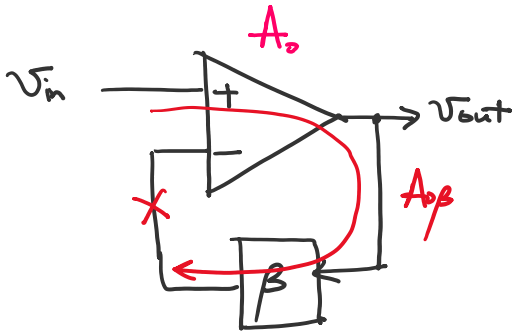
ECE 310 - Lecture 36

Wednesday, April 25, 2018 10:35 AM



$\beta \rightarrow$ precise

$0 \leq \beta \leq 1$

open-loop gain (loop gain) $= A_o\beta$

closed-loop gain $\dfrac{v_{out}}{v_{in}} = \dfrac{A_o}{1+A_o\beta}$

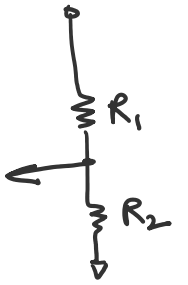
$(1+x)^{-1} \approx 1-x$

$= \dfrac{1}{\beta}\left(1+\dfrac{1}{A_o\beta}\right)^{-1}$

$= \dfrac{1}{\beta}\left(1-\dfrac{1}{A_o\beta}\right)$

$1-\epsilon$

$\hookrightarrow \epsilon = \dfrac{1}{A_o\beta}$

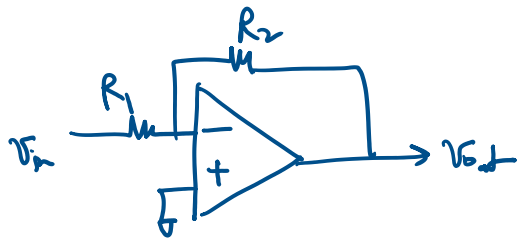


$\beta = \dfrac{R_2}{R_1+R_2}$

higher closed-loop gain $\Rightarrow \dfrac{1}{\beta} \uparrow$

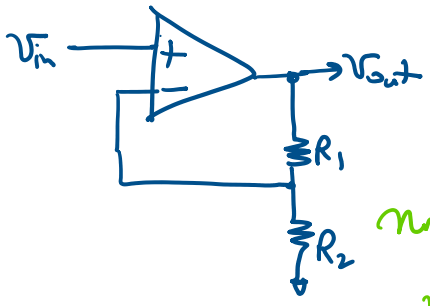
$\Rightarrow \beta \downarrow$

$A\beta \downarrow$



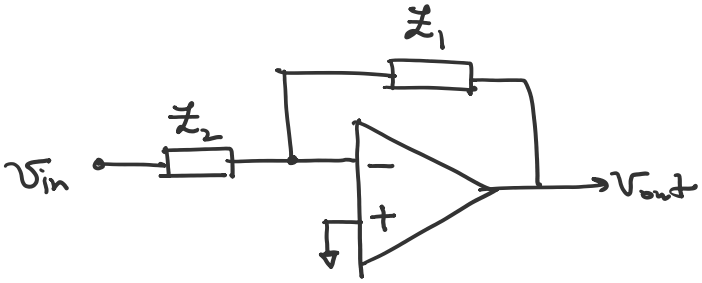
inverting

$$\frac{V_{out}}{V_{in}} = -\frac{R_2}{R_1}$$



Noninverting

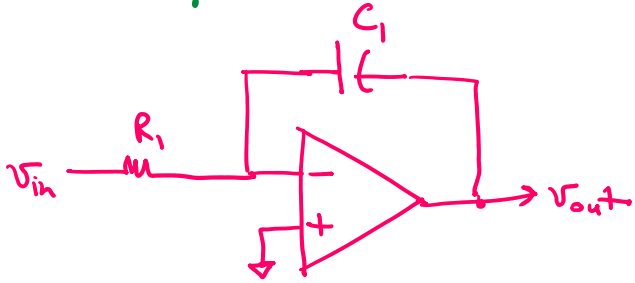
$$\frac{V_{out}}{V_{in}} = 1+\frac{R_2}{R_1}$$



inverting topology

$$\frac{v_{out}}{v_{in}} = \frac{-Z_1}{Z_2}$$

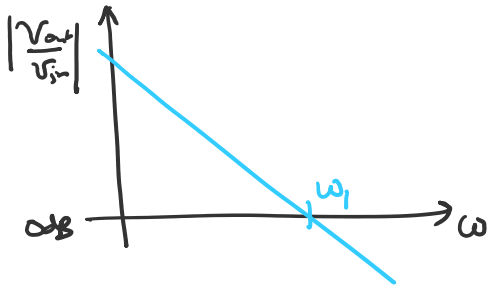
Integrator

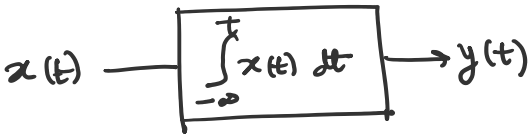


$$Z_1 = \frac{1}{sC_1}, \quad Z_2 = R_1$$

$$\frac{v_{out}}{v_{in}}(s) = -\frac{Z_1}{Z_2} = \frac{-1}{sR_1C_1} = -\frac{\omega_1}{s}$$

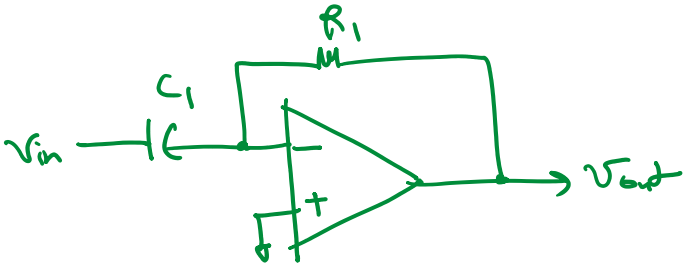
$$\omega_1 = \frac{1}{R_1C_1}$$





$X(s)$

$$Y(s) = \frac{X(s)}{s} - \int_{-\infty}^{0} x(t)\,dt$$

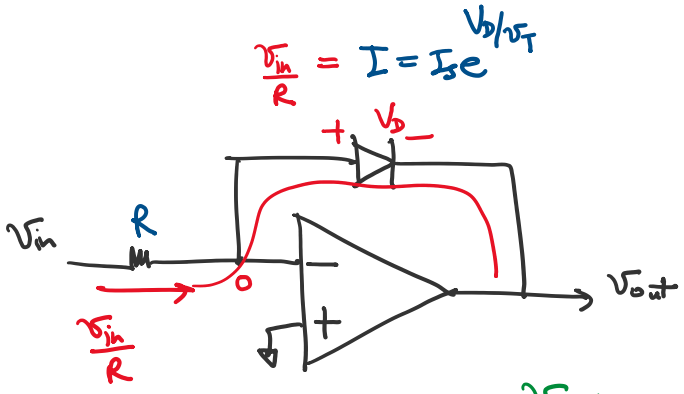


$$\frac{v_{out}}{v_{in}} = -\frac{R_1}{1/sC_1} = -sR_1C_1$$

↳ Dil...

$\frac{V_{out}}{V_{in}} = -\frac{}{1/sC_1} = -$ ...

↳ Differentiator



$v_{out} = -v_D$

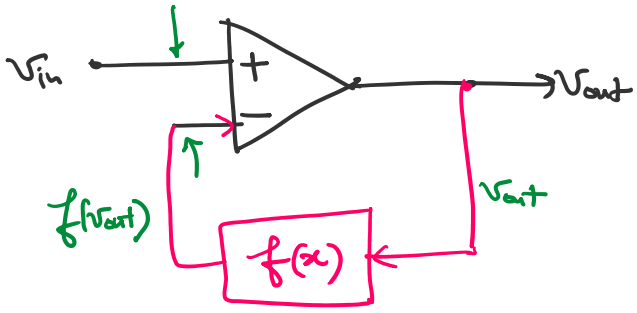
$\frac{v_{in}}{R} = I_s e^{v_D/v_T}$

$\Rightarrow \frac{v_{in}}{R} = I_s e^{-v_{out}/v_T}$

$\Rightarrow \left(\frac{v_{in}}{I_s R}\right) = e^{-v_{out}/v_T}$

$\Rightarrow -v_T \ln\left(\frac{v_{in}}{I_s R}\right) = v_{out}$

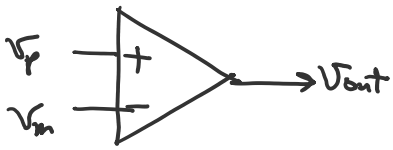
Logarithmic circuit



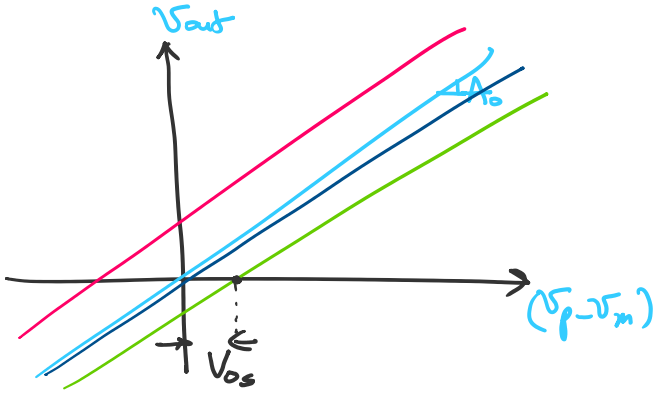
$v_{in} = f(v_{out})$

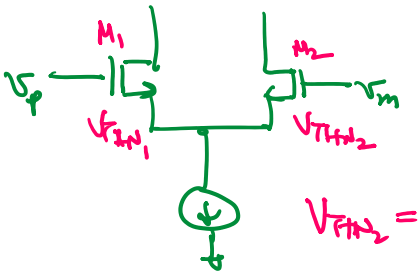
$\Rightarrow v_{out} = f^{-1}(v_{in})$

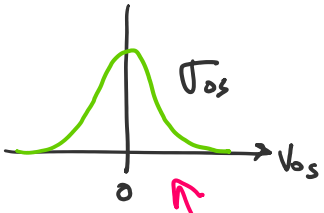
Opamp Non-idealities:



$$V_{out} = A_0 (V_p - V_m)$$

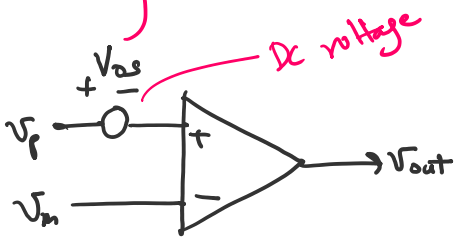


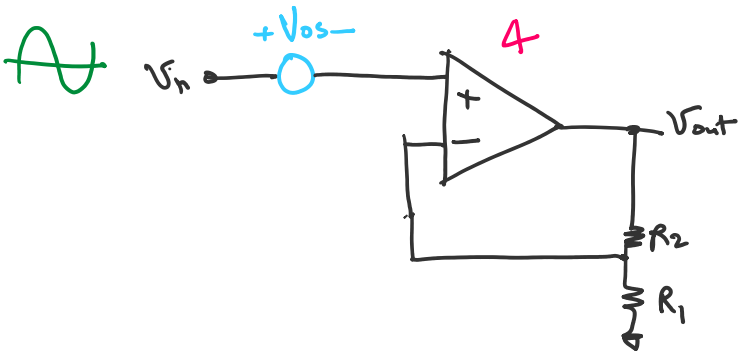


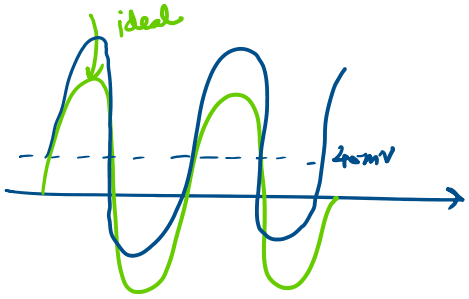


OFFSET Voltage

↳ random variation from chip to chip







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

V_{os}: 10mV

↳ offset is also amplified
↳ accuracy limitation!