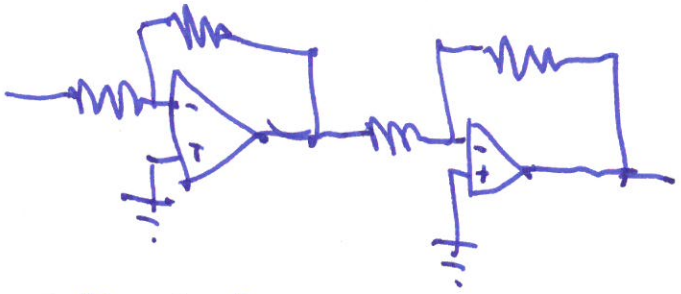
Multi Stage Amps



$$A_v(f) = \frac{A_{V_1}(0)}{1 + j\, f/f_{B1}} \cdot \frac{A_{V_2}(0)}{1 + j\, f/f_{B2}}$$

$$= \frac{A_{V_1}(0)\, A_{V_2}(0)}{1 + jF\left(\frac{1}{f_{B1}} + \frac{1}{f_{B2}}\right) + \frac{f^2}{f_{B1} f_{B2}}}$$

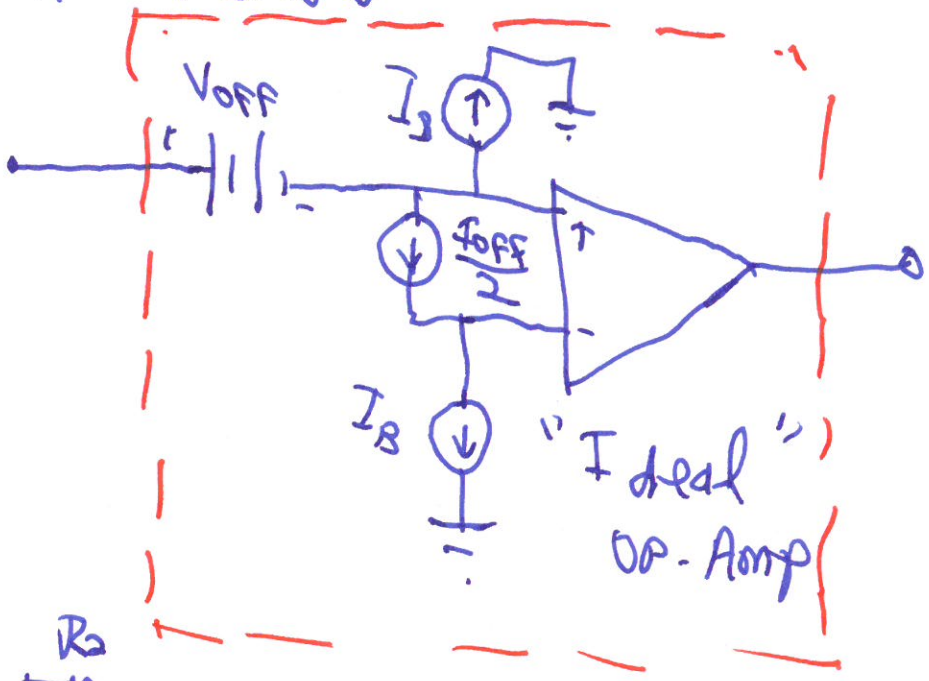
$$f_{B\,eff} \approx \frac{1}{\frac{1}{f_{B1}} + \frac{1}{f_{B2}}}$$

f small

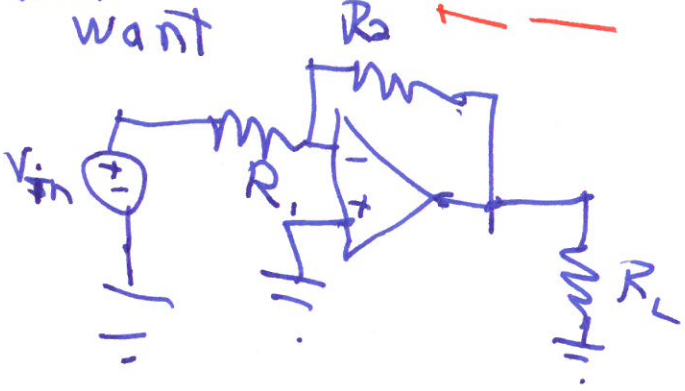
f large gain $\propto \frac{1}{f^2}$ (40dB/decade)

	1 Stage		2 Stages	
$A_v = 100$	20dB	1 MHz		
$A_v = 100^2$	40dB	10 kHz		
	60dB	100 Hz	40dB	644 kHz.

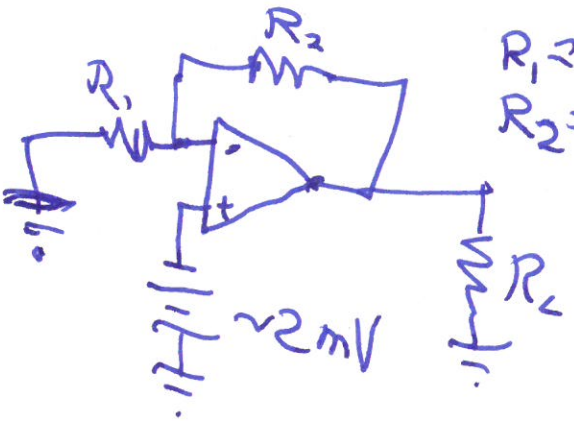
DC imperfections



what we want



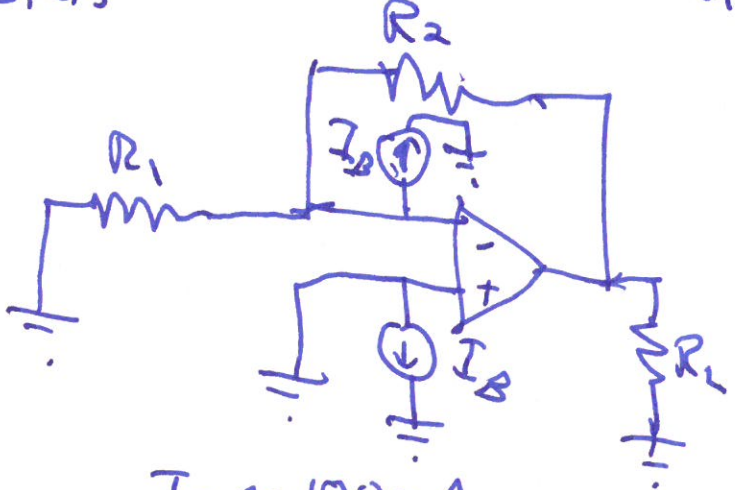
offset Voltage



$R_1 \simeq 10k$
$R_2 = 100k$

$V_{out} = \left(1 + \frac{R_2}{R_1}\right) V_{off} \simeq 22mV$

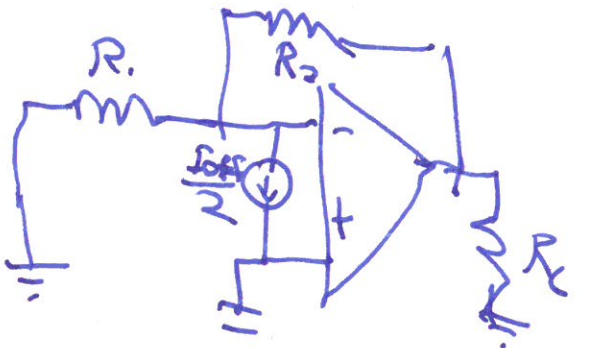
Bias Current



$I_B \simeq 100nA$

$V_{out} = R_2 I_B \simeq 10mV$

offset current



$V_{out} = -R_2 \frac{I_{off}}{2} \simeq -2mV$

Desired output $V_{in} \frac{-R_2}{R_1} = -V_{in} * 10$

offset voltage $\left(1 + \frac{R_2}{R_1}\right) V_{off} \approx 22mV$

Bias Current $V_{off} = R_2 I_B \approx 10\,mV$

offset current $-R_2 \frac{I_{off}}{2} \approx -2\,mV$

Worst Case $22 + 10 + 2 = 34mV$

$-22 + 0 - 2 = -24mV$

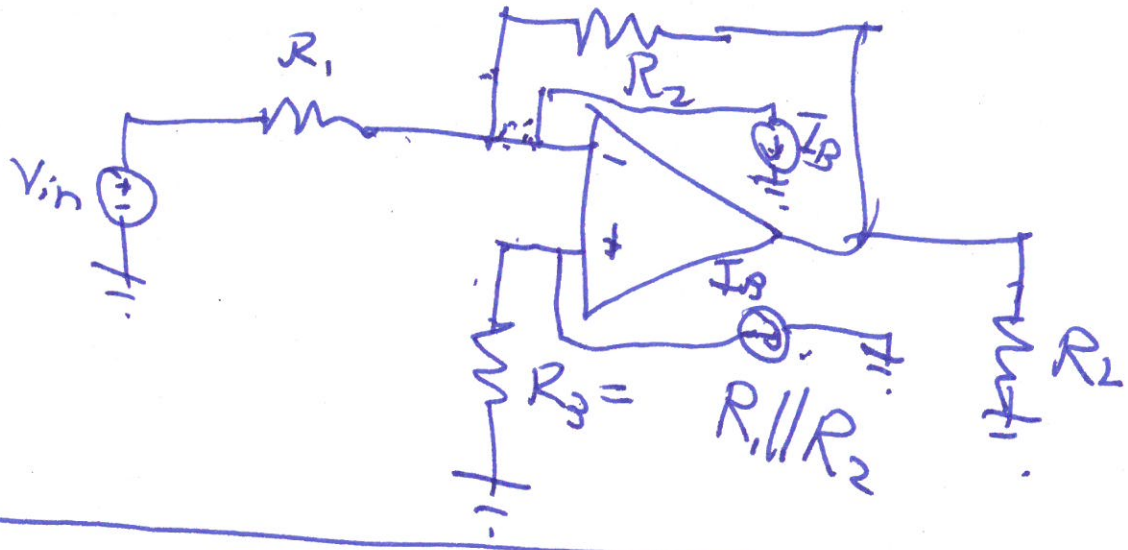
Typical $5mV \pm \sqrt{22^2 + 2^2}$

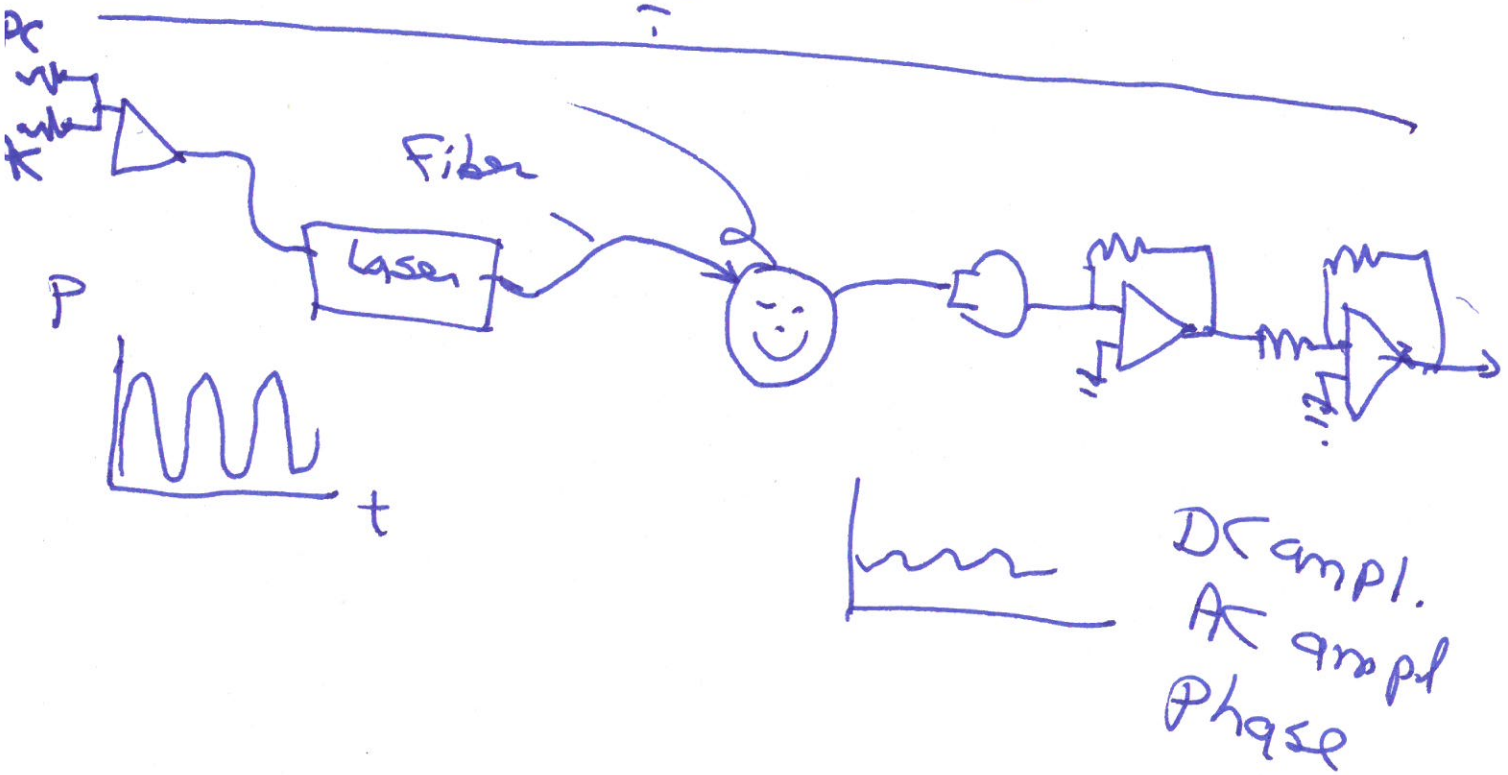
about 27 mV uncertainty in output

Dynamic Range $\frac{V_{max}}{V_{min}} = \frac{15\,V}{27mV}$

≈ 555 (55dB)

Correct for Bias current





DC ampl.
AC ampl
Phase