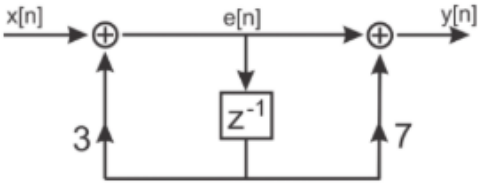

Figure: System 1

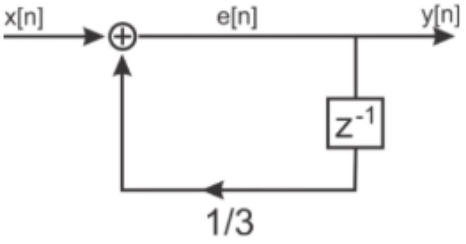

Figure: System 2

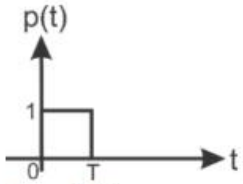

Figure: $P(t)$

a. (2 pts) Find the difference equation of the 2 systems. For each case, find and plot the impulse response using **impz()** and **stem()** for $n = -100 : 100$. Based on the graphs, determine the stability of each system.

b. (2 pts) Consider only the stable system and its corresponding difference equation. Considering an input of the form $x[n] = e^{K}\delta[n]$, an initial condition of $y[-1] = 0$, and $K = 0$, find analytically the impulsive response of the system. **DO NOT USE Z TRANSFORM**. Plot the result using $n = -20 : 20$, use **stem()**.

c. (4 pts) **Conversion from discrete to a continuous impulsive response.** First, replace the variable n with the variable t in $h[n]$ found in item b. Then transform $h[t]$ according to:

$h_c(t) = h(\alpha t)$

Where α is an attenuation parameter.

If the input of the system is $p(t)$, the output of the system is calculated as $y_s(t) = p(t) * h_c(t)$.

Use the definition of convolution to find y_s and show its graph (use **plot()**) as a function of time ($t = 0 : 0.01 : 10$ s).

Consider $\alpha = 1$ and $T = 1$.

Hint: Since $p(t)$ has three regions (see its graph), $y_s(t)$ should also have 3 domains:

i) $t < 0$

ii) $0 < t < T$ (integrate from 0 to t)

iii) $t > T$ (integrate from 0 to T

d. (2 pts) Despite transmitting a signal during a time T, the received signal goes beyond T. This interference is highly dependent of the α value. Using different values of $\alpha = 10, 3, 1/3, 1/10$, discuss the relationship between α and the degree of interference registered. Plot $y_s(t)$ for each α value to support your answer.