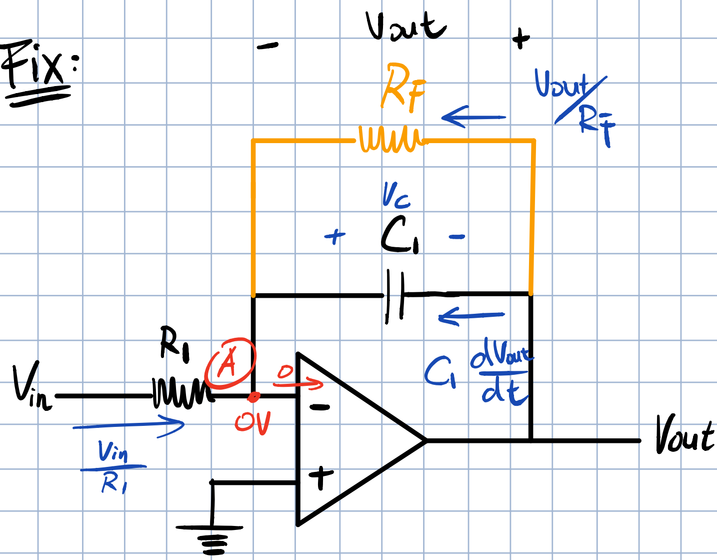
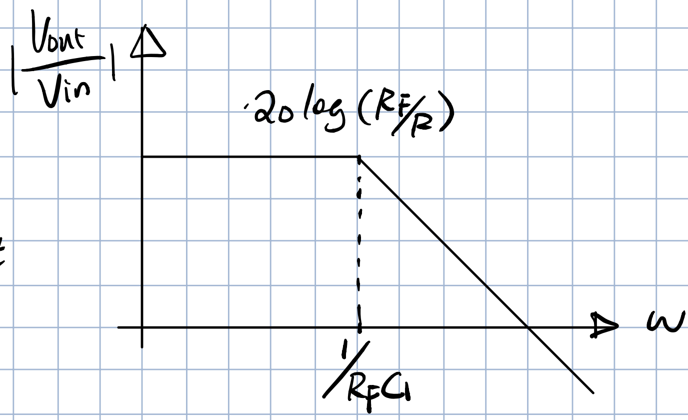
Fix:



$$\frac{V_{out}}{V_{in}} = -\frac{R_F \,//\, \frac{1}{j\omega C_1}}{R_1} = -\frac{R_F/R_1}{1+j\omega R_F C_1}$$



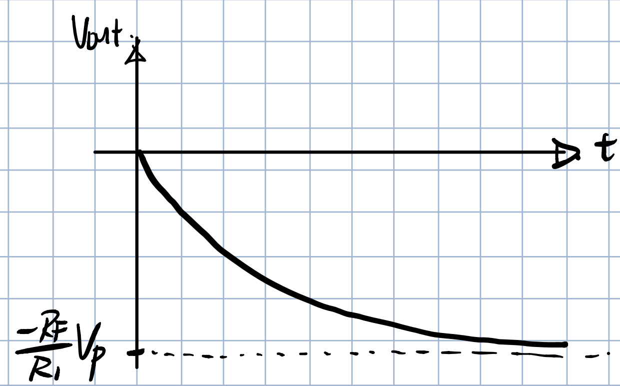
KCL @ Node (A):

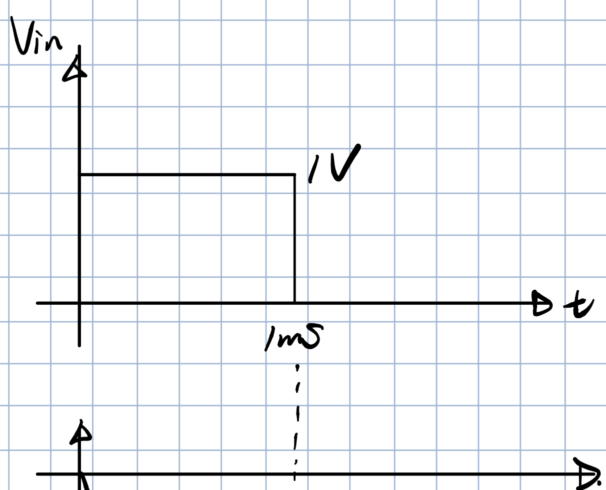
$$\frac{V_{in}}{R_1} + \frac{V_{out}}{R_F} + C_1\frac{dV_{out}}{dt} = 0$$

$$R_F C_1 \frac{dV_{out}}{dt} + V_{out} = -\frac{R_F}{R_1} V_{in}$$

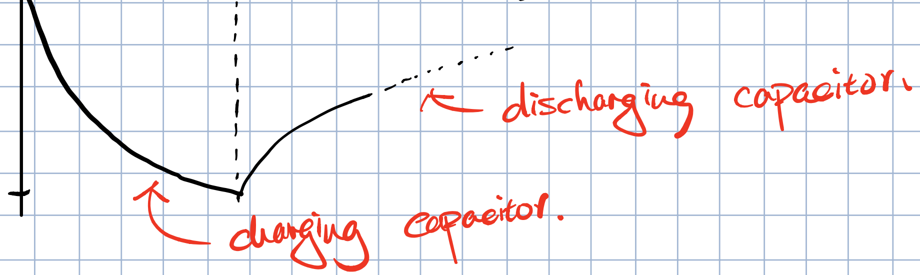
1st order D.E.

$$V_{out} = -\frac{R_F}{R_1} V_p \left(1 - e^{-t/R_F C_1}\right)$$

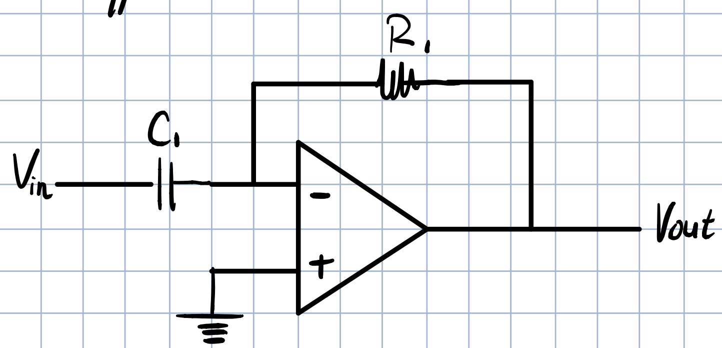




把 1ms 带进 Vout equation 得出的值.

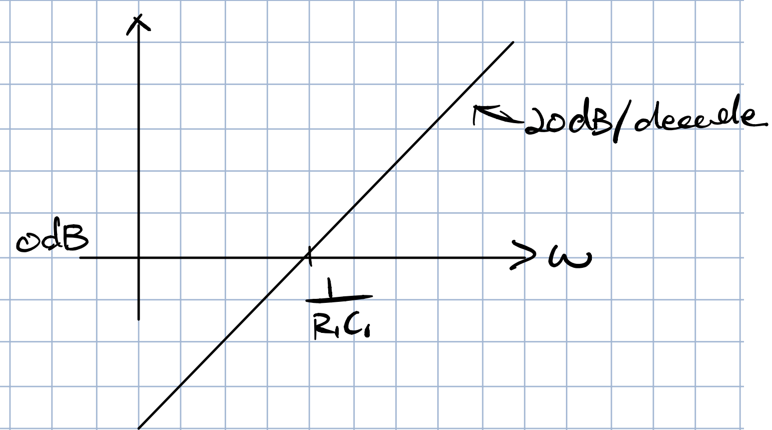


Differentiator.

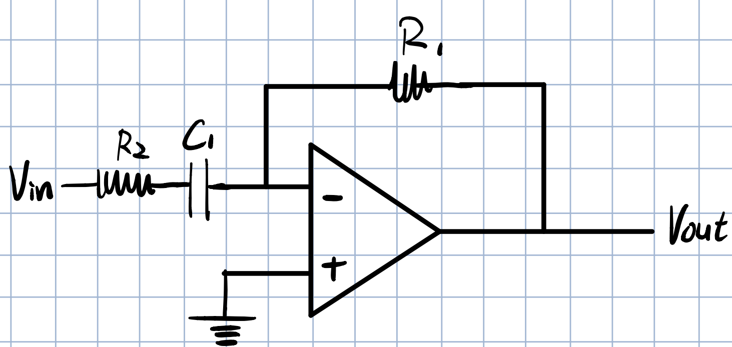


$$\frac{V_{out}}{V_{in}} = \frac{-R_1}{\frac{1}{j\omega C_1}} = -j\omega R_1 C_1$$

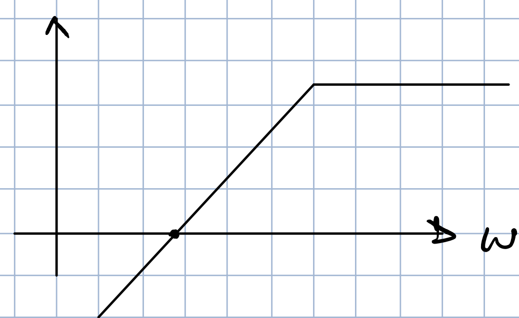
transfer function $\left|\frac{V_{out}}{V_{in}}\right| = \omega R_1 C_1$



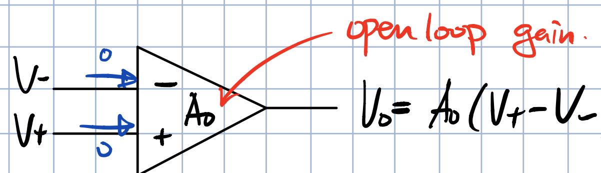
$\boxed{\text{drawbacks}}$: amplifie noise @ high freq.



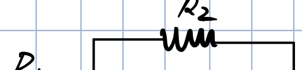
$$\frac{V_{out}}{V_{in}} = -\frac{R_1}{R_2 + \frac{1}{j\omega C_1}} = \frac{-sR_1C_1}{1+sR_2C_1}$$



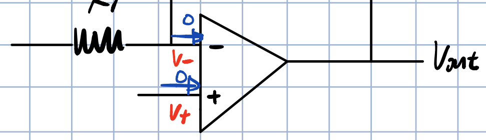
Summary of op-amp



$V_o = A_0(V_+ - V_-)$



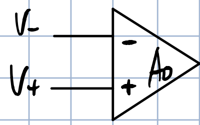
closed loop amplifier w/ negative feedback



$V_- = V_+$

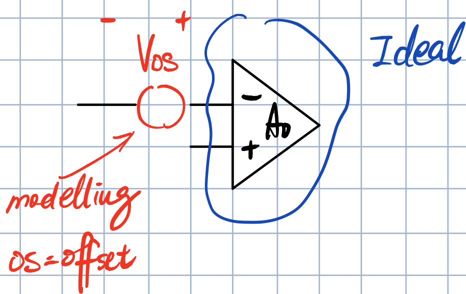
Op-Amp Imperfection.

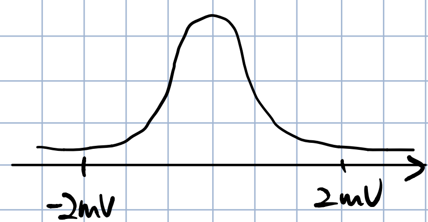
1) DC offset



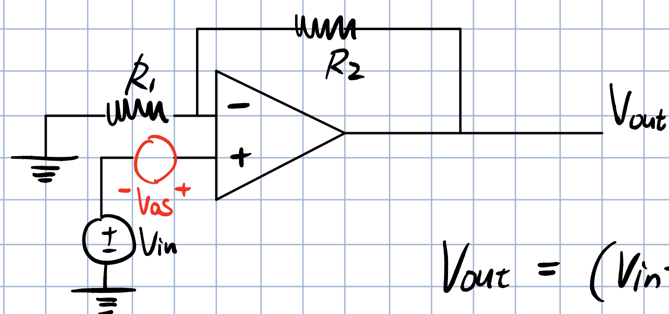
$V_{out} = A_0(V_+ - V_-)$

perfect op-amp : if $V_+ = V_0 = 0$, $V_{out} = 0$

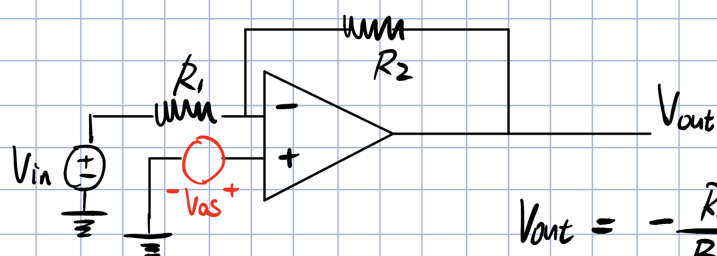




Effect of DC offset:



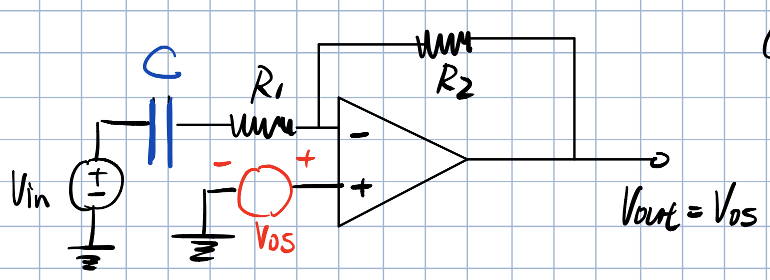
$$V_{out} = (V_{in} + V_{os})\left(1 + \frac{R_2}{R_1}\right)$$



$$V_{out} = \underbrace{-\frac{R_2}{R_1} V_{in}}_{V_{os}\text{ turned off}} + \underbrace{V_{os}\left(1 + \frac{R_2}{R_1}\right)}_{V_{in}\text{ turned off}}$$

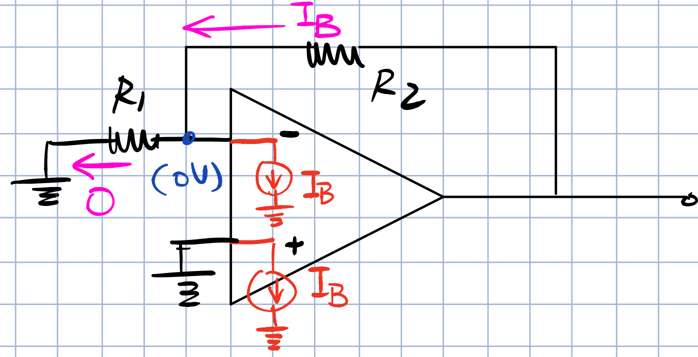
In both cases presented above, V_{os} is amplified. ☹

Some relief for ac circuit.



Capacitor is used to pass AC signal while blocking DC signal (V_{OS})

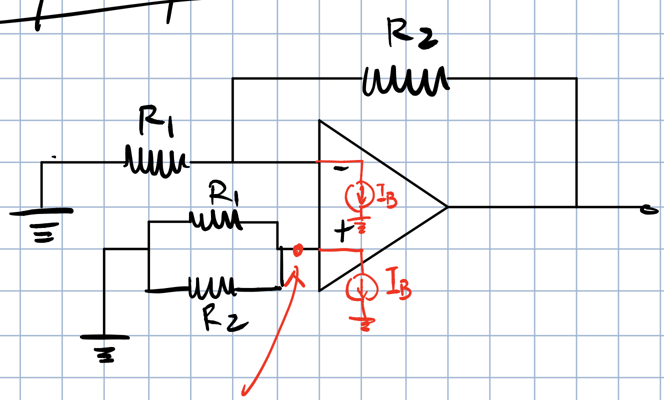
2) Input Bias Current



$V_o = I_B R_2$

non-zero voltage.

quick fix:



$-I_B(R_1 // R_2) = -I_B \frac{R_1 R_2}{R_1 + R_2}$

$$V_{out} = I_B R_2 - I_B \frac{R_1 R_2}{R_1 + R_2} \underbrace{\left(1 + \frac{R_2}{R_1}\right)}_{\frac{R_1 + R_2}{R_1}}$$

$$= 0$$