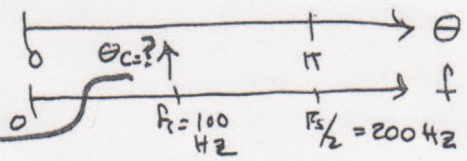
FIR

PROBLEM - Design a Low-pass Finite Impulse Response (FIR) filter of order 6 (i.e., this filter will have 7 coefficients: b_0, b_1, b_2 …, b_6). This filter will operate on sequences sampled at a sampling rate of Fs = 400 Hz. The cut-off frequency (upper edge of the pass band of the filter) should be designed at fc = 100 Hz. Design the filter for a gain K = 10 in the passband.

a) Write down the numerical value of each of the 7 coefficients: b_0 = …, b_1 = …, etc.
b) Draw a block diagram for this filter, and include in it all the numerical values of the coefficients that you found in your design. Also label the points in the block diagram where the input sequence x(n) and the output sequence y(n) would be found.
c) Sketch the impulse response sequence, h(n), of the filter you designed, as a stem plot, indicating the numerical value of the samples of h(n) for 0 <= n <=10

We want gain = K = 10 in passband

$\theta_c = \frac{100\ Hz}{(400/2)}(\pi) \rightarrow \theta_c = \pi/2$



So: $h_{Lp}(n) = \frac{K}{\pi n}\sin(\theta_c n)$ for $n = 0, \pm 1, \pm 2, \pm 3$

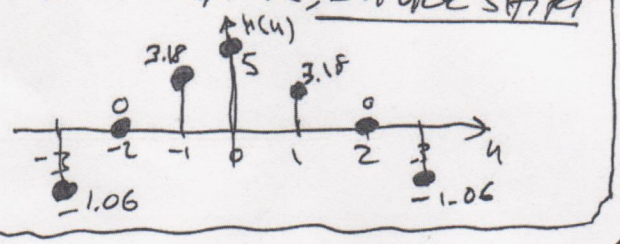
for $n=0$, $h_{Lp}(0) = \frac{10}{\pi(0)}\sin(0(\frac{\pi}{2}))$ → limit (eval. instead for 0.00001) = 5

for $n = \pm 1$, $h_{Lp}(1) = \frac{1}{\pi(1)}\sin(\frac{\pi}{2}(1)) = 3.1831$

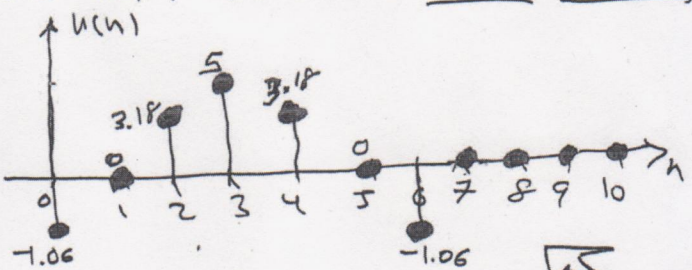
for $n = \pm 2$, $h_{Lp}(2) = \frac{1}{\pi(2)}\sin(\frac{\pi}{2}(2)) = 0$

for $n = \pm 3$, $h_{Lp}(3) = \frac{1}{\pi(3)}\sin(\frac{\pi}{2}(3)) = -1.0610$

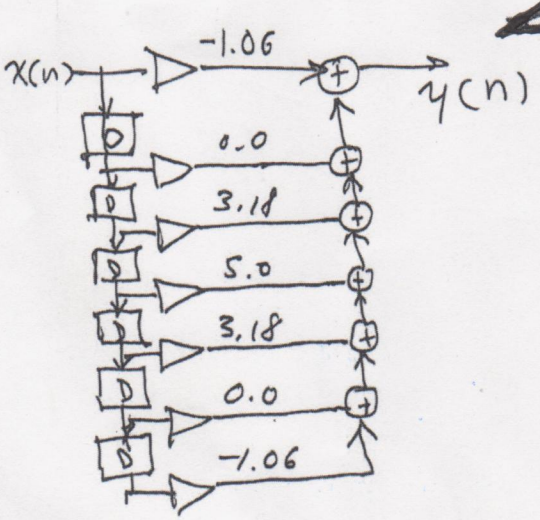
Impulse Response, BEFORE SHIFT



IMPULSE RESPONSE AFTER THE SHIFT TO MAKE FILTER CAUSAL



RESULT FOR PART C)



BLOCK DIAGRAM

$b_0 = -1.06$
$b_1 = 0.0$
$b_2 = 3.18$
$b_3 = 5.0$
$b_4 = 3.18$
$b_5 = 0.0$
$b_6 = -1.06$

FIR COEFFICIENTS