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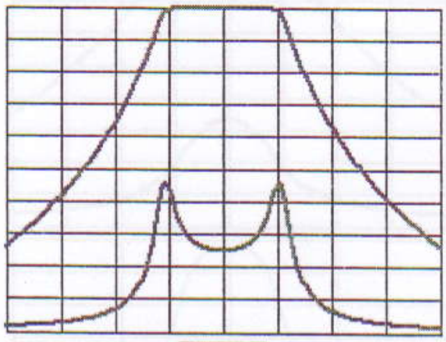
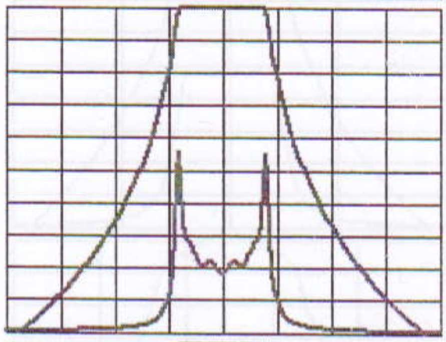
Butterworth

Produces a very smooth, flat passband with a fair rate of roll-off. This approximation produces easily realized networks.



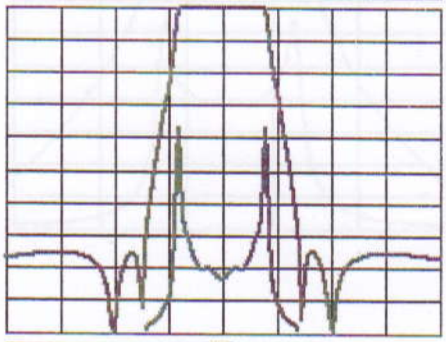
Chebyshev

The response is similar to the Butterworth but with ripple within the passband and an improved roll-off rate. Networks obtained by this approximation are the most easily realized.



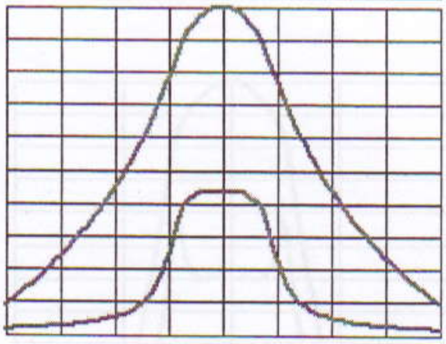
Cauer or Elliptic Function

The passband ripple is similar to the Chebyshev but with greatly improved stopband selectivity due to the addition of finite attenuation peaks. The network complexity is increased over the Butterworth or Chebyshev but it still yields practical realizations over nearly the entire operating region.



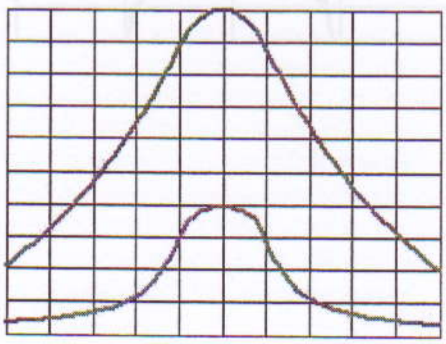
Bessel or Linear Phase

This approximation is the Butterworth of delay control. It produces filters with a flat delay around center frequency. The more poles used, the wider the flat region extends. The roll-off rate is poor. There are some realization restrictions and so these designs cannot be obtained over the entire operating region.



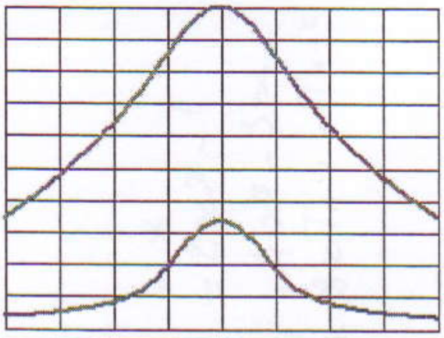
Gaussian

Very similar to the Bessel except that the delay has a slight "hump" at center frequency and the rate of roll-off is slower. Because of the delay response, the ringing characteristics are better than the Bessel. Realization restrictions also apply to these filters.



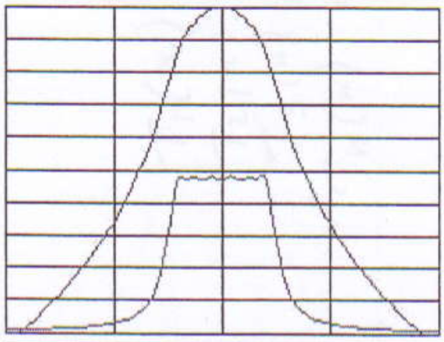
Synchronously Tuned

These filters have the same advantages and disadvantages as the Bessel and Gaussian except that the ringing response is the best of all design types and the roll-off is even slower that the Gaussian. As with the other two types, some realization restrictions apply.



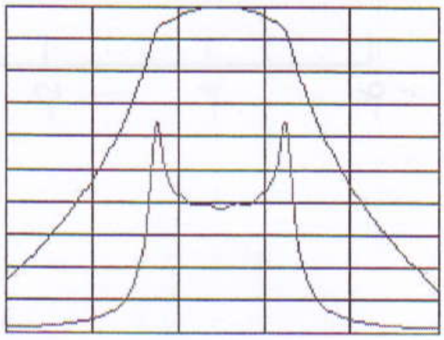
Chebyshev Phase Error

In this approximation the Chebyshev approximating technique is applied to the phase (delay) over the passband region. It produces the bell shaped amplitude response similar to a Gaussian or Bessel design and an equiripple phase and delay response. The selectivity is better than the Bessel or Gaussian.



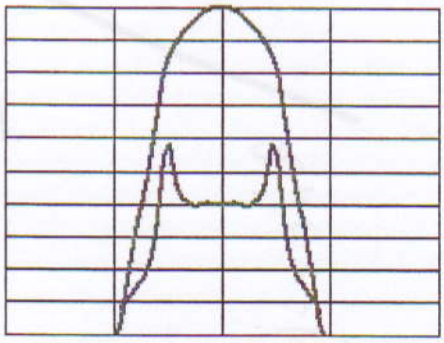
Gaussian to 6 (or 12) dB

These filters have a passband response that follows the Gaussian shape and, at either the 6 or 12 dB point, the response changes and follows the Butterworth characteristic. The phase, or delay, response is somewhat improved over a strict Butterworth and the attenuation is better than the pure Gaussian and so it is a true compromise type of approximation. As with all of the filters where there is an attempt to control the phase response, the realization becomes more difficult and so its operating region is slightly restricted.



Custom Ringing Response

Sometimes it is necessary to obtain both good ringing response and good attenuation at the same time. In these instances a custom ringing response filter can be synthesized. Because both phase and attenuation must be controlled, these filters require more components and are somewhat larger and more costly than other types.



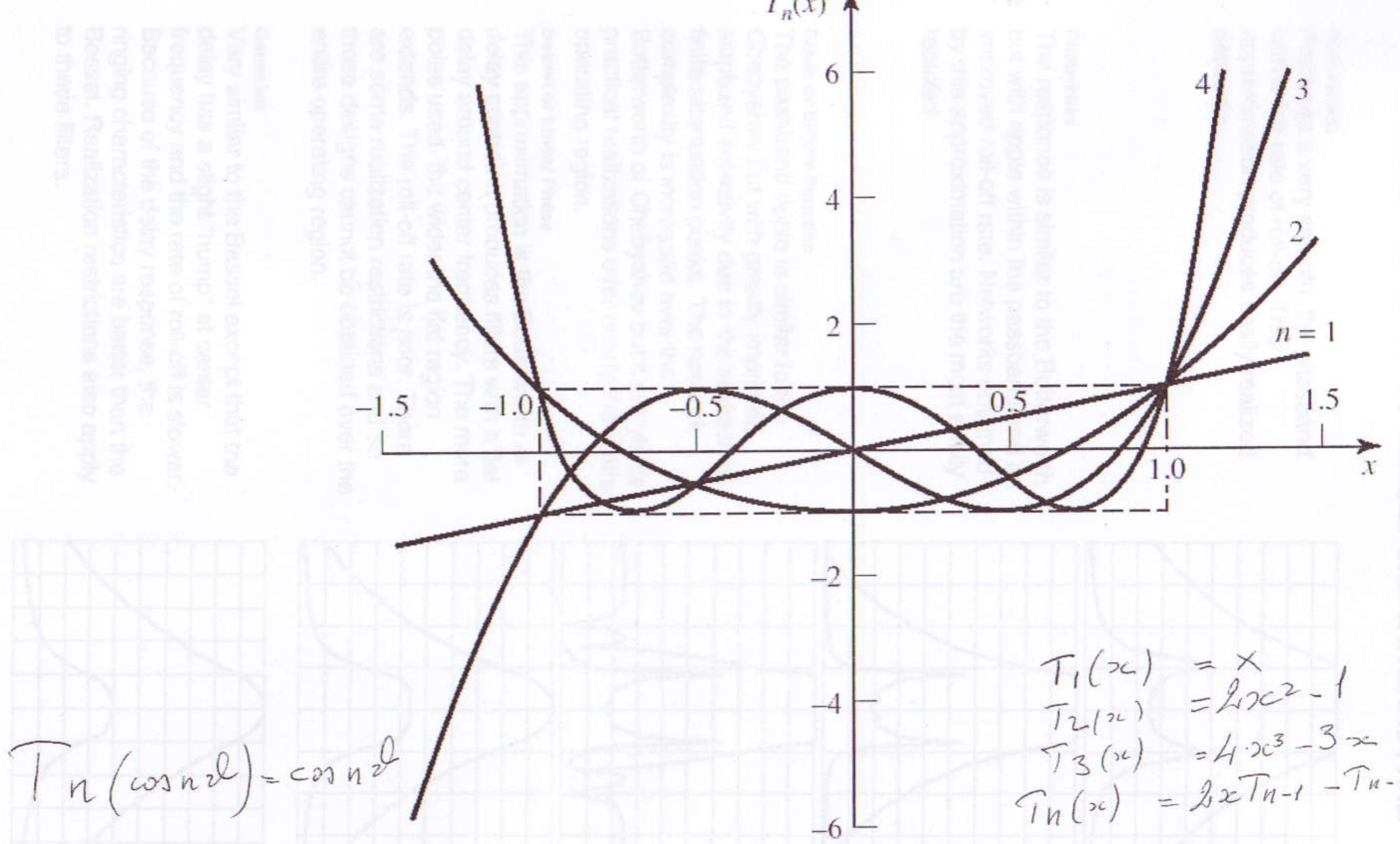


Figure 5.16 (p. 251)

The first four Chebyshev polynomials $T_n(x)$.