EE3025 Assignment-1

Shreekara Raghavan - EE18BTECH11040

Download all python codes from

```
https://github.com/Shreekara277/IDP/tree/main/
    codes
```

1 Problem

The command

```
output_signal = signal.lfilter(b,a,
    output_signal)
```

in Problem 2.3 is executed through following difference equation

$$\sum_{m=0}^{M} a(m)\, y(n-m) = \sum_{k=0}^{N} b(k)\, x(n-k) \tag{1.0.1}$$

where input signal is $x(n)$ and output signal is $y(n)$ with intial values all 0. Replace **signal.filtfilt** with your own routine and verify.

2 Solution

Applying Z transform on the equation 1.0.1 we get,

$$\mathcal{Z}\Big(\sum_{m=0}^{M} a(m)\, y(n-m)\Big) = \mathcal{Z}\Big(\sum_{k=0}^{N} b(k)\, x(n-k)\Big) \tag{2.0.1}$$

$$\sum_{m=0}^{M} \mathcal{Z}(a(m)\, y(n-m)) = \sum_{k=0}^{N} \mathcal{Z}(b(k)\, x(n-k)) \tag{2.0.2}$$

Using the property

$$\mathcal{Z}\{x(n-a)\} = z^{-a} X(z) \tag{2.0.3}$$

where $X(z)$ is the Z- transform of x(n).(1.0.1) We

then get:

$$\sum_{m=0}^{M} a(m)\, Y(z)\, z^{-m} = \sum_{k=0}^{N} b(k)\, X(z)\, z^{-k} \tag{2.0.4}$$

$$Y(z) = \frac{\sum_{k=0}^{N} b(k)\, z^{-k}}{\sum_{m=0}^{M} a(k)\, z^{-m}} X(z) \tag{2.0.5}$$

The numerator and denominator of the butterworth coefficients are b and a respectively which can be calculated.By taking the fft of x(n) and multiplying it with the transfer function,

$$H(z) = \frac{\sum_{k=0}^{N} b(k)\, z^{-k}}{\sum_{m=0}^{M} a(k)\, z^{-m}} \tag{2.0.6}$$

We get Y(z). Taking the ifft of Y(z) will yield us y(n). Python code for the problem

```
codes/ee18btech11040.py
```

Below are the plots which verifies our own routine

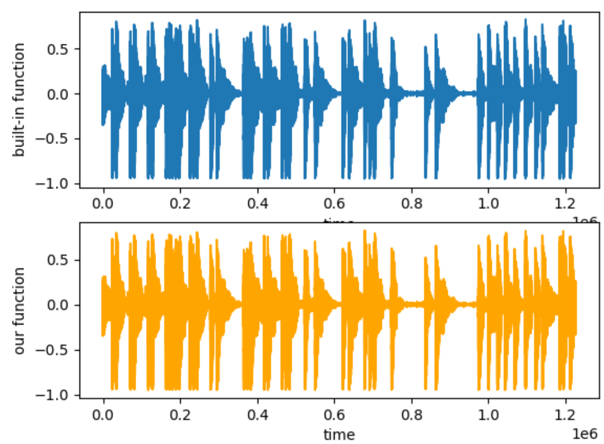

Fig. 0: Time response

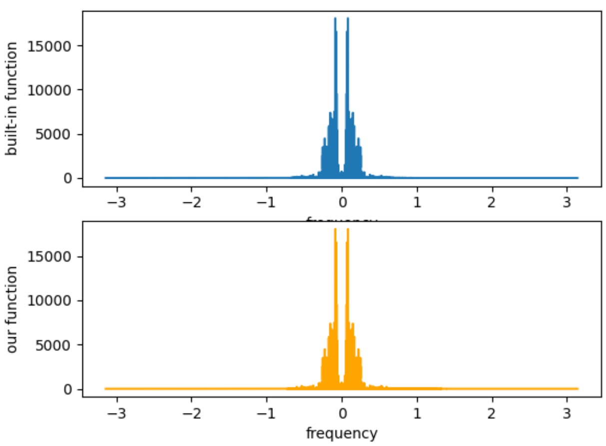

Fig. 0: Frequency response