FALL 24 EC516 Problem Set 10

Due: Sunday November 17 (Before 11:59pm)

You must submit your homework attempt on Blackboard Learn. For this purpose, you must convert your homework attempt to a pdf file and upload it at the corresponding homework assignment on Blackboard Learn. The problems here are from the Midterm exam.

Problem 10.1

Consider a digital filter ***F*** with impulse response $h[n] = (-1)^n\{u[n] - u[n-4]\}$

(a) What are the locations of the zeros of the system function, $H(z)$, of the filter ***F***? Justify your answer.

(b) For what frequency in the range $0 \leq \omega \leq \pi$, does the magnitude of the frequency response of filter ***F*** attain its maximum value? Justify your answer,

Problem 10.2

Consider$0 \leq \omega \leq \pi$ a filter ***G*** with system function $H(z) = 1 - z^{-8}$.

(a) Is the filter ***G*** FIR? Justify your answer.

(b) If the filter ***G*** is provided the input $x[n] = \cos(0.25\pi n + 0.15\pi)$, for what values of n is it *guaranteed* that the output signal $y[n]$ is equal to zero? Justify your answer.

Problem 10.3

(a) Consider a digital filter ***Q*** whose output $y[n]$ is related to its input $x[n]$ through the difference equation, $y[n] = 0.5y[n-1] + x[n] - (0.5)^4x[n-4]$. Sketch the pole-zero plot for this filter.

(b) Sketch a *flowgraph* for an IIR filter **G** which for input $x[n] = \cos(0.25\pi n)$ produces the output $y[n] = 0$ but for any other input $x[n] = \cos(\omega_0 n)$ in which $|\omega_0| \neq 0.25\pi$ and $|\omega_0| \leq \pi$, there is at least one non-zero sample in the corresponding output $y[n]$. *Justify your answer*.

Problem 10.4

(a) Sketch and label the inverse of the Discrete-Time Fourier transform (DTFT) given as $X_a(e^{j\omega}) = e^{-j\frac{5\omega}{2}} \dfrac{\sin(3\omega)}{\sin(0.5\omega)}$. *Justify your answer.*

(b) If the Bilinear transformation is applied to an analog filter whose frequency response $H(j\omega)$ is such that $H(j\omega_0) = 0$ for some ω_0, is it guaranteed that the resulting digital filter will have at least one zero on the unit circle? Justify your answer.

Problem 10.5

Sketch the phase of the Discrete-Time Fourier Transform (DTFT) of the signal specified as $x[n] = \sum_{k=-\infty}^{\infty} g[k]g[n-k]$ where $g[n] = \delta[n] + \delta[n-1]$ and $\delta[n]$ is the unit impulse. Show your work.

Problem 10.6

During the design process for a digital filtering application, it is determined that the desired digital filter must have linear phase. Could Bilinear transformation be useful during the design process?