# RC Circuit AC analysis

Via LTspice simulation

 

Amplitude slope is asymptotically

-6 dB /octave or -20 dB / decade

Simulated RC – Frequency sweep from 10 Hz to 10 kHz Vc Amplitude and Phase plotted (log-log graph)

Note: Decibels are a logarithmic measure of voltage ratios dB = 20\*log10(VC/V1) in this case. (6 db is a factor of 2, 3 dB is the “half power point”)

Analysis:

V1 = 1\*sin(2πft) = 1 at 0°, VC = ?

$Z\_{C}=\frac{1}{jωC}=\frac{1}{j2πfC}=\frac{-j}{2πfC}=\frac{1}{2πfC}at-90$

Our current is therefore

$I=\frac{V\_{1}}{Z\_{T}}=\frac{1}{\left(R-\frac{j}{2πfC}\right)}$ so

 $V\_{R}=R\*I=\frac{R}{\left(R-\frac{j}{2πfC}\right)}=\frac{2πfRC}{\left(2πfRC-j\right)}=\frac{2πf}{\left(2πf-j/RC\right)}$ and $ V\_{C}=1-V\_{R}=1-\frac{R}{\left(R-\frac{j}{2πfC}\right)}=\frac{\left(R-\frac{j}{2πfC}\right)}{\left(R-\frac{j}{2πfC}\right)}-\frac{R}{\left(R-\frac{j}{2πfC}\right)}=\frac{-\frac{j}{2πfC}}{\left(R-\frac{j}{2πfC}\right)}=\frac{-j}{\left(2πfRC-j\right)}=\frac{1}{\left(j2πf+1/RC\right)}$

This is at the “half power point” when the magnitudes of the real and imaginary parts are equal

2πf = 1/RC (Remember that RC is the “Time Constant”) or

 $f=\frac{1}{2πRC}=\frac{1}{2π\*10^{4}\*10^{-7}}=\frac{10^{3}}{2π}=159.2 Hz$ and the phase at that frequency is 45°