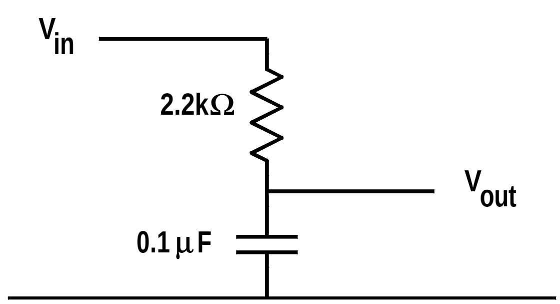
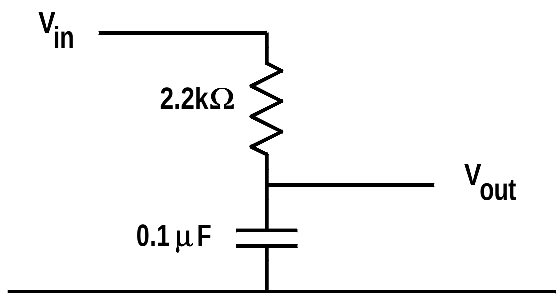
For a first order filter, RC or RL, the Corner Frequency, f_c, in Hertz is given by:–

$$f_c = \frac{1}{2\pi CR} \quad \text{or} \quad \frac{R}{2\pi L}$$

On a dB versus log frequency plot, the filter response is approximated by two straight lines, one of slope 0 and the other of slope -20dB per decade and drawn through the point at the corner frequency and 0dB (logf_c, 0dB).

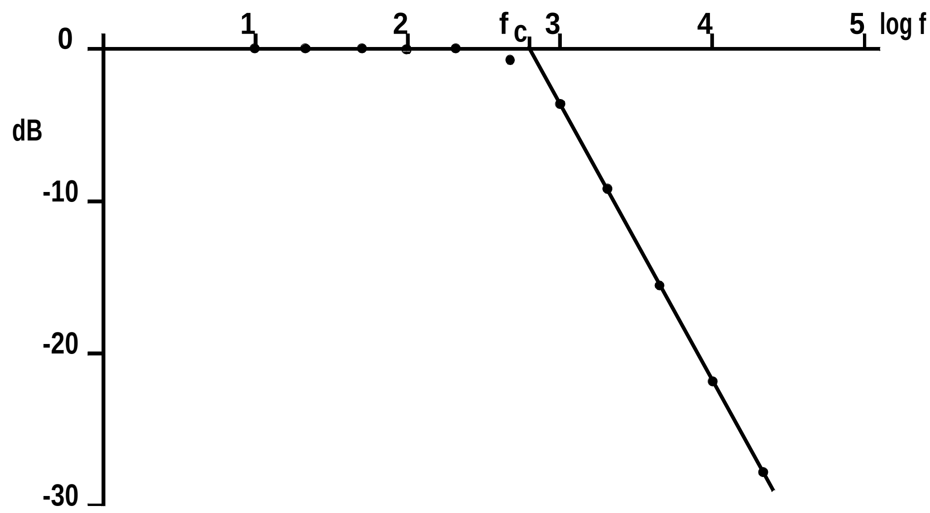
At the corner frequency the attenuation is -3dB and the phase shift is $\frac{\pi}{4}$ or 45 degrees.



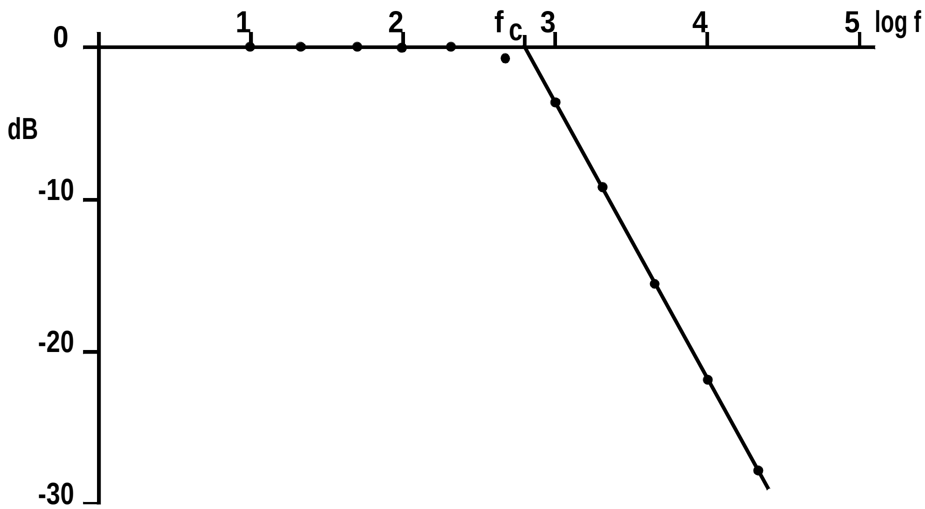


Calculate the frequency response by repeating the calculations of Example 15.1 for a range of frequencies.

The response in decibels, dB, as a function of the log of the frequency, is plotted and a response curve such as that in Figure 16.2 is obtained.



Use frequencies 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000 Hz and the resulting points are shown on the plot.
The sequence 1, 2, 5 and multiples of 10 give roughly equally spaced points on a log frequency plot.
In the laboratory you should try to use these multiples where possible.



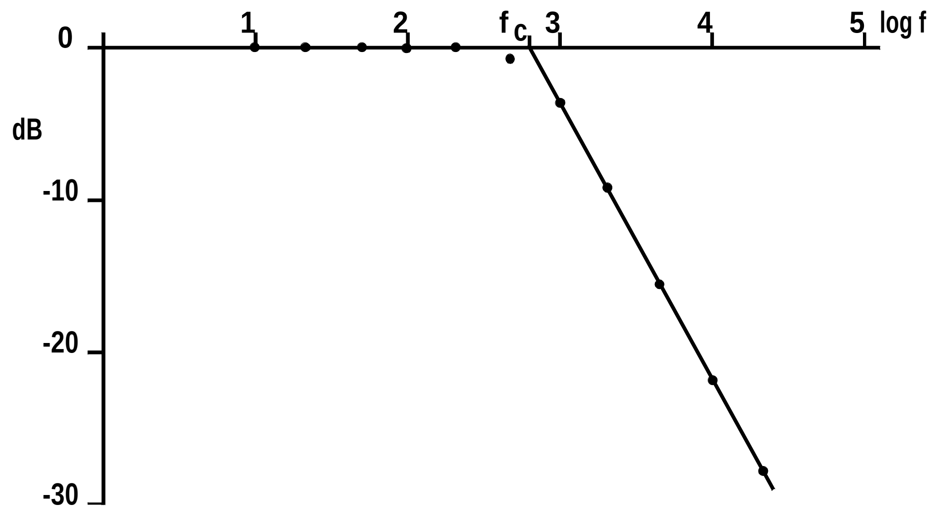
Corner frequency for first order filters

$$f_c = \frac{1}{2\pi RC}\,\text{Hz}$$

For this example the corner frequency

$$f_c = \frac{1}{2\pi 2200 \times 0.1 \times 10^{-6}} = 724 Hz$$

$\log(724) = 2.86$ and is marked as f_c.



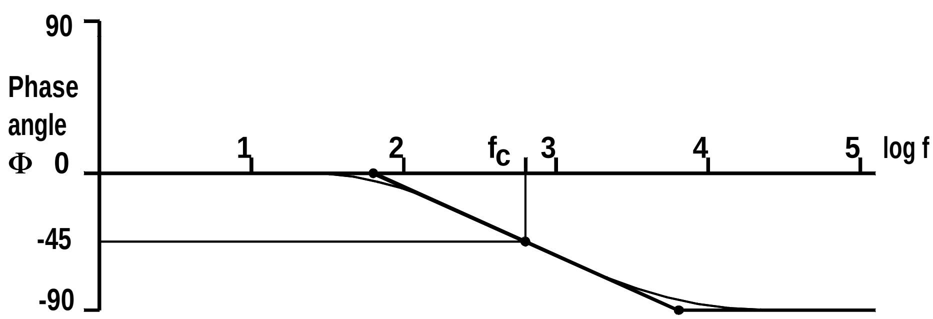
The response curve can be approximated by two straight lines through ($\log f_c$, 0dB).
One of the lines is at a constant 0dB and is the frequency axis.
The second line has a slope of -20 dB for each decade in frequency or each change of 1.0 on the log frequency scale.
Only need one number, the corner frequency, is needed to give a plot of the frequency response of an RC or RL circuit.

At the corner frequency $\tan\phi = 2\pi f_c CR = 1$ and therefore the attenuation is:–

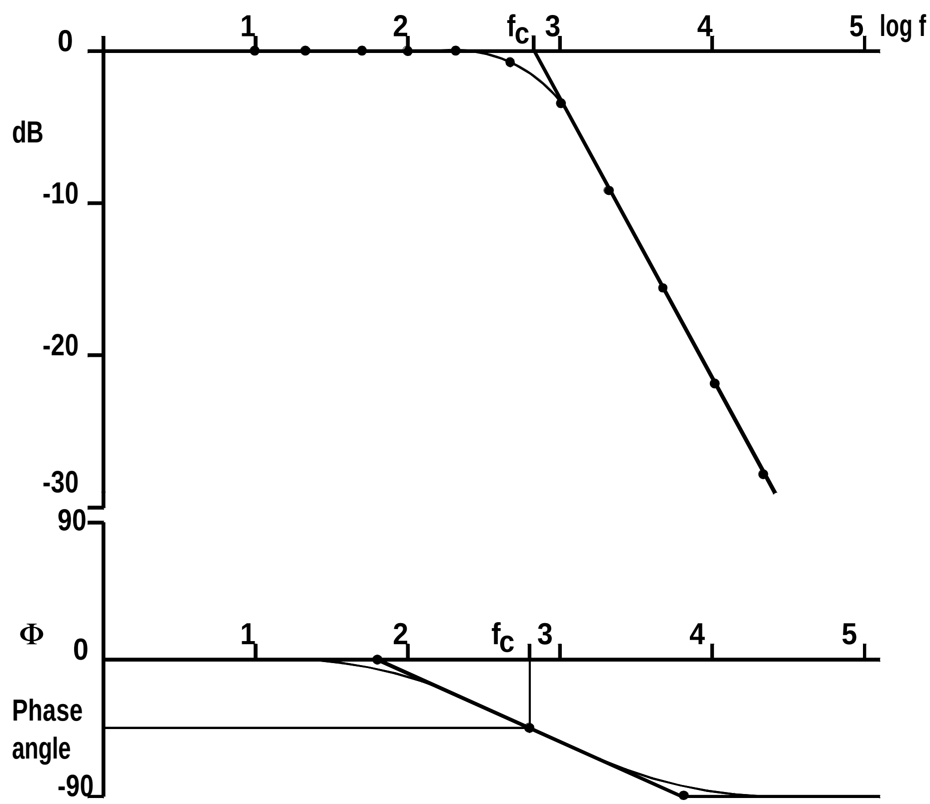
$$\frac{1}{\sqrt{1+\tan^2\phi}} = \frac{1}{\sqrt{1+1}} = \frac{1}{\sqrt{2}} = .707$$

Expressed in dB this becomes $20\log 0.707 = -3$ dB

so a small rounding off of the sharp corner made by the straight lines at the intersection accommodates this –3dB error at the corner frequency.



When the amplitude response and the phase response are combined on one diagram with the log frequency scale the pair of curves is called a Bode Plot.



The RC circuit is a low pass circuit.
A CR circuit where the capacitor and resistor are interchanged is a high pass circuit.
When you have an RC circuit or a CR circuit the type of response can be easily determined by remembering that at low frequencies a capacitor is essentially an open circuit and at high frequencies a capacitor is a short circuit.