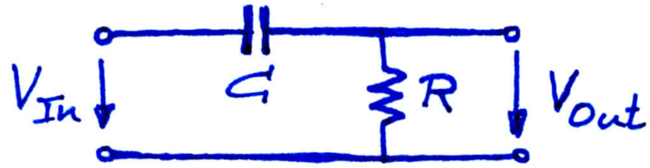
High-frequency-pass filter



$$H(\omega) = \frac{V_{out}}{V_{In}} = \frac{R}{\frac{1}{j\omega C} + R} = \frac{j\omega RC}{1 + j\omega RC}$$

$$|H(\omega)| = \frac{\omega RC}{\sqrt{1 + \omega^2 R^2 C^2}}$$

$\omega \to 0 \quad \Rightarrow |H(\omega)| \approx \omega RC \quad \Rightarrow |H(\omega)| \to 0$

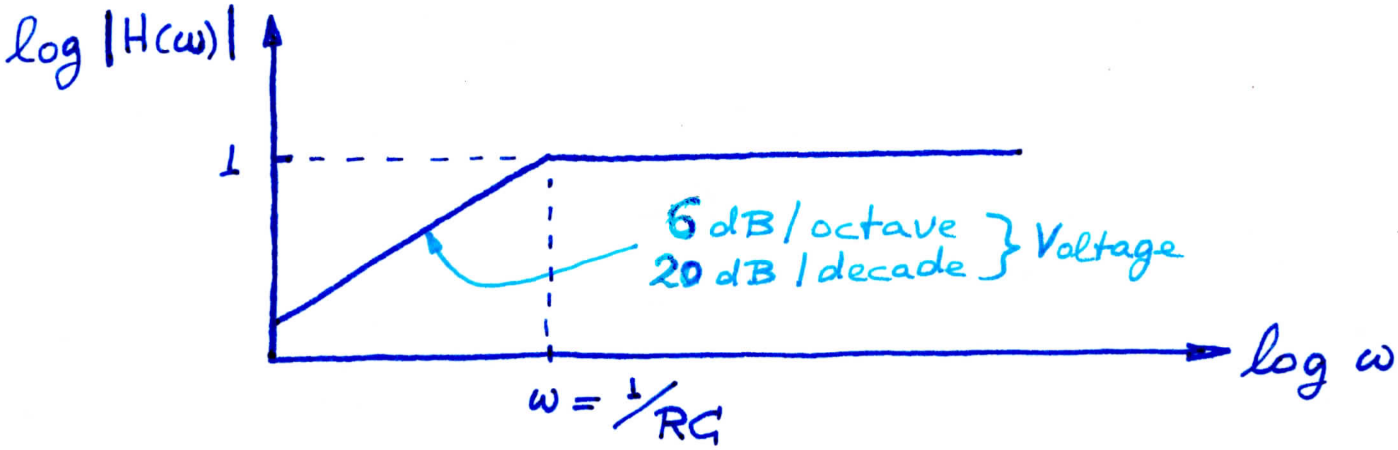
$\omega \to \infty \quad \Rightarrow |H(\omega)| \approx 1 \quad \Rightarrow |H(\omega)| \to 1$

$\omega = 1/RC \quad \Rightarrow |H(\omega)| = \frac{1}{\sqrt{2}} \quad \Rightarrow$ 3dB point

$$\omega \ll 1/RC \quad \Rightarrow \underbrace{|H(\omega)| \approx \omega RC}_{|H(\omega)| \propto \omega}$$

$\Rightarrow$ 6 dB / octave
20 dB / decade
} Voltage & Power

Bode plot

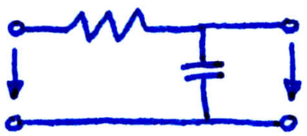


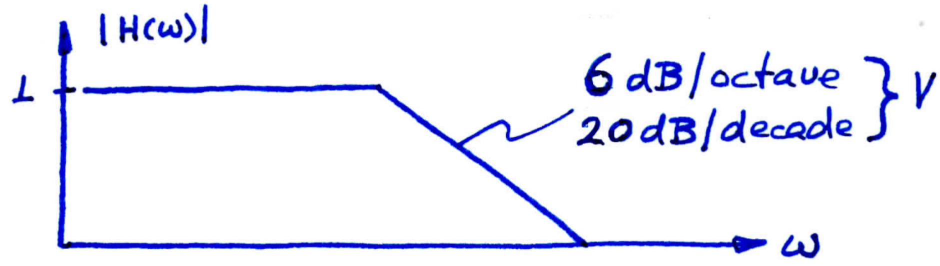
⇒ We find a qualitatively similar behavior (but opposite behavior) for low-pass filters and high-pass filters.

⇒ Common devices (Op Amps, BJTs, FETs...) share the characteristics discussed above because they are governed by RC circuits and associated RC time constants.

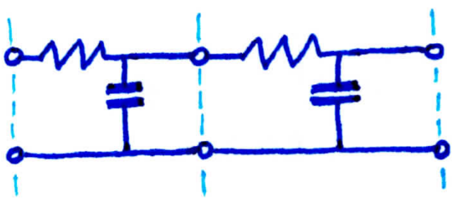
Multi-stage filters

Recall:

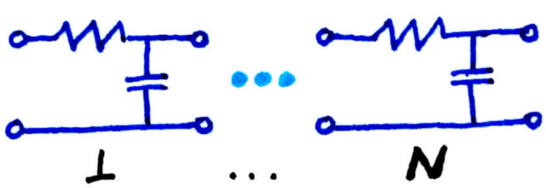


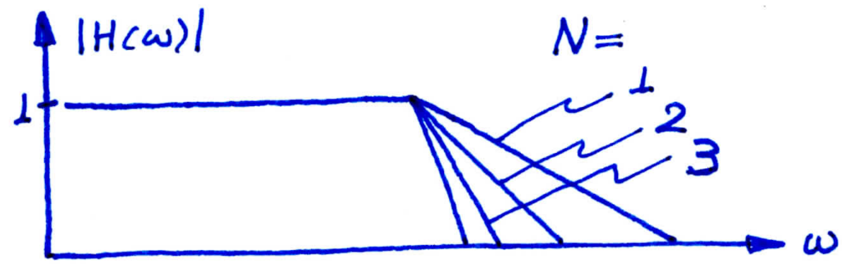


Consider two RC filters



Consider N RC filters

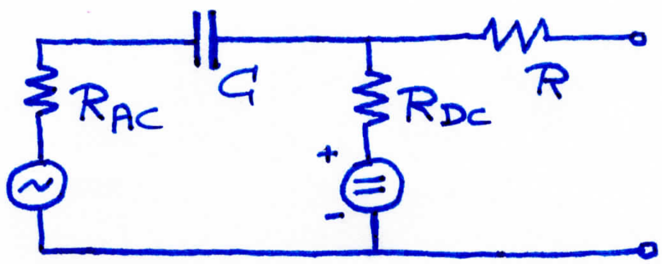




⇒ We can design the steepness of the cut-off region of the filter.

DC - blocking capacitors

Consider the following circuit



Q: What kind of filter is this ?

⇒ High-frequency-pass filter

Q: What about DC ?

⇒ For DC ⇒ $f = 0$

⇒ DC is blocked

Q: Implications for circuit ?

⇒ DC is blocked at C

⇒ AC source is decoupled from DC source

⇒ AC source is protected from DC source

⇒ We can use a C to let AC & DC propagate on different paths.

⇒ If C is sufficiently large, it lets AC go through yet blocks DC.