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

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

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

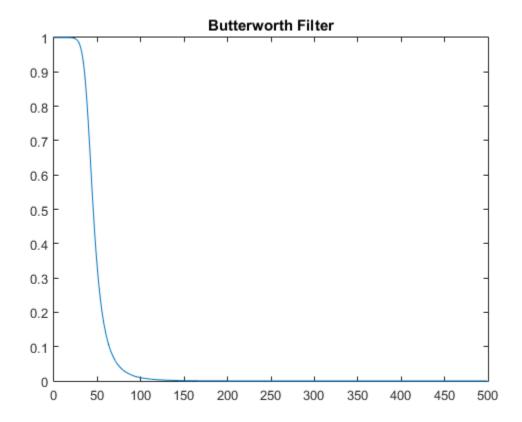
$$W = w*Fs/pi;$$

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')
```



Derivation of order

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

Applying the Chebyshev Type I filter function

```
[b,a] = chebyl(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

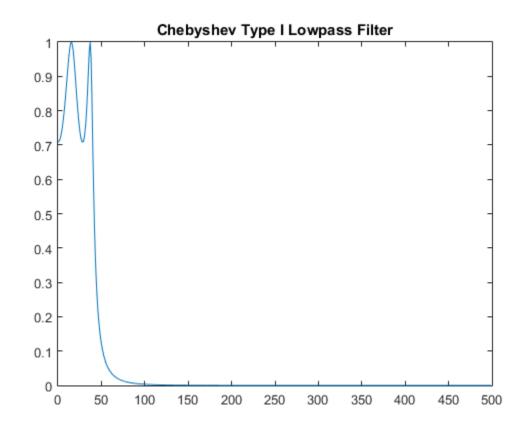
```
W = w*Fs/pi;
```

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,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

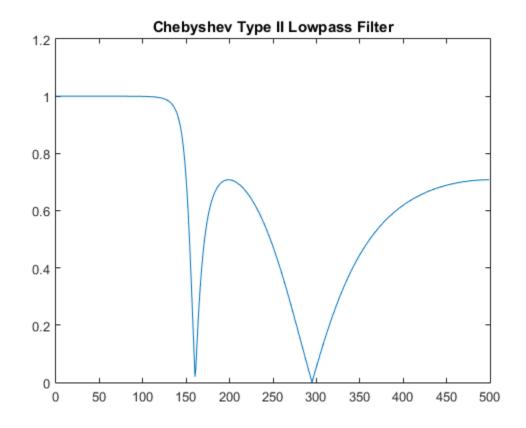
```
W = w*Fs/pi;
```

Again to remove the negative values of h we take absolute

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

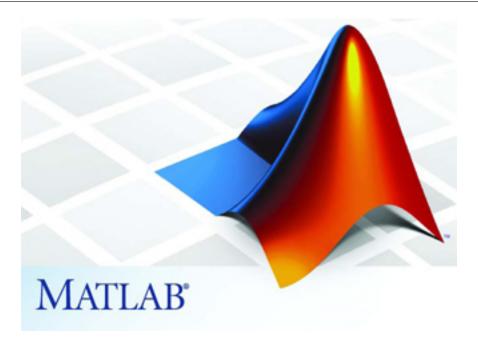
The PLOT for Chebyshev Type II Filter

```
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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