Problem 3.3

An analogue Butterworth-Lowpass shall be realised, showing the following characteristics:

- Pass-tolerance	$\delta_\mathrm{d} = 0.05$
- Stop-tolerance	$\delta_\mathrm{s} = 0.05$
- Corner frequency of the Pass-Band	$f_\mathrm{d} = \omega_\mathrm{d}/2\pi = 12$ kHz
- Corner frequency of the Stop-Band	$f_\mathrm{s} = \omega_\mathrm{s}/2\pi = 13$ kHz

3.3.1 Draw the tolerance scheme for the absolute of the transfer-function $H_\mathrm{fF}(f) = H_\mathrm{F}(\omega = 2\pi f)$ of the low-pass, as well as the tolerance-scheme for the approximating function $A_\mathrm{f}(f) = A(\omega = 2\pi f)$. Input the given values.

3.3.2 Calculate the minimal order N needed to realise the low-pass.

3.3.3 Calculate the 3dB-frequency $f_\mathrm{T} = \omega_\mathrm{T}/2\pi$ of the low-pass using the results of 3.3.2.

3.3.4 Calculate – using the results of 3.3.2 – the frequency $f_\mathrm{s,min}$, at which $|H_\mathrm{F}(\omega = 2\pi f)|$ gets lower than δ_s, if the frequency f is increased from $f = 0$.

3.3.5 Determine the $2N$ poles of the function $A_\mathrm{L}(p) = A(\omega = p/\mathrm{j})$.

3.3.6 Determine the N poles of the system-function $H_\mathrm{L}(p)$ of the low-pass and give an expression for $H_\mathrm{L}(p)$.

3.3.7 Calculate the values of $H_\mathrm{fF}(f)$ for $f_\mathrm{n} = f_\mathrm{d} + nf_\mathrm{d}/120$ with $n = -1(1)10$, using the results of 3.3.2 and draw the function in the tolerance-scheme of $H_\mathrm{fF}(f)$ drawn in 3.3.1.

Problem 3.4

An analogue Chebyshev-Lowpass of type 1 shall be realised, showing the following characteristics:

- Pass-tolerance	$\delta_\mathrm{d} = 0.1$
- Stop-tolerance	$\delta_\mathrm{s} = 0.05$
- Corner frequency of the Pass-Band	$f_\mathrm{d} = \omega_\mathrm{d}/2\pi = 5$ MHz
- Corner frequency of the Stop-Band	$f_\mathrm{s} = \omega_\mathrm{s}/2\pi = 5.5$ MHz

3.4.1 Draw the tolerance scheme for the absolute of the transfer-function $H_\mathrm{fF}(f) = H_\mathrm{F}(\omega = 2\pi f)$ of the low-pass, as well as the tolerance-scheme for the approximating function $A_\mathrm{f}(f) = A(\omega = 2\pi f)$. Input the given values.

3.4.2 Calculate the minimal order N needed to realise the low-pass.

3.4.3 Calculate the value of ϵ, which gives the amplitude of the fluctuations of $A(\omega)$ in the pass-band, independently of the low-pass order.

3.4.4 Determine the poles of the system-function $H_\mathrm{L}(p)$ of the low-pass using the previous results.

3.4.5 Calculate the values of $H_\mathrm{fF}(f)$ for $f_\mathrm{n} = f_\mathrm{d} + nf_\mathrm{d}/50$ with $n = -1(1)10$, using the previous results and draw the function in the tolerance-scheme of $H_\mathrm{fF}(f)$ drawn in 3.4.1.