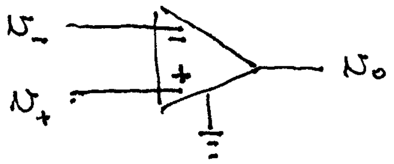
Op-Amps Saturation Region

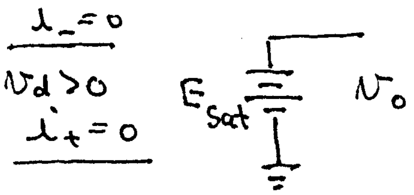
$i_- = 0$ + Saturation

$i_+ = 0$

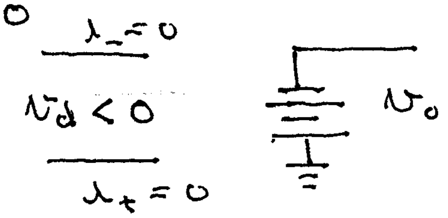
$v_o = E_{sat}$

$v_d = v_+ - v_- > 0$

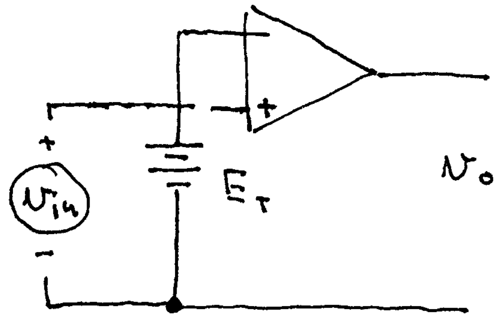




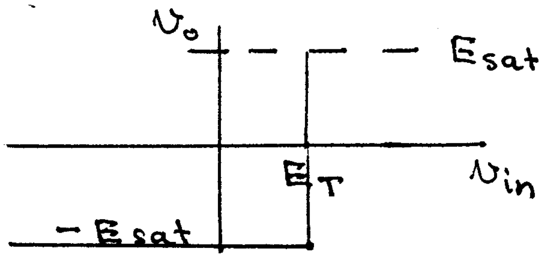
$v_d = v_+ - v_- < 0$



$-E_{sat} < v_o(t) < E_{sat}$



Unless $v_{in} = E_T$ saturation occurs!



Comparator

Positive an Negative Feedback and Saturation

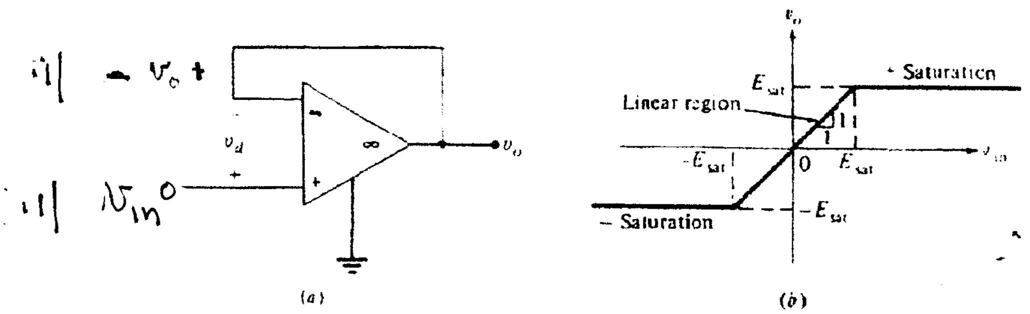


Figure 3.5 (a) A negative feedback circuit and (b) its transfer characteristic.

$v_F = v_o$

$v_d = v_{in} - v_o$

$v_o = A v_d$

$= A(v_{in} - v_o)$

$v_o = \dfrac{A v_{in}}{1 + A}$

negative feedback

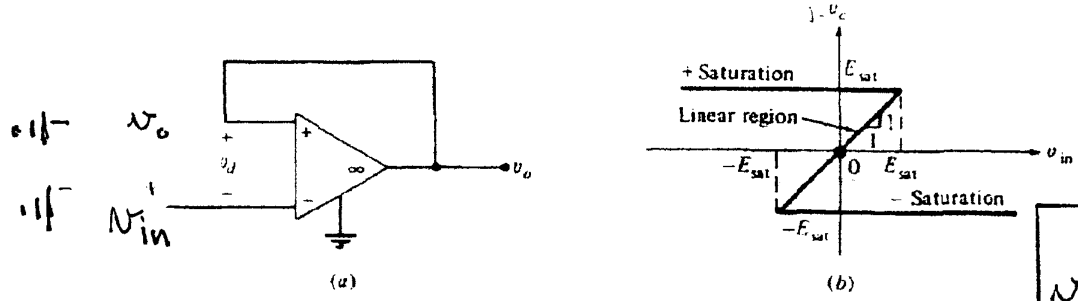


Figure 3.6 (a) A positive feedback circuit and (b) its transfer characteristic.

$v_F = v_o$

$v_d = v_o - v_{in}$

$v_o = A(v_o - v_{in})$

$v_o(1 - A) = -A v_{in}$

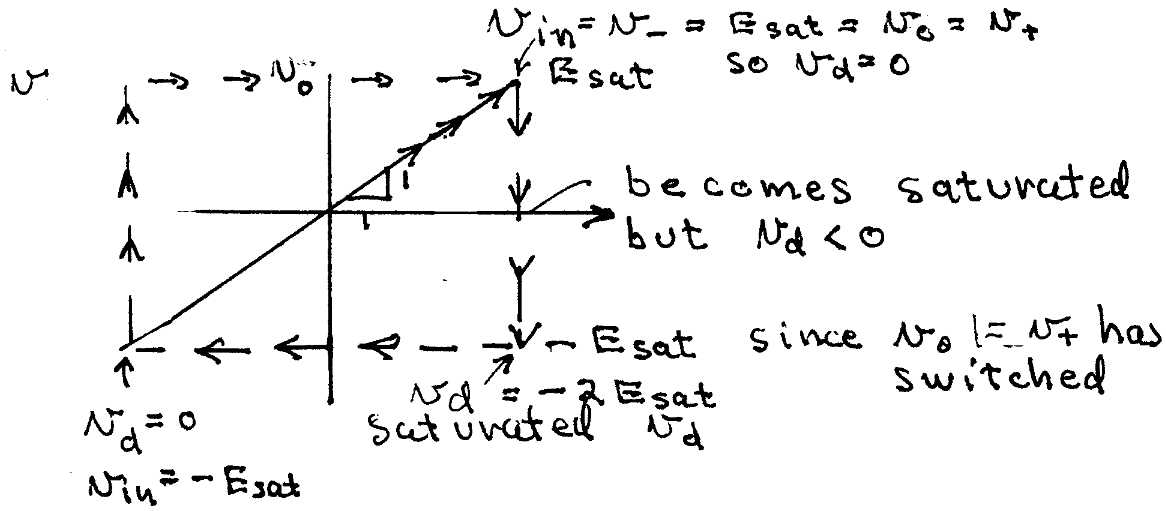
$v_o = -\dfrac{A v_{in}}{1 - A}$

positive feedback

For Fig 3.6

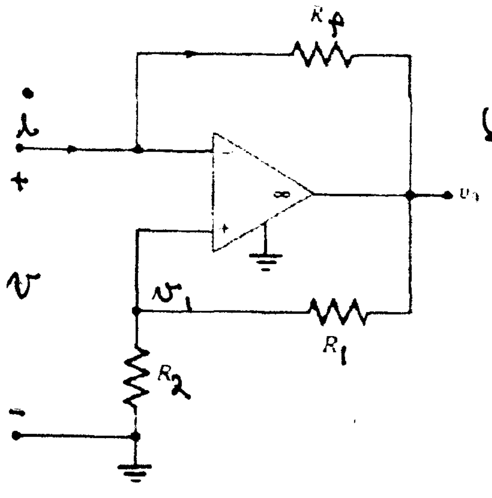
1. when saturated with $v_{in} = E_{sat} = v_o$
2. $v_o = +E_{sat}$ but when $v_{in} > E_{sat}$
3. v_d becomes negative so v_o switches to $-E_{sat} = v_+$
4. But Now Op amp is saturated until $v_{in} < -E_{sat}$ and then it must switch to $+E_{sat}$

This gives bi- behavior

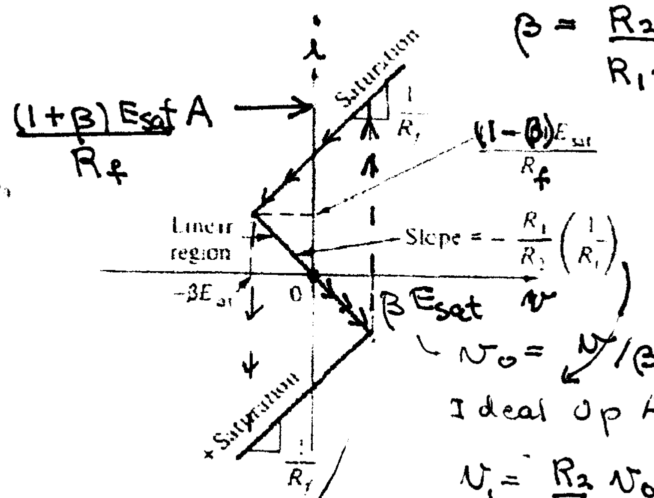


Bistable behavior

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



(a)



(b)

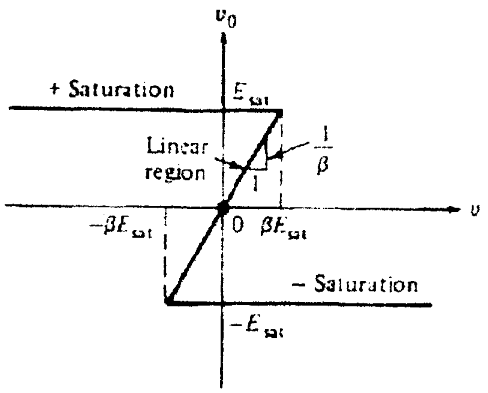
$v_0 = v/\beta = E_{sat}$

Ideal Op Amp

$v_1 = \dfrac{R_2 v_0}{R_1 + R_2} = v = \beta v_0$

$\dfrac{v_0 - v_1}{R_f} = -i$ sub for v_0

$\dfrac{R_1}{R_2}\dfrac{v}{R_f} = -i$



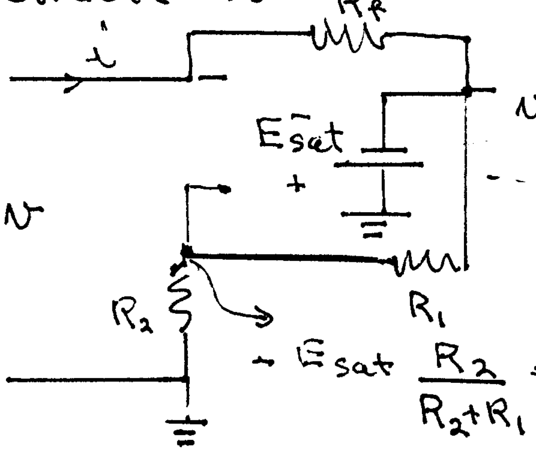
(c)

at this point $v = v_1 = \beta v_0$
just the edge of sat
for $v > \beta E_{sat}$ $v_+ - v_-$ is <0

Thus the equivalent

Figure 3.8 A negative-resistance converter and its driving-point and transfer characteristics. Here, $\beta \doteq R_2/(R_1 + R_2)$.

circuit is



$-E_{sat}\dfrac{R_2}{R_2 + R_1} = -E_{sat}\beta$

$i = \dfrac{v + E_{sat}}{R_f} = \dfrac{\beta E_{sat} + E_{sat}}{R_f}$

at point A