

Frequency Response

L17

Frequency Response

$$V_o = V_E \frac{Z_C}{Z_R + Z_C} = V_E \frac{\frac{j\omega C}{1}}{R + \frac{j\omega C}{1}} = V_E \frac{1}{j\omega RC + 1}$$

$$\frac{V_o}{V_E} = \frac{1}{j\omega RC + 1} \rightarrow \frac{V_o}{V_E} \equiv H(j\omega)$$

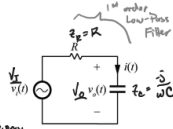
$H(j\omega)$ is the Frequency Response. It is some complex number with ω as a variable that tells us the gain & phase shift of our output compared to the input

$$H(j\omega) = |H| \angle \phi$$

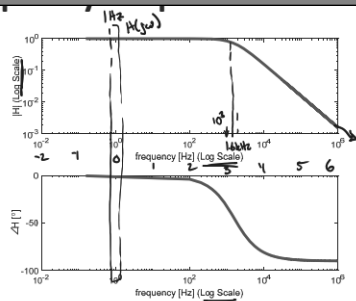
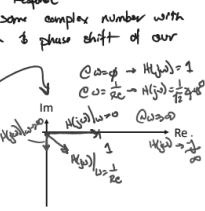
$$H(j\omega) = \frac{1}{j\omega RC + 1} = \frac{1}{1 + j\omega RC}$$

$$\text{Output is: } \frac{V_o}{V_E} = H(j\omega) = \frac{1}{1 + j\omega RC}$$

$$\frac{V_o}{V_E} = \frac{1}{1 + j\omega RC} = \frac{1}{\sqrt{1 + (\omega RC)^2}} \angle -\tan^{-1}(\omega RC)$$



Frequency Response



Bode Plots

dB Scale

Decibels

$$\|G\|_{\text{dB}} = 20 \log_{10}(\|G\|)$$

Decibels of quantities having units (impedance example): normalize before taking log

$$\|Z\|_{\text{dB}} = 20 \log_{10}\left(\frac{\|Z\|}{R_{\text{base}}}\right)$$

Table 8.1. Expressing magnitudes in decibels

Actual magnitude	Magnitude in dB
1/2	− 6dB
1	0 dB
2	6 dB
5 = 10/2	20 dB − 6 dB = 14 dB
10	20dB
1000 = 10 ³	3 · 20dB = 60 dB

5Ω is equivalent to 14dB with respect to a base impedance of $R_{\text{base}} = 1\Omega$, also known as 14dBΩ.

60dBμA is a current 60dB greater than a base current of 1μA, or 1mA.

Logarithm Review

Plotting on Logarithmic Axes



Single Pole Response

