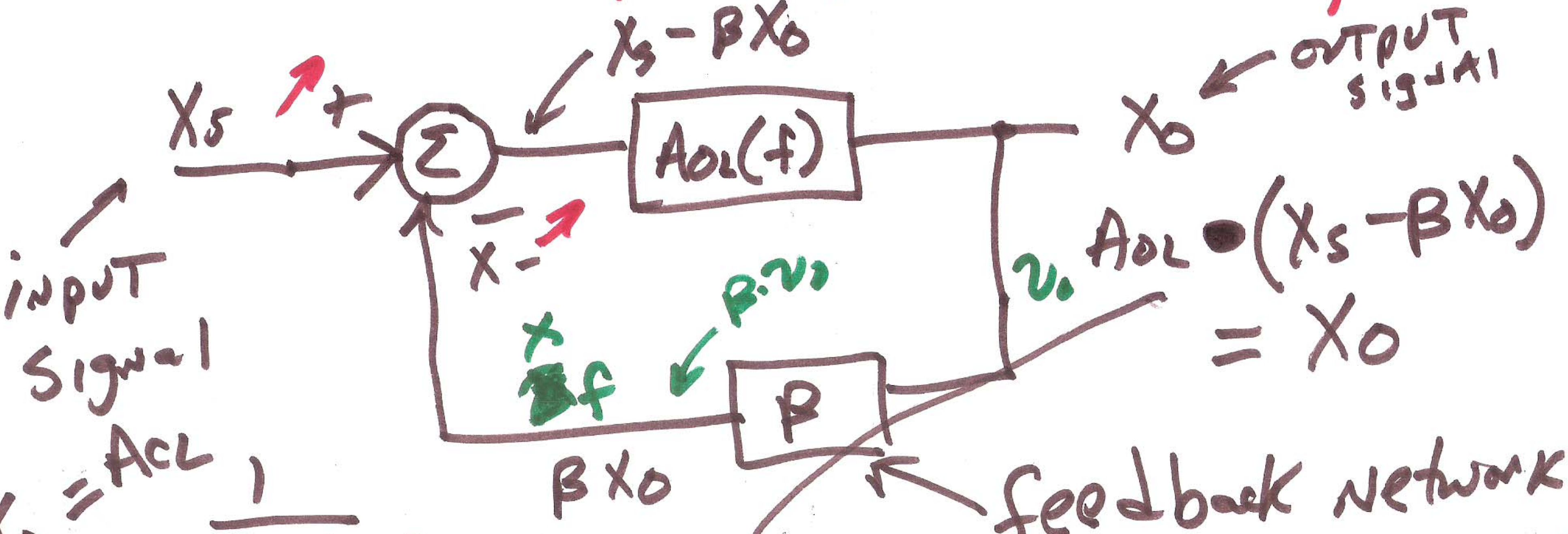
Sec. 31.1

The feedback Eq.



$$A_{OL} \bullet (X_S - \beta X_O) = X_O$$

$$\frac{X_O}{X_S} = A_{CL} = \frac{1}{\frac{1}{A_{OL}} + \beta}$$

$$A_{OL} \cdot X_S = X_O (1 + A_{OL}\beta)$$

closed loop gain

$$A_{CL} = \frac{X_O}{X_S} = \frac{A_{OL}}{1 + \beta A_{OL}}$$

$$A_{OL} \to \infty \quad \left\{ A_{CL} = \frac{X_O}{X_S} \approx \frac{1}{\beta} \right.$$

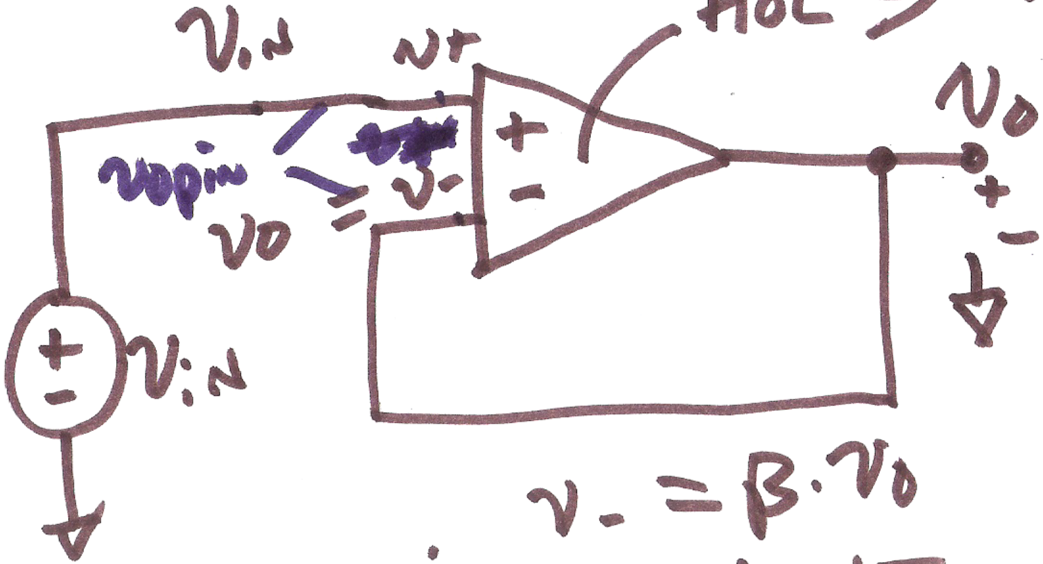
$A_{CL} \geq 10 \quad \beta \geq 0.1$

$\beta \cdot A_{OL}$ = loop gain

β = feedback factor

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

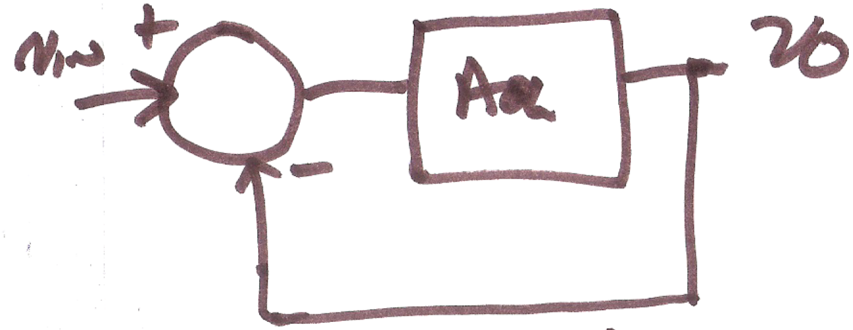
CMOSedu.com



$A_{OL} \Rightarrow v_0 = A_{OL}(v_+ - v_-)$

$= A_{OL}(v_{IN} - v_{OUT})$

open loop gain of op-Amp



$v_- = \beta \cdot v_0$

$\beta = 1$

Series – Shunt

V V

$v_+ - v_- = v_{opin}$

$v_{IN} = v_{opin} + v_0$

ideally $v_o = v_i$

$$v_0 = \frac{A_{OL}}{1+\beta A_{OL}} \cdot v_i$$

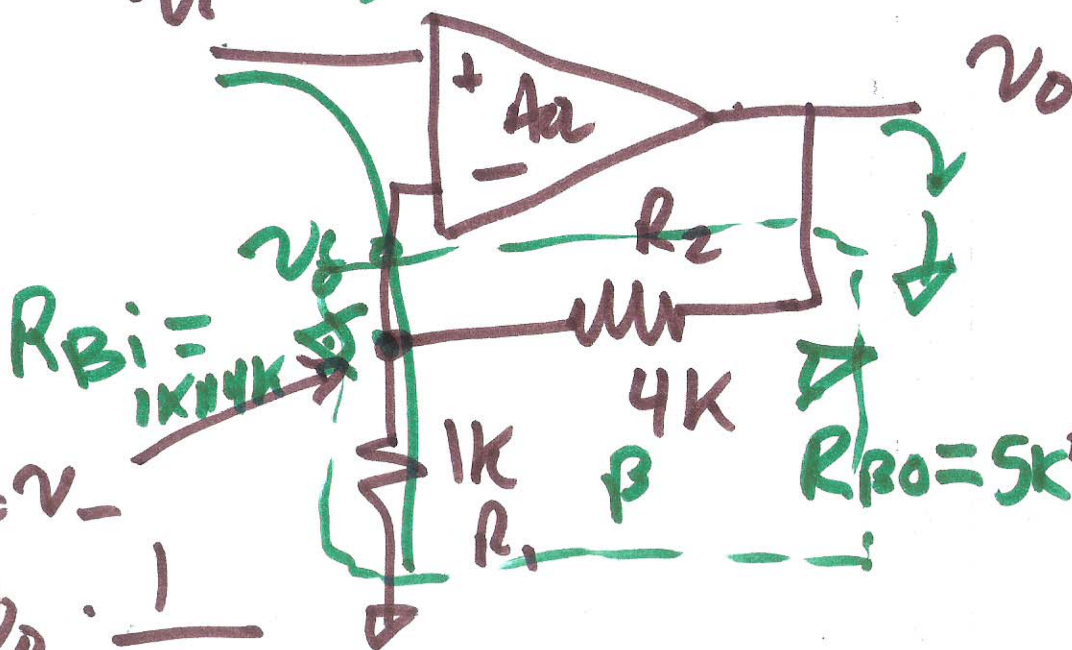
$\beta = 1$

UNLV

UNIVERSITY OF NEVADA LAS VEGAS

CMOSedu.com

Series − Shunt



$$A_{CL}\Big|_{\text{ideally}} = \frac{1}{\beta}$$

$$v_f = v_- = v_o \cdot \frac{1}{1+4}$$

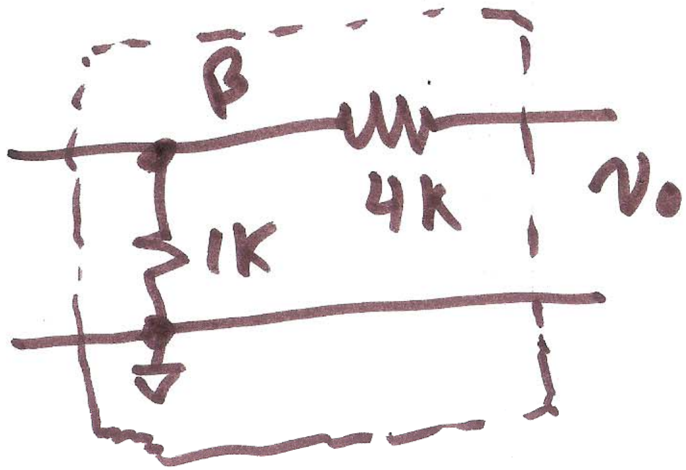
$$\beta = \frac{1}{5}$$

$$A_{CL} = \frac{A_{OL}}{1+\beta A_{OL}}$$

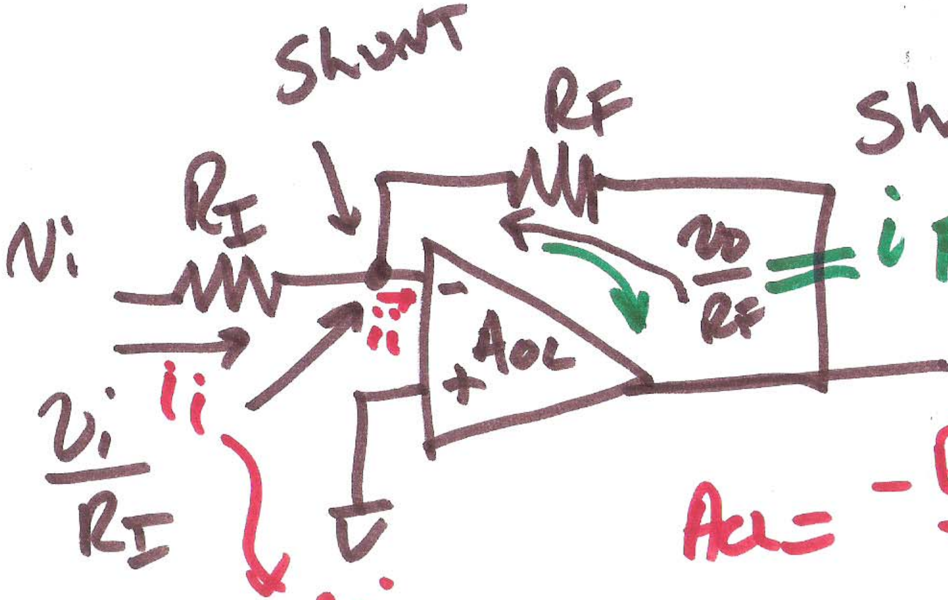
$\beta \rightarrow 1/5$

ideally then

$$A_{CL} = 5 = 1 + \frac{R_2}{R_1}$$



$$\beta v_o = \frac{1}{5} v_o$$



$$\frac{v_o}{R_F} = i_F = v_o \cdot \beta$$

$$\boxed{\beta = -\frac{1}{R_F}}$$

$$A_{CL} = -\frac{R_F}{R_I}$$

$$I_o = I_I + \cancel{I_F} - \frac{v_o}{R_F} \quad I_F$$

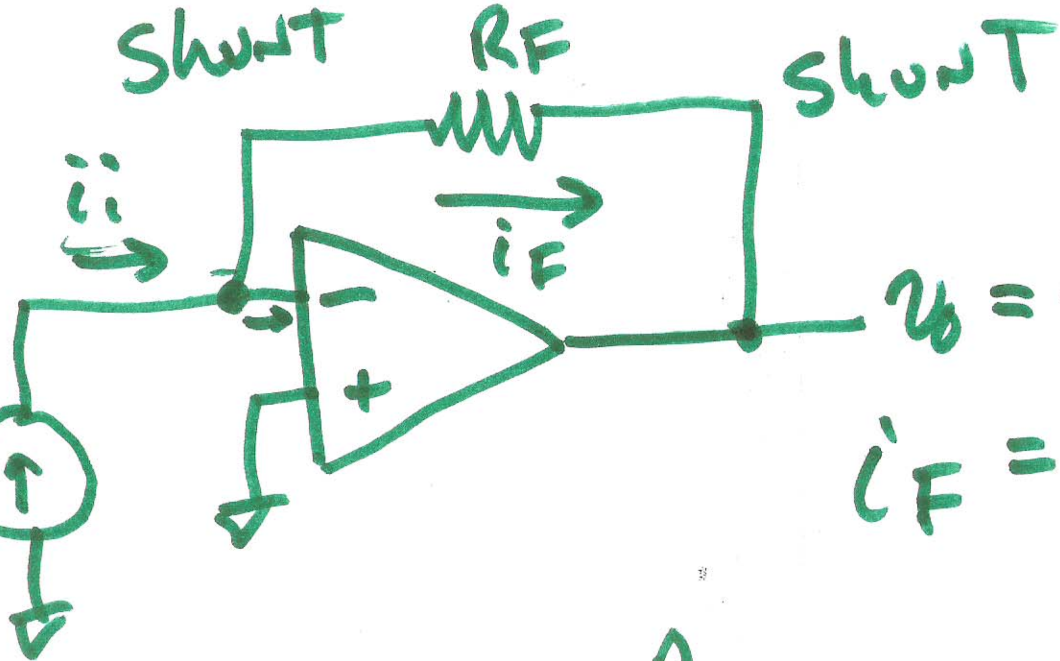
$$A_{CL} = \frac{v_o}{i_i} = \frac{v_o}{v_i/R_I} = \frac{\cancel{A_{OL}} \; \frac{v_o}{i_i}}{1 + A_{OL}\cdot\left(-\frac{1}{R_F}\right)}$$

$$A_{OL} \to \infty \qquad A_{CL} = -\frac{R_F}{R_I}$$

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

CMOSedu.com

$$\frac{v_i}{R_i} = i_i$$

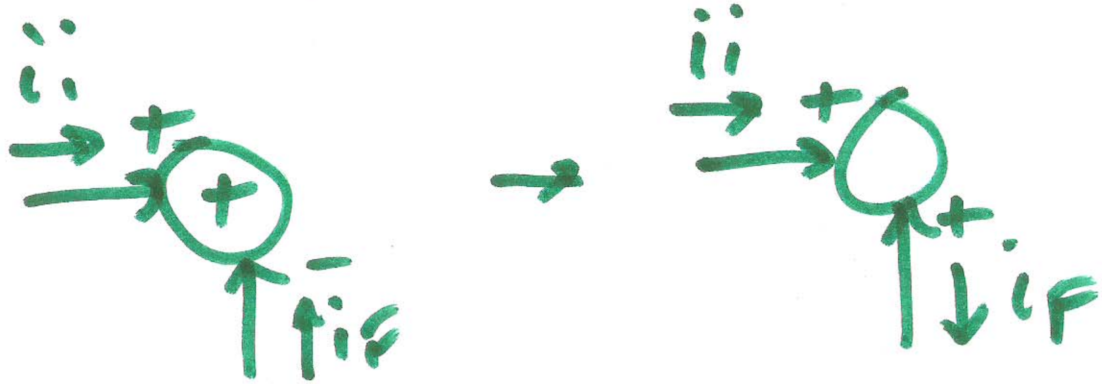


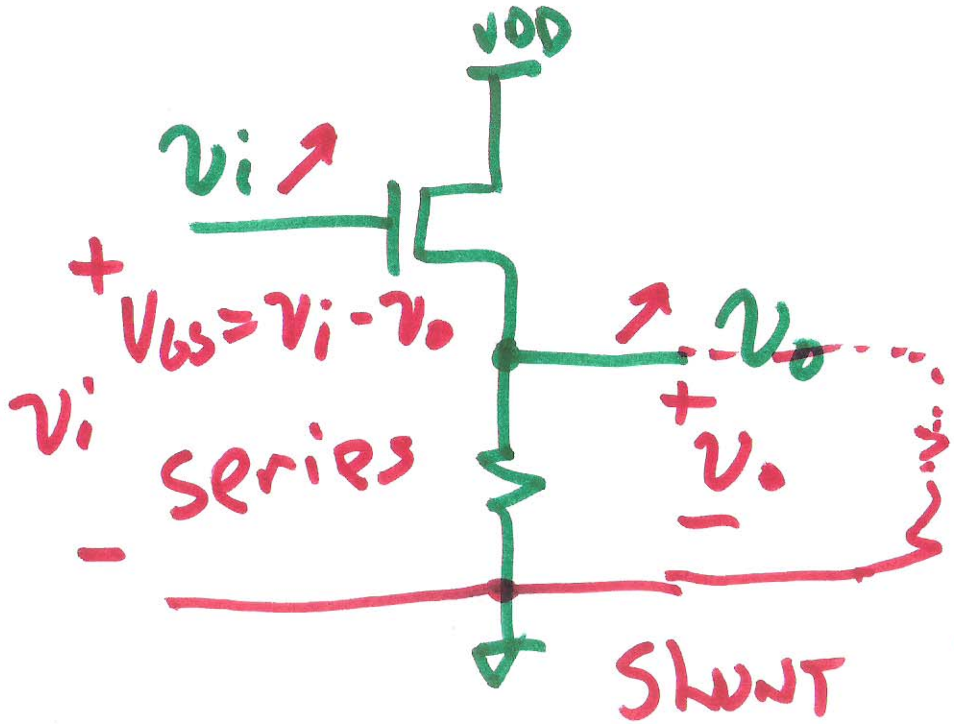
$$v_o = -i_F \cdot R_F$$

$$i_F = v_o \cdot -\frac{1}{R_F}$$

$$\beta = -\frac{1}{R_F}$$

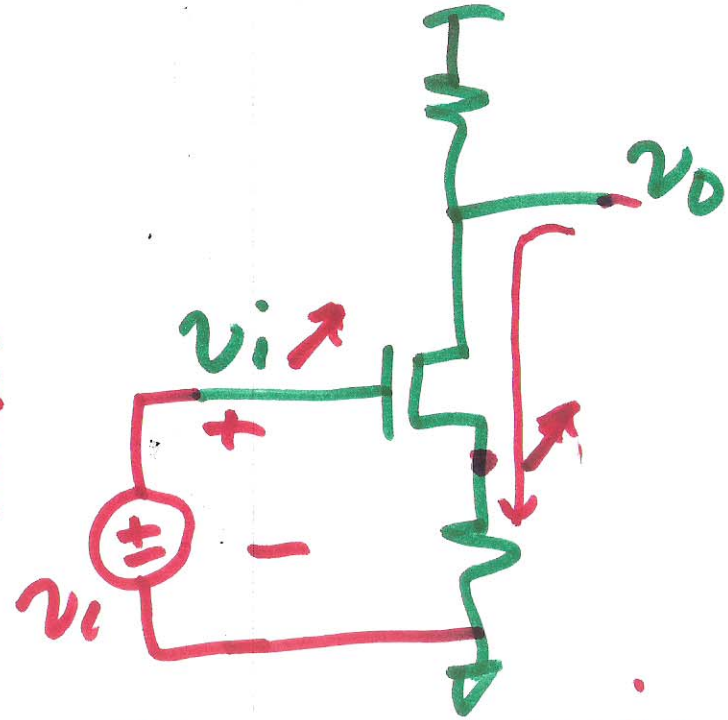
$$A_{CL} = \frac{v_o}{i_i} = \frac{A_{OL}}{1 + A_{OL} \cdot \beta} \Rightarrow \Big|_{A_{OL} \to \infty} -R_F$$





series-shunt

V/V



series − ~~series~~ ~~shunt~~ ?