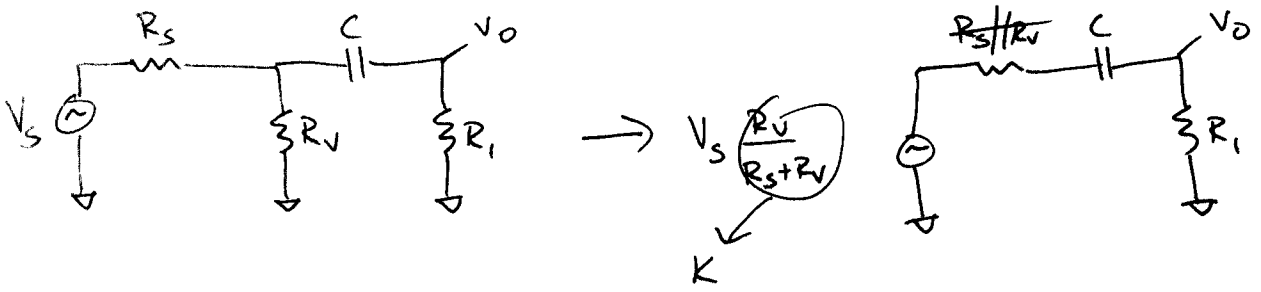

$$\frac{V_o}{V_s} = K\,\frac{SCR_1}{1+SC(R_1+KR_S)}$$

$$\left|\frac{V_o}{V_s}\right| = K\,\frac{\omega C R_1}{\sqrt{1+\omega^2 C^2 (R_1+KR_S)^2}}$$

$$\angle\frac{V_o}{V_s} = 90^\circ - \arctan\left[\omega C(R_1+KR_S)\right]$$

for attenuation in the volume pot,

$K \to K' = xK$ where $0<x<1$

$R_S \to R_S' = R_S + R_V(1-x)$

for no phase distortion @ low freq.

$10 f_p < 20\ Hz$

where $f_p = \frac{1}{2\pi}\cdot\frac{1}{C(R_1+KR_S)}$

Do we care about R_S?

$$\lim_{R_S\to 0} f_p = \frac{1}{2\pi}\cdot\frac{1}{C(R_1+x(1-x)R_V)}$$

$$\lim_{R_S\to \infty} f_p = \frac{1}{2\pi}\cdot\frac{1}{C(R_1+xR_V)}$$

$$\lim_{R_S\to R_V} f_p = \frac{1}{2\pi}\cdot\frac{1}{C(R_1+xR_V(1-\frac{x}{2}))}$$

no

to satisfy the worst case

choose $C > \frac{1}{4\pi R_1}$

$$K'R_S' = x\,\frac{R_V(R_S+(1-x)R_V)}{R_S+R_V}$$

Noise due to R_1:

$V_{n1}^2 = 4 k_b T R_1 \Delta f$

$T = 300^\circ K$

$k_b = 1.38E{-}23\ J/K$

$\Delta f = 20{,}000\ Hz$

$V_{n1,rms} = \sqrt{4 k_b T R_1 \Delta f}$

for $R_1 = \begin{cases}100K\\500K\end{cases} \to V_{n1,rms} = \begin{cases}5.76\mu V_{rms}\\12.87\mu V_{rms}\end{cases}$