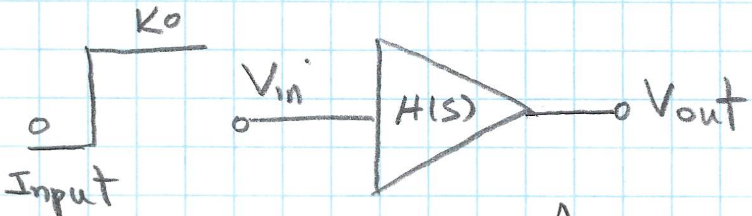
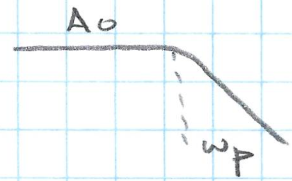
Monolithic Silicon Power — F. Moravej i

OP-Amp App Note 1 — 3/4/2021

"Amplifier Rise Time / Bandwidth"

⇒ A pulse with amplitude K_o is applied to an amplifier with gain of A_o and a pole of ω_p





$$H(s) = \frac{A_o}{S+\omega_p} \Rightarrow$$

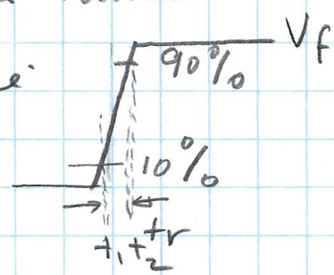
$$A_v(s) = \frac{V_o(S)}{V_{in}(S)} = \frac{K_o}{S} \cdot \frac{A_o}{S+\omega_p} = \frac{A_f}{S(S+\omega_p)}$$

To find the amplifier performance, we need to obtain the inverse Laplace tranfer of $A_v(S)$

$$A_v(t) = L^{-1}(A_v(s)) = \frac{A_f}{\omega_p}\left(1-e^{-\omega_p t}\right)$$

Rise Time: The time necessary for the output to go from 10% to 90% of its final value.

As $t \to \infty$, $A_v(t) = \frac{A_f}{\omega_p}$ = Final Value



$$(1)\quad A_v(t_1) = 0.1\frac{A_f}{\omega_p} = \frac{A_f}{\omega_p}\left(1-e^{-\omega_p t_1}\right)$$

$$(2)\quad A_v(t_2) = 0.9\frac{\cancel{A_f}}{\cancel{\omega_p}} = \frac{A_f}{\omega_p}\left(1-e^{-\omega_p t_2}\right)$$

if we divide equation (2) to (1) $\quad 9 = e^{\omega_p(t_2-t_1)}$

$$t_2 - t_1 = t_r \Rightarrow t_r = \frac{\ln 9}{\omega_p} = \frac{\ln 9}{2\pi f_{-3dB}}$$

$$\boxed{t_r = \frac{0.35}{f_{-3dB}}}$$

if $f_{-3dB} = 1\,GHz$ $\quad t_r = 0.35\,nsec$