HACETTEPE UNIVERSITY

Department of Electrical and Electronics Engineering

ELE 409: Digital Signal Processing Laboratory

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STUDENT ID:

December 18, 2020

EXPERIMENT 4 - IIR FILTERS

- Use "SPTOOL" for filter design.
- Produce all of the magnitude spectra of signals and responses of filters outside the toolbox by exporting them.
- Results **must not be** in dB for ease of comparison.

1. Suppose that you have three filter alternatives with the following specifications;

$$\begin{aligned} 0.8 < \left|H_1(e^{jw})\right| < 1 \quad &\text{for} \quad 0 < w < 0.22\pi \\ \left|H_1(e^{jw})\right| < 0.32 \quad &\text{for} \quad 0.48\pi < w < \pi \end{aligned} \tag{1}$$

$$\begin{aligned} 0.8 < \left|H_2(e^{jw})\right| < 1 \quad &\text{for} \quad 0 < w < 0.22\pi \\ \left|H_2(e^{jw})\right| < 0.26 \quad &\text{for} \quad 0.32\pi < w < \pi \end{aligned} \tag{2}$$

$$\begin{aligned} 0.8 < \left|H_3(e^{jw})\right| < 1 \quad &\text{for} \quad 0 < w < 0.10\pi \\ \left|H_3(e^{jw})\right| < 0.22 \quad &\text{for} \quad 0.13\pi < w < \pi \end{aligned} \tag{3}$$

   Load 'signals4.mat' in which there are two signals **x** and **y**. **y** is the filtered version of **x** with one of the above filters. By plotting the signal **x** and responses of three filters on a subplot, **y** on another subplot, determine the filter used to obtain **y** from **x**.

2. Design the digital Butterworth filter with the specifications that you found in the previous part.
   Export your filter to Matlab workspace with File → Export menu.
   Call numerator and denominator coefficients **b1** and **a1**, respectively, and filter order N1.

3. Design the digital Chebyshev filter (type 1) with the above specifications.
   Call numerator and denominator coefficients **b2** and **a2**, respectively, and filter order N2.

4. Compare your designs in terms of complexity, magnitude and phase response.

5. Load 's4_1.wav'.
   Pass the sound file from Butterworth filter (2). Call the output **y1**.
   Pass the sound file from Chebyshev filter (3). Call the output **y2**.
   Observe the signals **y1** and **y2**. Comment on them.