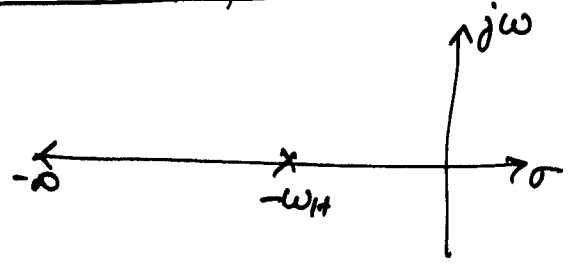
First-order, Low-pass Amplifier

$$A_v(s) = \frac{A_0 \omega_H}{(s+\omega_H)}$$

$$\downarrow$$

$$s+\omega_H = 0$$



$s = j\omega$

$$A_v(j\omega) = \frac{A_0 \omega_H}{j\omega + \omega_H} = \frac{A_0}{1 + j\left(\frac{\omega}{\omega_H}\right)}$$

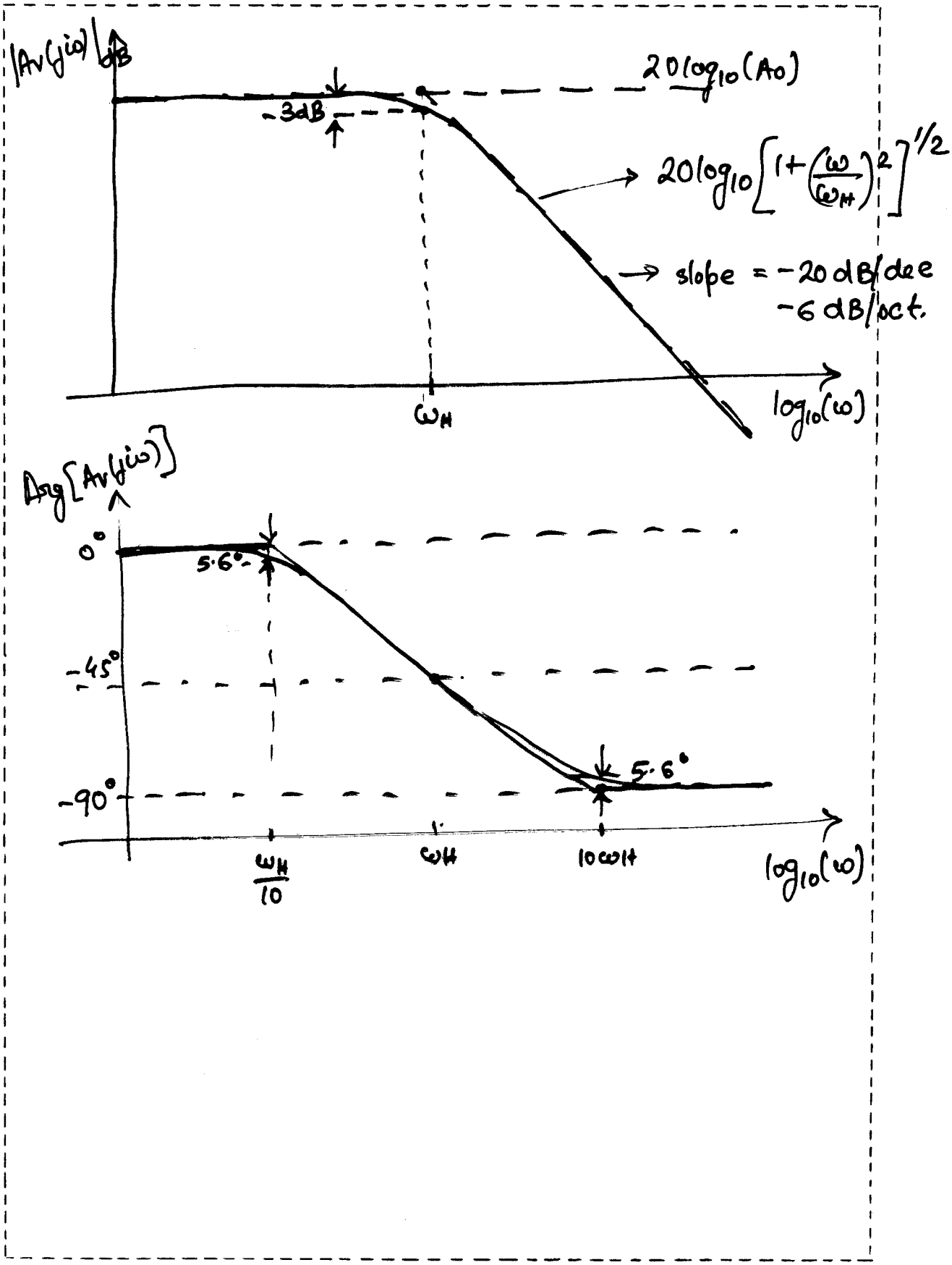
Magnitude: $$|A_v(j\omega)| = \frac{A_0}{\sqrt{1+\left(\frac{\omega}{\omega_H}\right)^2}}$$

Phase: $$\text{Arg}\left[A_v(j\omega)\right] = -\tan^{-1}\left(\frac{\omega}{\omega_H}\right)$$

Bode plots

$$|A_v(j\omega)|_{dB} = 20\log_{10}\left[\frac{A_0}{\sqrt{1+\left(\frac{\omega}{\omega_H}\right)^2}}\right] = 20\log_{10} A_0 - 20\log_{10}\left[1+\left(\frac{\omega}{\omega_H}\right)^2\right]^{1/2}$$

$$\text{Arg}\left[A_v(j\omega)\right] = -\tan^{-1}\left(\frac{\omega}{\omega_H}\right)$$


|Av(jω)| dB
20log10(Ao)
-3dB
20log10[1+(ω/ωH)^2]^1/2
slope = -20 dB/dec
-6 dB/oct.
log10(ω)
ωH
Arg[Av(jω)]
0°
5.6°
-45°
-90°
5.6°
ωH/10
ωH
10ωH
log10(ω)

First-order High-pass Amplifier

$$A_v(s) = \frac{A_0 s}{s+\omega_L}$$

$$A_v(j\omega) = \frac{A_0\left(j\frac{\omega}{\omega_L}\right)}{1+j\left(\frac{\omega}{\omega_L}\right)}$$

$$\text{Mag} \rightarrow 20\log_{10}\left[\frac{A_0\left(\frac{\omega}{\omega_L}\right)}{\sqrt{1+\left(\frac{\omega}{\omega_L}\right)^2}}\right] \approx \underbrace{20\log_{10}(A_0)}_{\omega >> \omega_L} + \underbrace{20\log_{10}\left(\frac{\omega}{\omega_L}\right)}_{\omega << \omega_L}$$

$$\text{Phase} \rightarrow 90^\circ - \tan^{-1}\left(\frac{\omega}{\omega_L}\right)$$