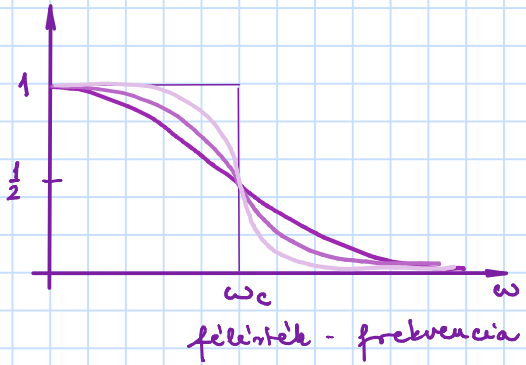
BUTTER WORTH SZŰRŐ



$$|W_B(\omega)|^2 = \frac{1}{1+\left(\frac{\omega}{\omega_c}\right)^{2N}} = 1 + \left(-\left(\frac{\omega}{\omega_c}\right)^{2N}\right) + \left(-\left(\frac{\omega}{\omega_c}\right)^{2N}\right)^2 + \left(-\left(\frac{\omega}{\omega_c}\right)^{2N}\right)^3 + \dots$$ mértani sor

monoton csökken

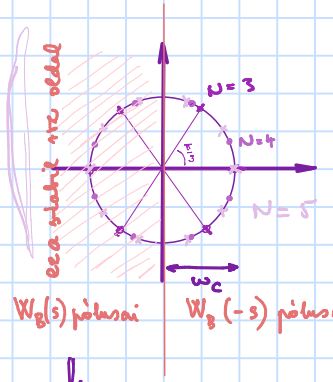
az első $2N-1$ deriváltja 0 az $\omega = 0$-ban

Pólusok:

$$|W_B(j\omega)|^2 = W_B(s)\cdot W_B^*(s) = W_B(s)\cdot W_B(-s) = \frac{1}{1+\left(\frac{s}{j\omega_c}\right)^{2N}}$$

van $2N$ db pólusa: $\left(\frac{s}{j\cdot\omega_c}\right)^{2N} = -1$ -ben

$$s_{pólus} = \omega_c \cdot e^{j\cdot\frac{2\pi}{2N}\cdot(2k+N-1)}$$



az ω_c sugarú körön $\frac{360°}{2N}$-enként

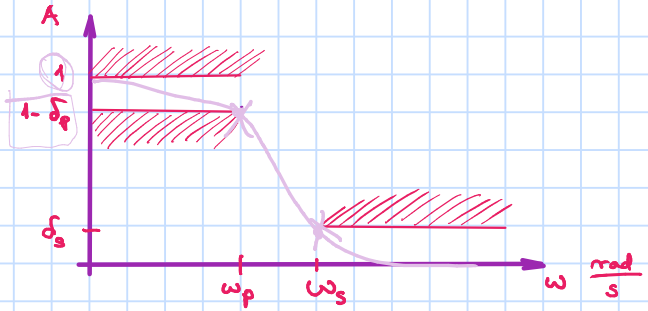
$W_B(s)$ pólusai | $W_B(-s)$ pólusai

$$W_B(s) = \frac{1}{\left(1-\frac{s}{\omega_c(-1)}\right)\cdot\prod_{k>\frac{N}{2}}\left[\left(1-\frac{1}{\omega_c\cdot e^{j\frac{\pi}{2N}\cdot k}}\right)\cdot\left(1-\frac{1}{\omega_c\cdot e^{j\frac{\pi}{2N}\cdot k}}\right)\right]} =$$

$$= \frac{\omega_c^N}{(s+\omega_c)\prod_{k>\frac{N}{2}}\left[\left(s-\omega_c\cdot e^{j\frac{\pi}{2N}k}\right)\left(s-\omega_c e^{-j\frac{\pi}{2N}\cdot k}\right)\right]}$$

TERVEZÉS:

SZABAD PARAMÉTEREK: ω_c és N



$$|W_B(\omega_p)|^2 = \frac{1}{1+\left(\frac{\omega_p}{\omega_c}\right)^{2N}} \geq (1-\delta_p)^2$$

$$|W_B(\omega_s)|^2 = \frac{1}{1+\left(\frac{\omega_s}{\omega_c}\right)^{2N}} \leq (\delta_s)^2$$

Ezt kell teljesíteni ω_c-vel és N-nel