EE386 Digital Signal Processing Lab **Aug-Nov 2023**

Report: Homework 6

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Note: The codes used in this task have been uploaded as a separate file along with the pdf report submission.

Throughout this document, the value of "a" used is given by : a = 1 + mod(109, 3) = 2

1 Butterworth filter design

Problem 1

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(Subproblem 1 : Finding transfer function of the filter)
(Solution)

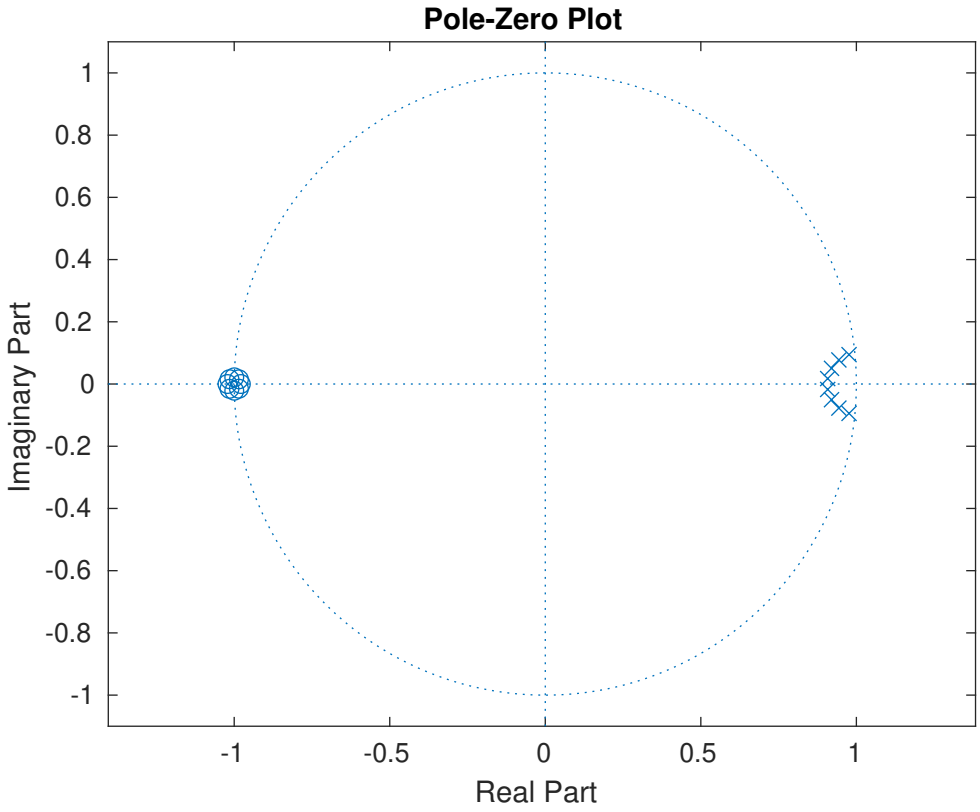
The Transfer function Coeffcients turn out to be :

b = [2.03721528e-11, 1.62977222e-10, 5.70420278e-10, 1.14084056e-09, 1.42605070e-09, 1.14084056e-09, 5.70420278e-10, 1.62977222e-10, 2.03721528e-11]

a = [1. , -7.51325809, 24.71049533, -46.46621772, 54.63969569, -41.14232214, 19.37196795, -5.21482871, 0.61446769]

(Subproblem 2 : Plot its pole zero plot. Comment on the system stability from the plot.)
(Solution)

The following plot is obtained :

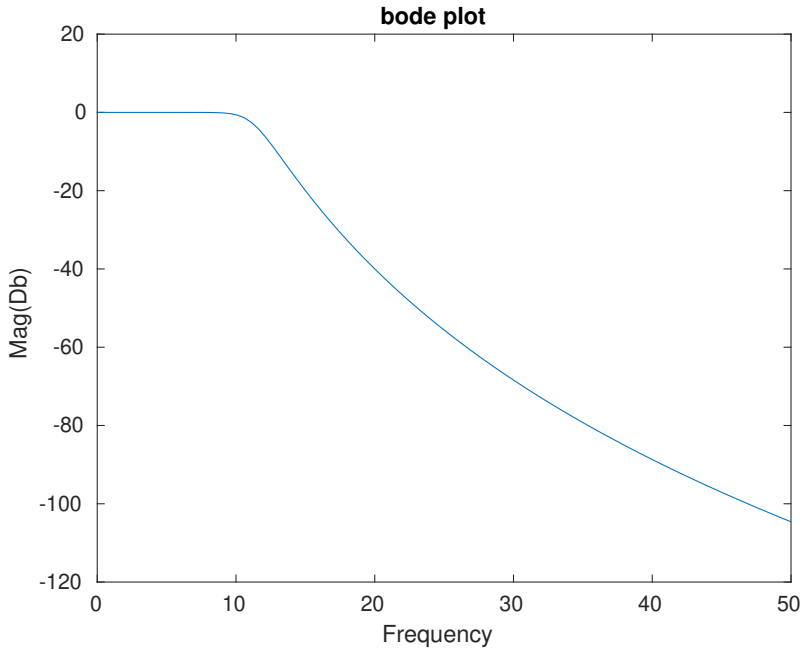


The system will be unstable since the poles are on the positive side of the plot. The poles are the power to which the exponential function is raised to. As this power is positive, it would say that the corresponding equation would be exponentially increasing, and hence the output will be unbounded, therefore the system will become unstable.

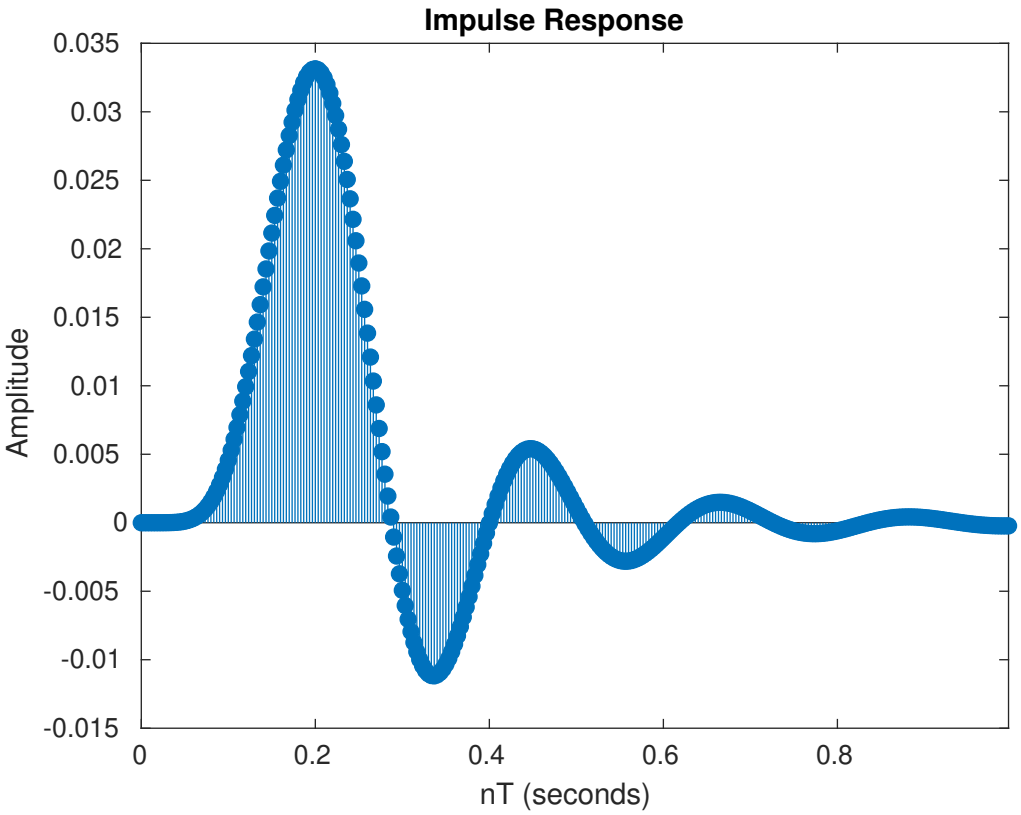
(Subproblem 3 : Plot also the bode plot (with respect to frequency in Hz).)

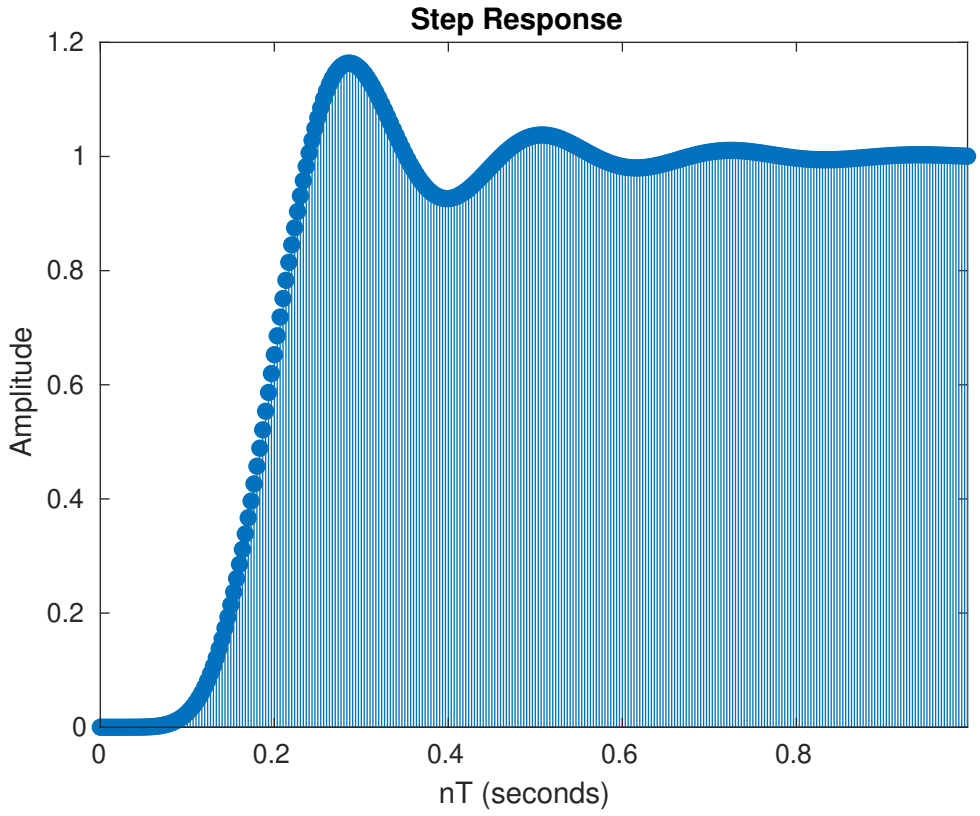
(Solution)

I plotted the bode plot and obtained :



I plotted the Impulse response and step response and obtained the following plots:



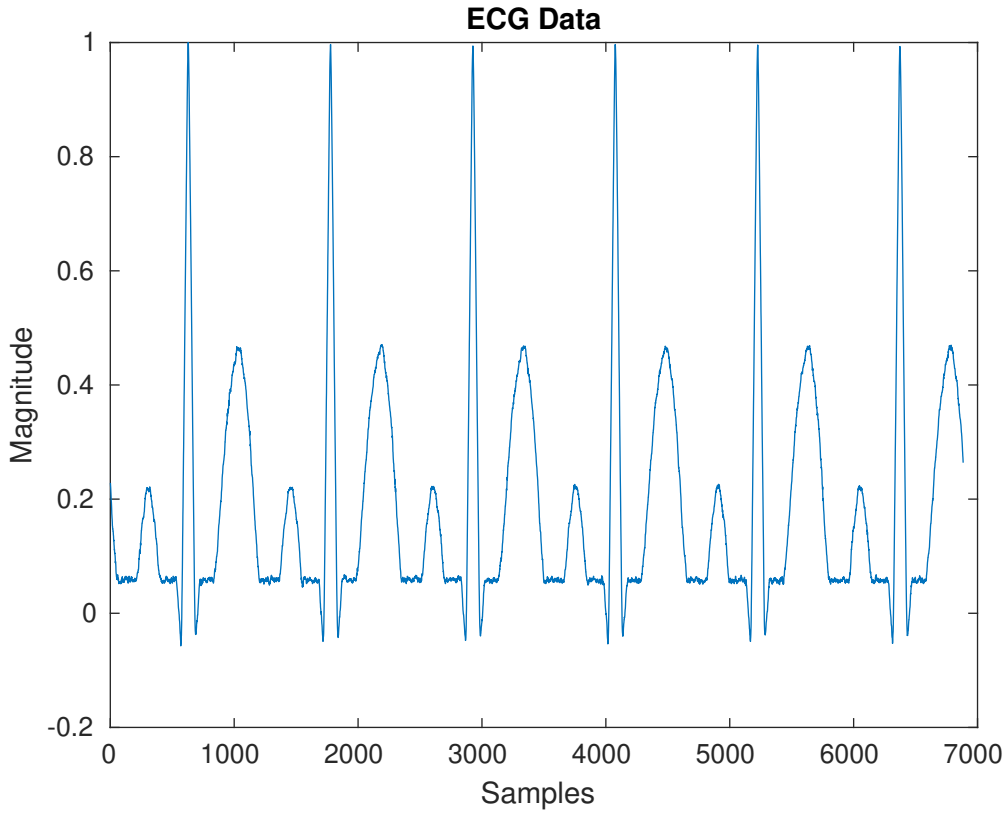


2 Filtering

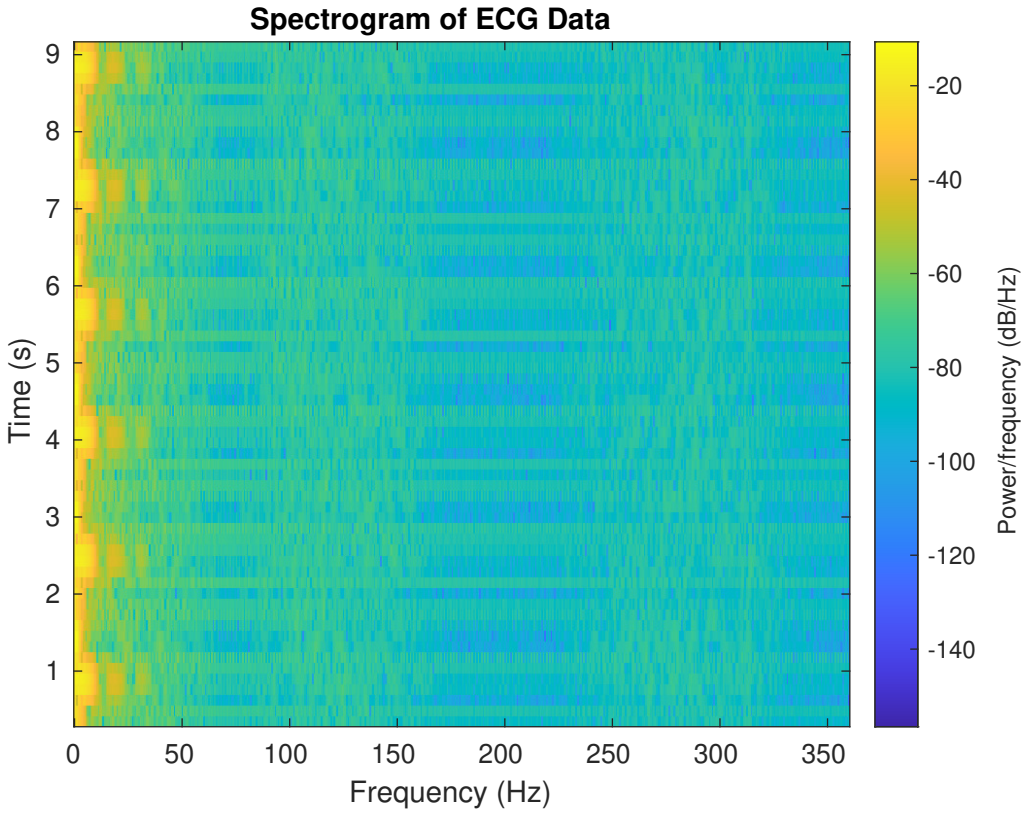
Problem 2

(Solution)

The input ECG data is as follows:



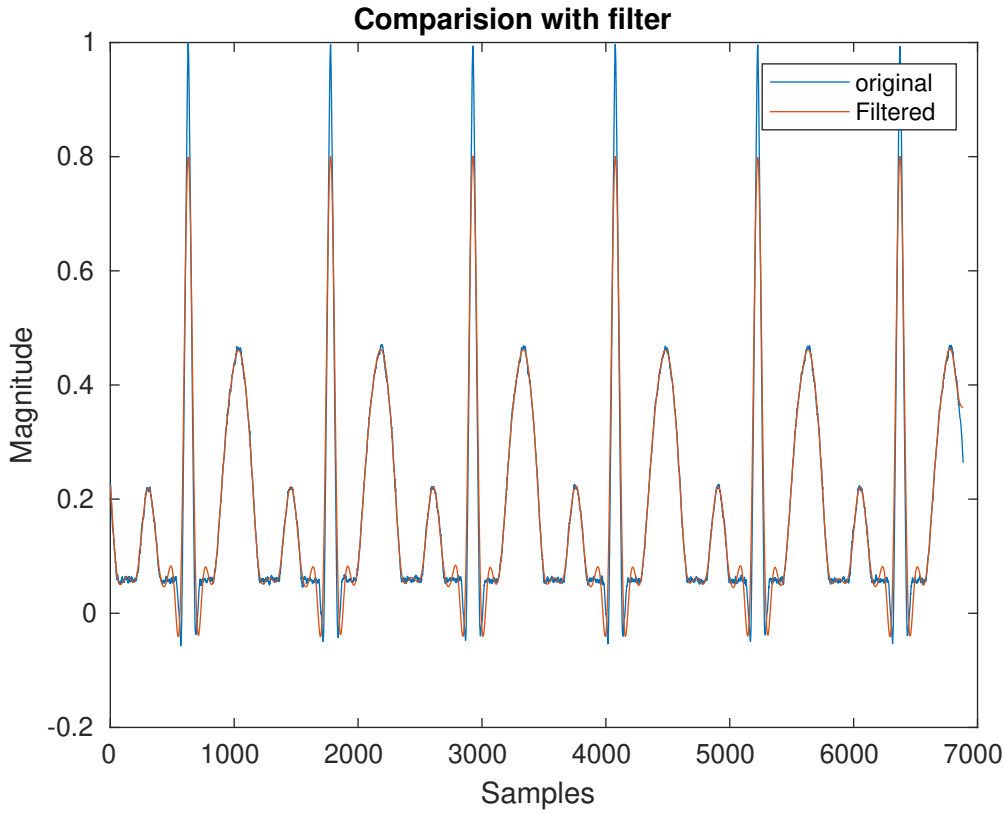
I plotted the spectrogram of the given ECG signal for better visulization, I obtained :



From above Spectrogram, I set the pass band as -1dB, 15Hz edge frequency, and stop band at

-45dB and 50Hz to design Low-Pass ButterWorth Filter. I set the sampling frequency to be equal to that of 720 Samples/Second.

The filtered ECG obtained is plotted :



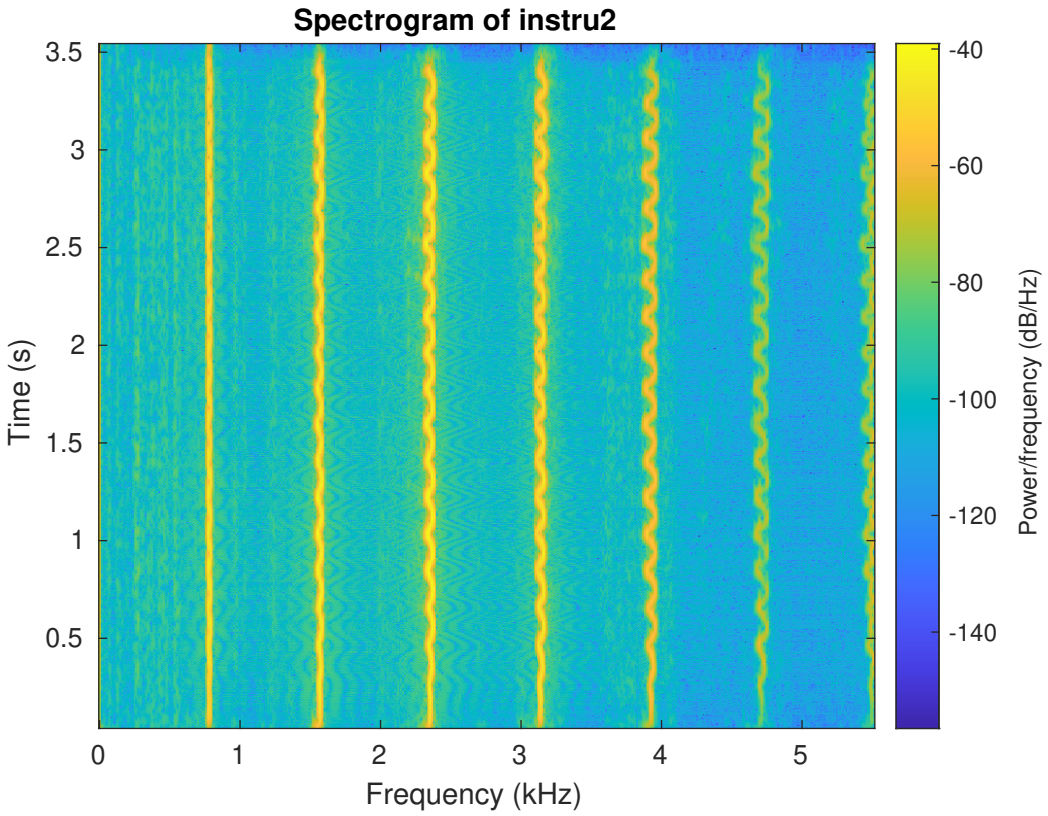
3 Filtering — Time-Frequency Analysis

Problem 3

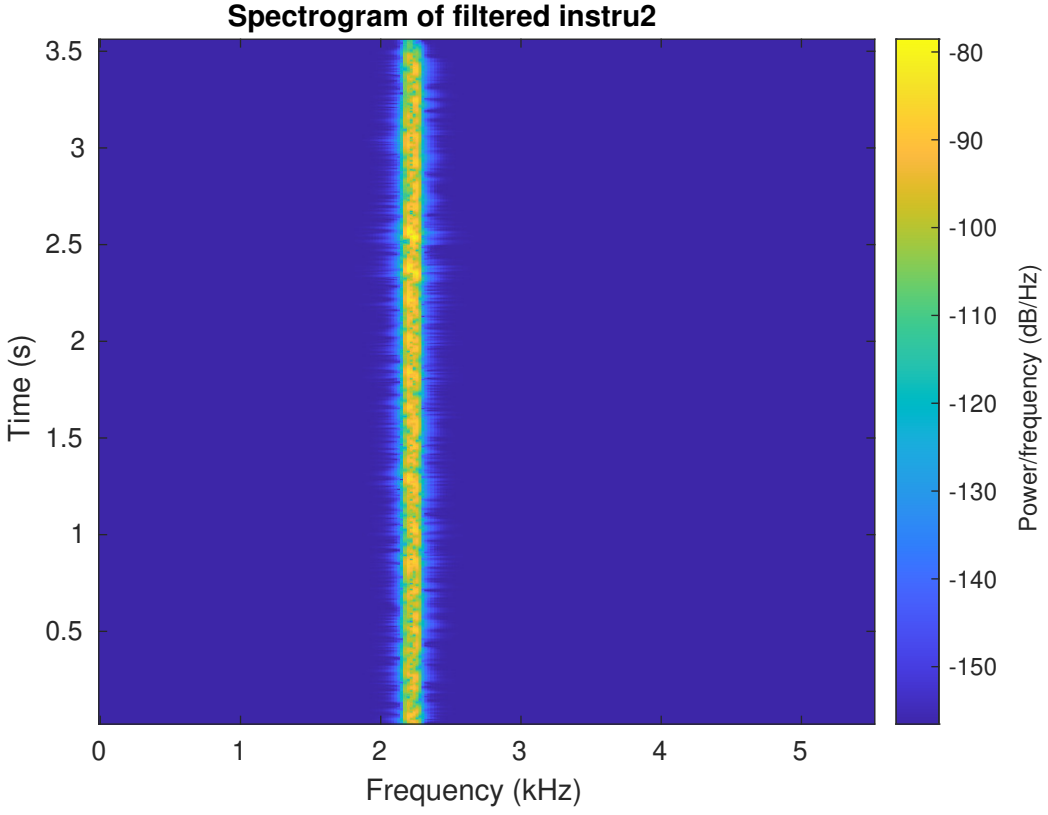
Througout the problem instru2.wav is used as a=2"

(Solution)

I plotted the spectrogram for for the above given .wav file and I obtained :



From the above Spectrogram, I set the pass band within -40dB from 2150Hz to 2300Hz, and rejecting at least -70dB above 2100Hz or below 2350Hz. I set the sampling frequency to be equal to that of instru2.wav. A filter of order 7 with band pass filterswas obtained. After Filtering the above given .wav file and then plottingits spectrogram we get :



4 Chebyshev filter design

Problem 4

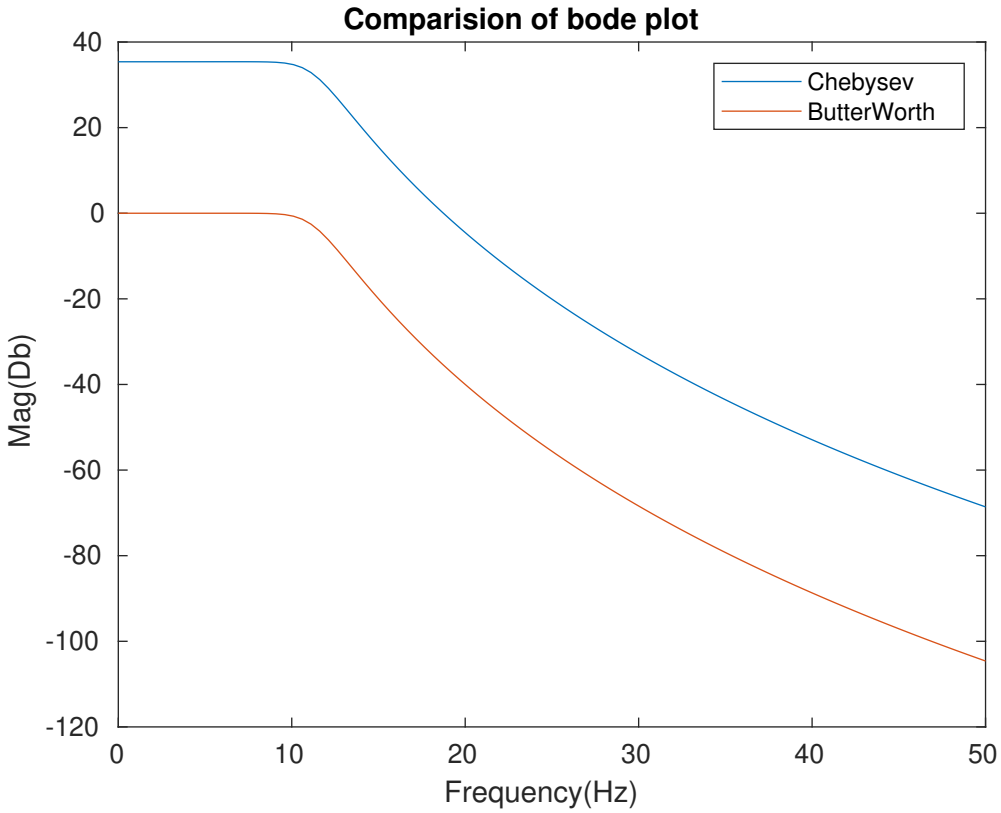
Here I have designed Low-Pass "Chebyshev Filter" using Cheb1ord and Cheby functions in matlab//

(Subproblem 1 :Compare the system order w.r.t Butterworth)

Here the order is 5, wheras in ButterWorth filter Case it was 8. This means that lesser components would be required to physically hardware-implement the Chebyshev filter than the Butterworth filter

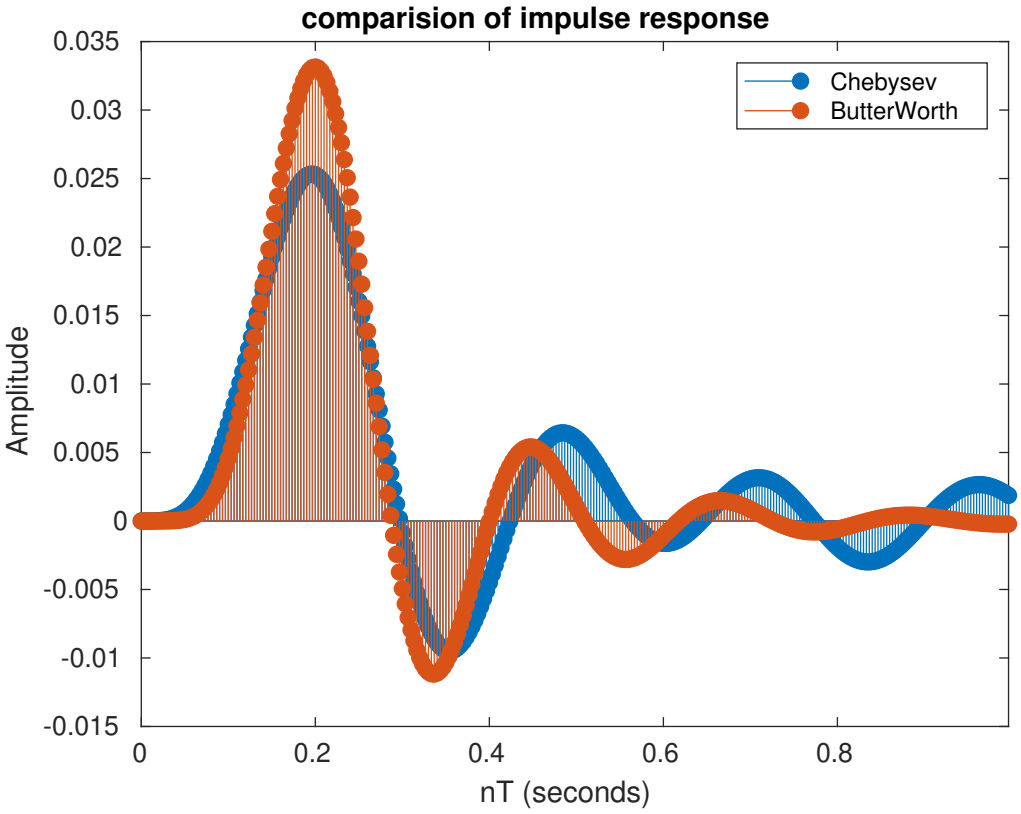
(Subproblem 2 : Compare the bode Plots)

The comparison of bode plot gives :

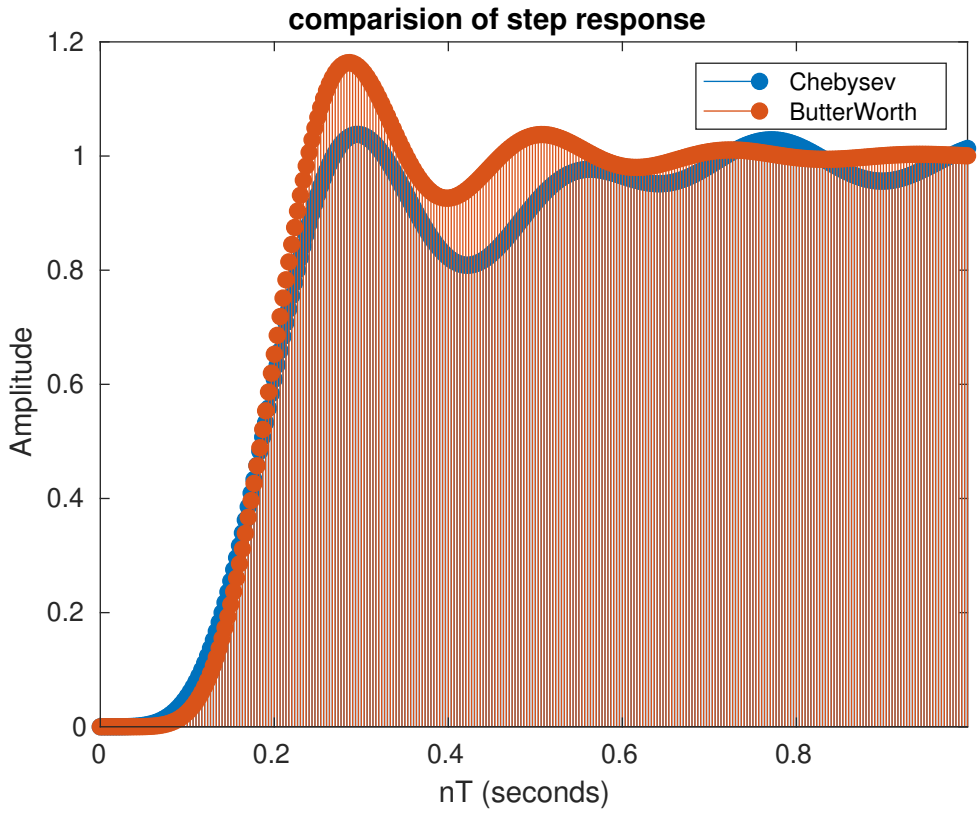


(Subproblem 3 : compare the impulse response and step response of the Butterworth and Chebyshev filter.)

The comparison of Impulse Response gives :



The comparison of Step Response gives :



5 Code Repository

The codes and other files to reproduce all the results in this homework can be found in the Matlab repository

`https://drive.matlab.com/sharing/5bde9cc5-521a-4249-b2bd-3692a075558c`