**Experiment 8**

**Aim: To design Butterworth filter.**

The Butterworth filter is a type of [signal processing filter](http://en.wikipedia.org/wiki/Filter_%28signal_processing%29) designed to have as flat a [frequency response](http://en.wikipedia.org/wiki/Frequency_response) as possible in the [passband](http://en.wikipedia.org/wiki/Passband) so that it is also termed a maximally flat magnitude filter. It was first described in 1930 by the British [engineer](http://en.wikipedia.org/wiki/Engineer) [Stephen Butterworth](http://en.wikipedia.org/wiki/Stephen_Butterworth) in his paper entitled "On the Theory of Filter Amplifiers".

Butterworth had a reputation for solving "impossible" mathematical problems. At the time, [filter design](http://en.wikipedia.org/wiki/Filter_design) required an amount of designer experience due to limitations of the [theory then in use](http://en.wikipedia.org/wiki/Image_parameter_filter). The filter was not in common use for over 30 years after its publication. Butterworth stated that:

"An ideal electrical filter should not only completely reject the unwanted frequencies but should also have uniform sensitivity for the wanted frequencies".

Such an ideal filter cannot be achieved but Butterworth showed that successively closer approximations were obtained with increasing numbers of filter elements of the right values. At the time, filters generated substantial ripple in the passband, and the choice of component values was highly interactive. Butterworth showed that a [low pass filter](http://en.wikipedia.org/wiki/Low_pass_filter) could be designed whose cutoff frequency was normalized to 1 radian per second and whose frequency response ([gain](http://en.wikipedia.org/wiki/Gain)) was

G(\omega) = \sqrt{\frac{1}{1+{\omega}^{2n}}},

clc

clear all

rp=input('Enter the passband attenuation');

rs=input('Enter the stopband attenuation');

wp=input('Enter the passband frequency');

ws=input('Enter the stopband frequency');

fs=input('Enter the sampling frequency');

w1=2\*wp/fs;

w2=2\*ws/fs;

[n,wn]=buttord(w1,w2,rp,rs,'s');

[b,a]=butter(n,wn,'s');

w=0:.01:pi

h=freqs(b,a,w)

m=20\*log10(abs(h));

an=angle(h);

subplot(2,1,1)

plot(m)

subplot(2,1,2)

plot(an)

**Output**

Enter the passband attenuation 0.15

Enter the stopband attenuation 47

Enter the passband frequency 1500

Enter the stopband frequency 60

Enter the sampling frequency 7000

