Name *Answers*

EE-3220-11 – Dr. Durant – Quiz 3
Spring 2015, Week 3

1. (2 points) Let f_s = 2000 Hz, f_1 = 0 Hz, f_2 = 500 Hz, and f_3 = 1500 Hz. ***Calculate*** the digital frequencies, ω_n, for each frequency, f_n. for f_1 through f_3. Recall that the digital frequency is how many radians a sinusoid moves through between samples. For example, if a signal is sampled 10 times per period, its digital frequency is 2π/10. Do ***not*** make any adjustments for aliasing.

$\omega_1 = \frac{f_1}{f_s} \cdot 2\pi = \frac{0}{2000} \cdot 2\pi = 0$ radians/sample

$\omega_2 = \frac{500}{2000} \cdot 2\pi = \frac{\pi}{2}$

$\omega_3 = \frac{1500}{2000} \cdot 2\pi = \frac{3\pi}{2}$

2. (2 points) ***Explain*** whether any of the 3 sinusoids above are aliased. For each frequency that is aliased, assuming it was not stopped by a suitable antialias filter, ***calculate*** what frequency would be observed at the output of the system due to aliasing.

$|\omega_3| > \pi \therefore$ it is aliased

Digital signals are periodic in frequency, so $\omega_3^* = \omega_3 + 2\pi k$ give same samples for all integers k ($k \in \mathbb{Z}$). Choose $k = -1$.
$\omega_3^* = \frac{3\pi}{2} - 2\pi = \frac{-\pi}{2}$. Now, $|\omega_3^*| \leq \pi$ so it is the reconstructed frequency.
(Since signal is real, the negative freq. component also exists, so $+\pi/2$ is also right.)

3. (4 points) ***Calculate*** the first ~~4~~ 3 samples of the unit step response of y(n) – 0.5 y(n–1) = x(n) – 3x(n–1) + 4x(n–2). Recall that the step response is y(n) when x(n) = u(n).

$y(n) = \frac{1}{2} y(n-1) + x(n) - 3x(n-1) + 4x(n-2)$

$y(0) = \frac{1}{2} \cdot 0 + 1 - 0 + 0 = 1$

$y(1) = \frac{1}{2} \cdot 1 + 1 - 3 \cdot 1 + 0 = -1.5$

$y(2) = \frac{1}{2} \cdot -1.5 + 1 - 3 \cdot 1 + 4 \cdot 1 = 1.25$

4. (2 points) What is the vector of "a" or autoregressive or IIR (infinite impulse response) coefficients in the above equation? (Recall that the "b" or FIR coefficients correspond to a weighted sum of inputs.)

$a = [1 \ \ -0.5] = [a_0 \ \ a_1]$

negative, keep all a's in standard form/left hand side