Infinite Impulse Response Filter Design

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This code will prove to be classic example for proper use of the given functions for Butterworth filter, Chebyshev Type 1 filter and Chebyshev Type 2 Filter Design

Inputs Provided

Passband Attenuation

```
Ap = 3;
```

Sampling Frequency

```
Fs = 500;
```

Stopband Attenuation

```
As = 60;
```

Passband Frequency

```
Wp = 40;
```

Dividing by Sampling Frequeny

```
Wp = Wp / Fs;
```

Stopband Frequency

```
Ws = 150;
```

Dividing by Sampling Frequeny

```
Ws = Ws / Fs;
```

Derivation of order by butterord

```
[n,Wn] = buttord(Wp,Ws,Ap,As);
```

Formula for Order n of Butterworth filter

$$n = \frac{\log \varepsilon}{\log \Omega_p - \log \Omega_s + \frac{1}{n} \log \sqrt{A^2 - 1}}$$

OR another simplified version will be

$$n = \frac{\log\left(\varepsilon \big/ \sqrt{A^2 - 1} \right)}{\log\left(\Omega_p \big/ \Omega_s \right)}$$

Applying the Butterworth filter function

```
[b,a] = butter(n,Wn);
```

Converting to frequency domain.

```
[h,w] = freqz(b,a);
```

Since the obtained input was in Normalized Form we get it back by multiplying with Sampling Frequency

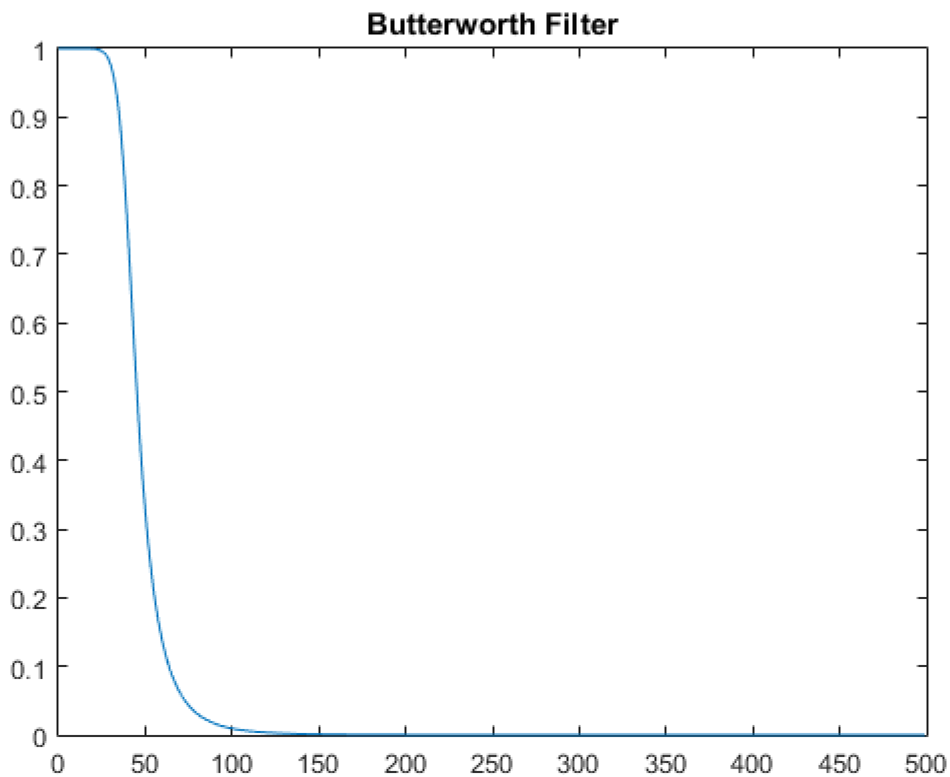
```
W = w*Fs/pi;
```

To remove the negative values of h we take absolute

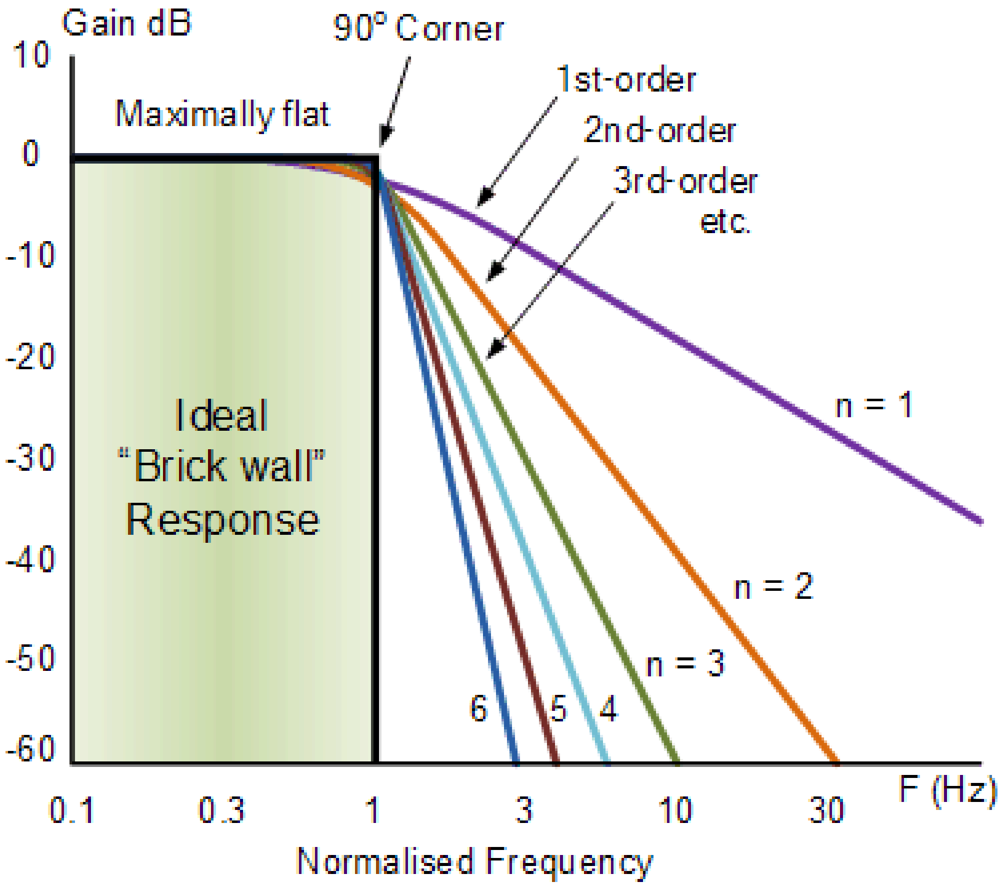
```
h = abs(h);
```

The PLOT for Butterworth Filter

```
figure();
plot(W,h);
title('Butterworth Filter')
```



Butterworth Filter Characteristics



Derivation of order

```
[n,Wp] = cheb1ord(Wp,Ws,Ap,As);
```

Applying the Chebyshev Type I filter function

```
[b,a] = cheby1(n,Ap,Wp);
```

Converting to frequency domain.

```
[h,w] = freqz(b,a);
```

Again since the obtained input was in Normalized Form we get it back by multiplying with Sampling Frequency

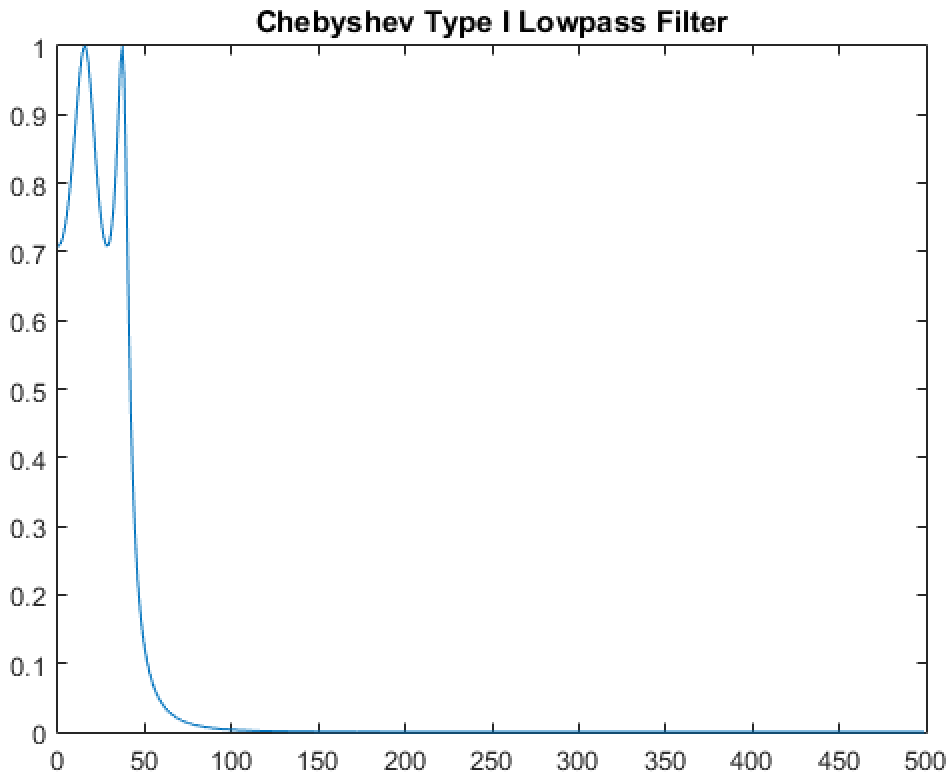
```
W = w*Fs/pi;
```

Again to remove the negative values of h we take absolute

```
h = abs(h);
```

The PLOT for Chebyshev Type I Filter

```
figure();
plot(W,h);
title('Chebyshev Type I Lowpass Filter')
```



Derivation of order

```
[n,Wp] = cheb2ord(Wp,Ws,Ap,As);
```

Applying the Chebyshev Type II filter function

```
[b,a] = cheby2(n,As,Wp);
```

Converting to frequency domain.

```
[h,w] = freqz(b,a);
```

Again since the obtained input was in Normalized Form we get it back by multiplying with Sampling Frequency

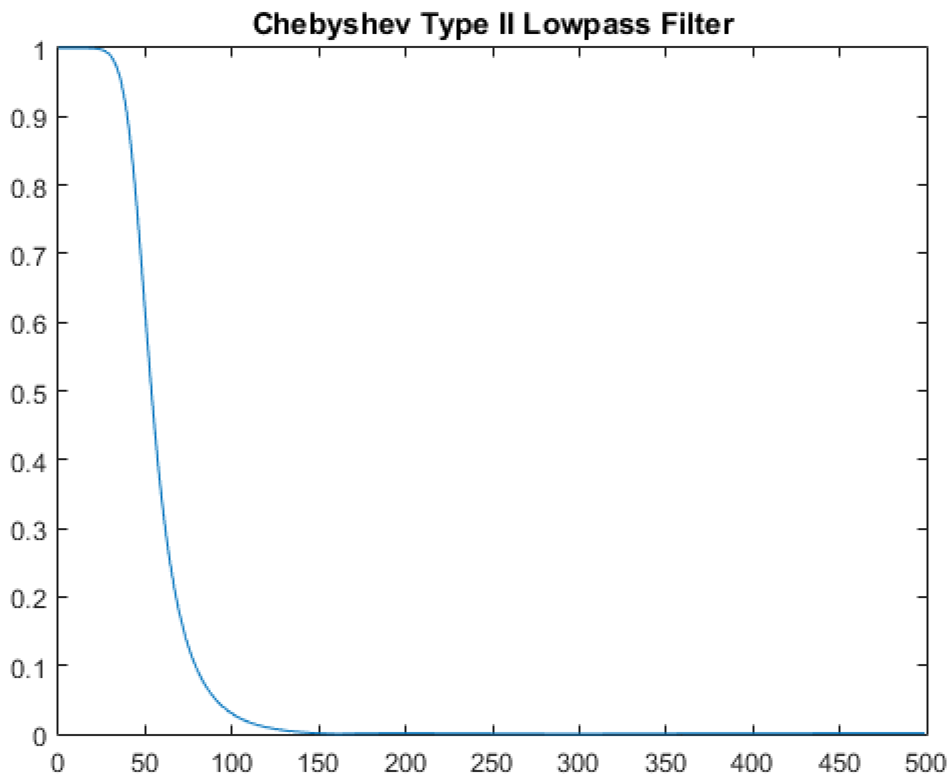
```
W = w*Fs/pi;
```

Again to remove the negative values of h we take absolute

```
h = abs(h);
```

The PLOT for Chebyshev Type II Filter

```
figure();
plot(W,h);
title('Chebyshev Type II Lowpass Filter')
```



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MATLAB Lab experiment of Linear to circular convolution.

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