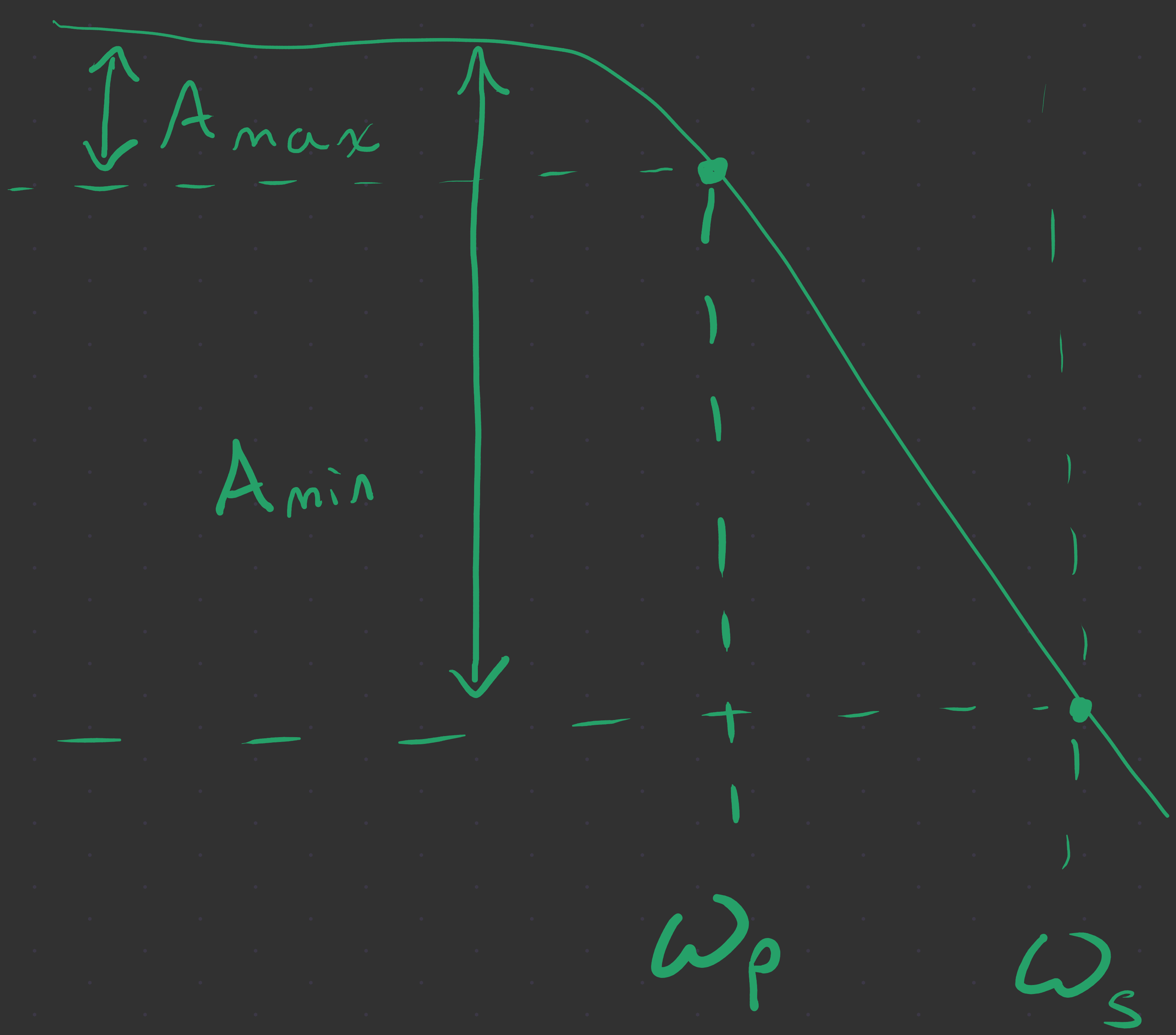

$A_{max} \rightarrow$ Max Passband Atten

$A_{min} \rightarrow$ Min Passband Attenuation

$\omega_p \rightarrow$ Passband limit

$\omega_s \rightarrow$ Stopband limit

Butterworth Filter

$$|H(j\omega)|^2 = (\omega_0)^{2n} / \omega_0^{2n} + \omega^{2n}$$

$$-\omega_0^{2n} = \omega^{2n}$$

★ attenuation

$$A(\omega) = 10 \log_{10} \left[1 + \left(\frac{\omega}{\omega_0} \right)^{2n} \right]$$

$$A(\omega) = -10 \log_{10} \left(|H(j\omega)|^2 \right)$$

$\Rightarrow$ This shows us that attenuation is the negative gain

We can use this expression at various values to find significant points.

e.g. $A_{max} = A(\omega_p)$

$A_{min} = A(\omega_s)$

We can use algebra to solve for ω_0:

$$\omega_0 = \omega_s / (10^{A_{min}/10} - 1)^{1/2n}$$

$$\omega_0 = \omega_p / (10^{A_{max}/10} - 1)^{1/2n}$$

ω_0 is the radius of every pole

If we set the 2 ω_0 equations equal to each other, we can solve for n, what is filter order

$$n = \frac{\ln\left(\frac{10^{A_{min}/10} - 1}{10^{A_{max}/10} - 1}\right)}{2\ln\left(\omega_s / \omega_p\right)}$$

* in matlab, ln is "log"