Analog Filter Design (EET 3132)

Lab 1: Introduction to Filter Design using MATLAB

Branch: ECE/EEE			
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1 Introduction

This lab will introduce generation of different signals, some elementary filters and their design. MATLAB will be used as a tool for designing and evaluating the digital filters. The filters used in this lab will be implemented using several different MATLAB functions. In the general case for high- and low-pass filters the slope increases (or decreases) by 6 dB/octave/zero (or pole) or 20 dB/decade/zero (or pole) respectively.

1.1 Low Pass Filter

The general low pass filter (LPF) is characterized by the attenuation of the higher frequencies and passing the low, sometimes with a gain. The phase characteristics depends on the order of the filter and the implementation.

1.2 Notch Filter

The notch filter is characterized by the sharp attenuation dip in frequency domain. This filter type is generally used to remove a disturbance of a known narrow band frequency. The width of the attenuation dip and the maximum attenuation depends on the order and implantation of the filter. The maximum gradient of the phase slope is at the center of the attenuation frequency.

2 Assignments

2.1 Assignment 02

Using MATLAB

(a) Generate a sine wave of duration 1 second and frequency 800 Hz. Its a convention to represent signals as column vectors. So follow the same convention throughout the course.

(b) Generate another sine wave of duration 1 second and of 1200 Hz.

(c) Generate a cosine wave of duration 2 second and frequency of 800 Hz.

(d) Generate another cosine wave of duration 1.5 second and frequency of 1200 Hz.

(e) Plot them in a single plot window. Clearly mark the x-y axes and the titles.

(f) How many samples are there in each signal?

(g) Play each of the signal generated in part (a) to (d) (use `sound()` function available in MATLAB). Do you find any similarities/differences between them? Explain.

(h) Add the signals generated in (a) and (b). Plot the same. Hear the signal. Do u feel any changes? How many samples are there? What is the duration of this signal?

(i) Append the signals generated in (a) and (b). Plot the same. Hear the signal. Do u feel any changes? How many samples are there? What is the duration of this signal?

(j) Using MATLAB write a program plot the spectrum of these signals? Plot the spectrum of all signals in a single plot window. Clearly mark the x-y axes and the titles.

(k) Generate a zero mean uniform noise signal of duration 1 second. Plot the signal in time domain and frequency domain in a single plot window. Clearly mark the x-y axes and the titles. Play the signal and hear it.

Solution

2.2 Assignment 02

Alternating current in the United States and several other countries oscillates at a frequency of 60 Hz. Those oscillations often corrupt measurements and have to be subtracted.

(a) Study the open-loop voltage across the input of an analog instrument in the presence of 60 Hz power-line noise. Use the MATLAB data file `openloop60hertz` to load such an example. The voltage is sampled at 1 kHz.

(b) Eliminate the 60 Hz noise with a Butterworth notch filter. Use `butter` command to design it. Define proper width of the notch filter.

(c) Plot the frequency response of the filter. Use the `freqz` command for the same.

(d) Pass the signal through the designed filter. Use the `filter` command to achieve this. Plot the original signal and the filtered signal in the same plot window.

(e) Test the filter output by changing the order of the filter.

(f) Make suitable observations and conclusions.

Solution

3 Explain what you have learned in this assignment set.

4 References used

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