Butterworth Filter Design

A Filter is a signal processor that transmits signals in some frequency bands and rejects or attenuates signals in other bands. The low-pass filter passes frequencies below its cuttoff frequency ω_c and attenuates the high frequency components in the stopband above the cutoff frequency.

Active RC filter realizations use resistors, capacitors, and OP AMPS. These filters offer the following advantages:

1. They combine amplifier gain with the frequency-response characteristics of passive RLC circuits.
2. The transfer function can be divided into stages that can be designed independently and then connected in cascade to realize the required gain function.
3. They are often smaller and less expensive than RLC filters because they do not require inductors, which can be quite large in low-frequency applications.

The design process begins by constructing a transfer function whose gain response meets the specifications. Except in the case of simple first-and second-order filters, we partition the transfer function into a product of the form

$$T(s) = T_1(s) \times T_2(s) \times T_3(s) \times ...T_n(s)$$

Note that

- several transfer functions may exist that adequately approximate the required gain characteristics.
- there usually are several ways to asign numerical values to circuit elements in the selected building block for each stage.

Goal: Design, build and test an analog low-pass Butterworth filter with the following specifications:

$T_{max} = 20$ dB

$\omega_c = 1000$ rad/s

$T_{min} = -20$ dB at $\omega_{min} = 4000$ rad/s.