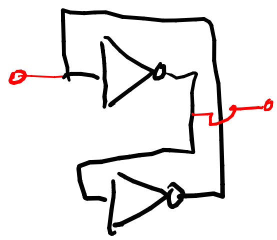
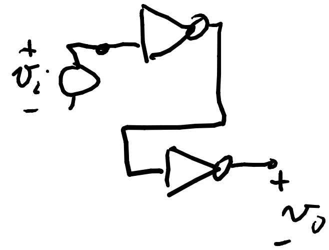
EE303

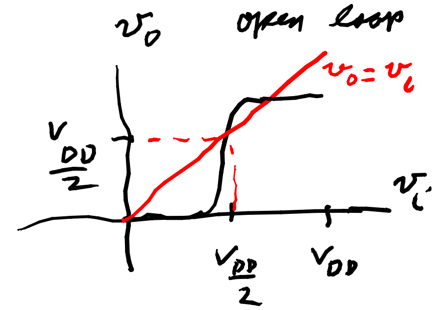
03/14/12

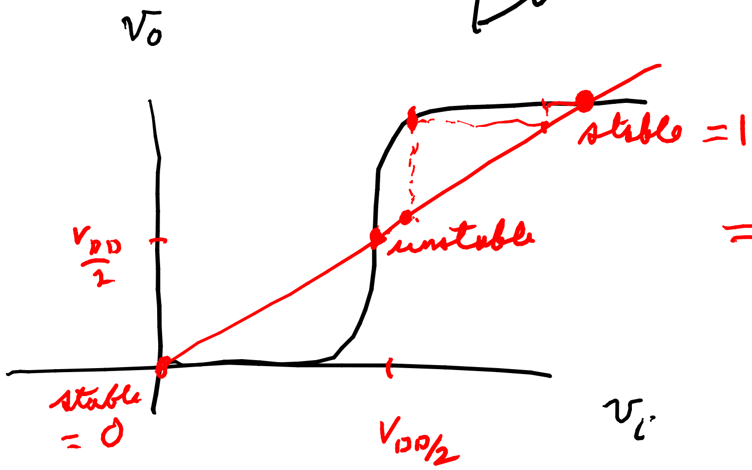
Note Title 3/14/2012

P. 1205 latch



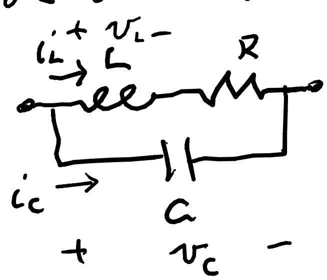



$\Rightarrow$ SRAM p. 1218

Van der Pol oscillator




$i_c = C\frac{dv_c}{dt} = -i_L$ KCL

$v_L = L\frac{di_L}{dt} = v_c - Ri_L$ KVL

laws of components

laws of connection

$$C\frac{dv_c}{dt} = -i_L$$
$$L\frac{di_L}{dt} = v_c - Ri_L$$

$$\longrightarrow \quad C\frac{d^2v_c}{dt^2} = -\frac{di_L}{dt} = -\frac{1}{L}v_c + \frac{R}{L}\left(-C\frac{dv_c}{dt}\right)$$

$$\frac{d^2v_c}{dt^2} + \underline{\frac{R}{L}\frac{dv_c}{dt}} + \frac{1}{LC}v_c = 0 \Rightarrow \left(s^2 + \frac{R}{L}s + \frac{1}{LC}\right)v_c = 0$$

to get $v_c(t) = V_c e^{st}$

$$\Rightarrow V_c s^2 e^{st} + s\frac{R}{L}V_c e^{st} + \frac{1}{LC}e^{st} = 0 = \left(V_c s^2 + s\frac{R}{L}V_c + \frac{V_c}{LC}\right)e^{st} = 0$$

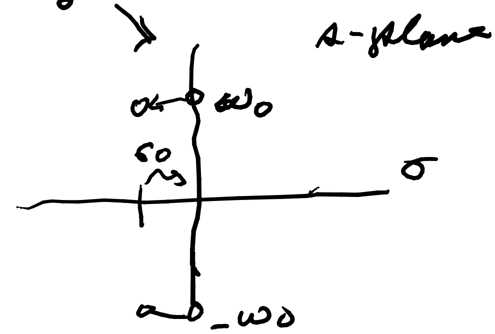
if $V_c \neq 0$, $e^{st}$ never zero $\Rightarrow s^2 + \frac{R}{L}s + \frac{1}{LC} = 0$

$$= s^2 + \frac{\omega_0}{Q}s + \omega_0^2 = 0, \quad Q \propto \frac{1}{R}$$

$$P(s) = s^2 + \frac{R}{L}s + \underbrace{\frac{1}{LC}}_{\omega_0^2}$$

if $R=0 \Rightarrow s^2 + \omega_0^2 = 0$

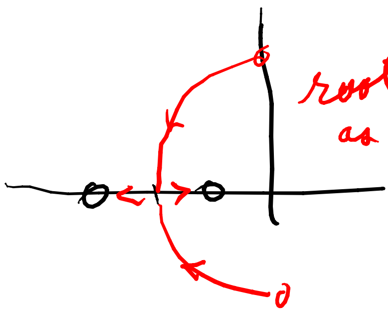
$s = \pm j\omega_0$



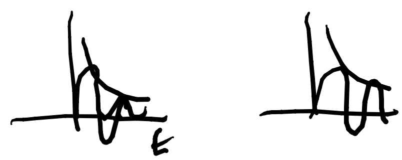

if $R \neq 0 \Rightarrow s_{1,2} = -\frac{R}{2L} \pm \frac{1}{2}\sqrt{(R/L)^2 - 4/LC}$

$= \sigma_0 \pm j(\omega_0 - \epsilon)$

If R is large $s_{1,2} = \sigma_0 \pm \sigma_0'$




$$A_1 e^{s_1 t} + A_2 e^{s_2 t}$$




$$\ddot{y} + \epsilon(y^2-1)\dot{y} + \omega_0^2 y = 0$$

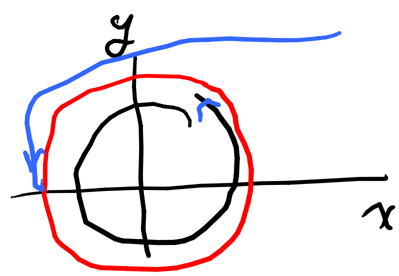
$$\frac{d}{dt}\left(\dot{y} + \epsilon f(y)\right) = \ddot{y} + \epsilon \frac{d f(y)}{dy}\dot{y}$$

Van der Pol oscillator
nonlinear with a
limit cycle
structurally stable

$x = \dot{y}$

$\dot{x} = \ddot{y} = -\epsilon(y^2-1)x - \omega_0^2 y$

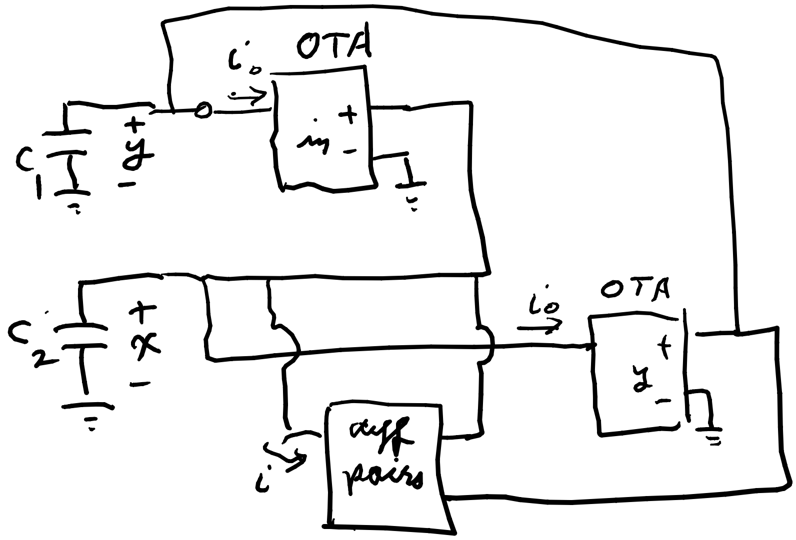
$$\left.\begin{aligned}\dot{y} &= x \\ \dot{x} &= -\boxed{\epsilon(y^2-1)}x - \omega_0^2 y\end{aligned}\right\}$$ state variable equation




We can make with OTA's & C's

$C_1 \frac{dy}{dt} \Rightarrow$

$C_2 \frac{dx}{dt}$

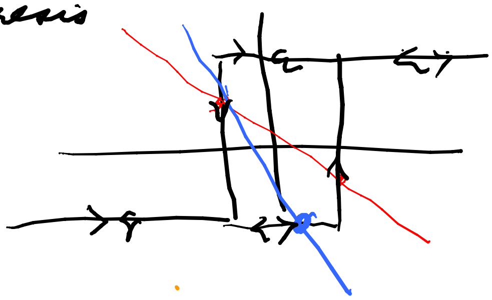



$\epsilon(y^2-1)x$

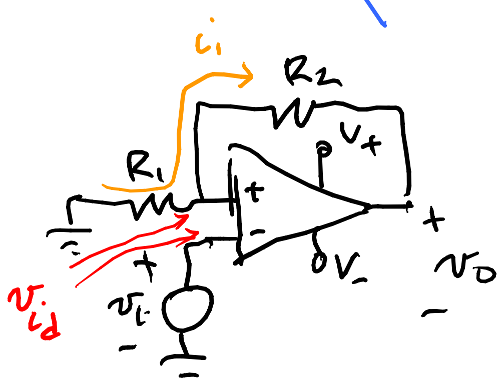
In Spice G components are voltage in current out & beautifully there is the G value which allows to type in function.

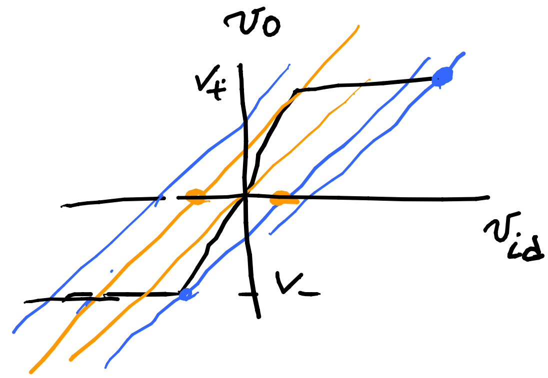
---

hysteresis




Schmitt trigger p. 1358




$v_o = f(v_{id})$

$$0 = R_1 i_1 + v_{id} + v_i \quad (1)$$

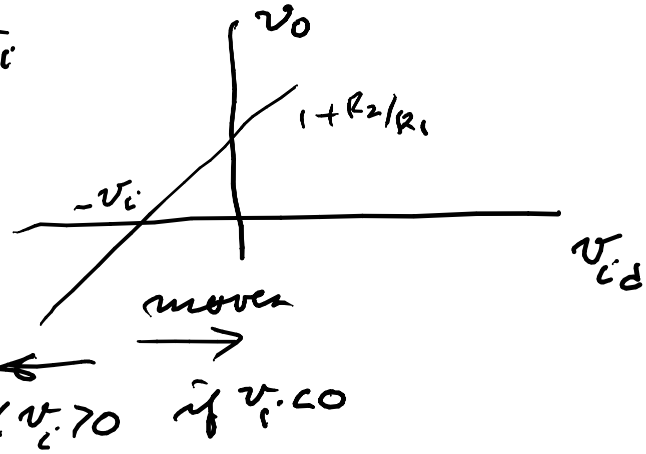
$$0 = -v_i - v_{id} + R_2 i_1 + v_o \quad (2)$$

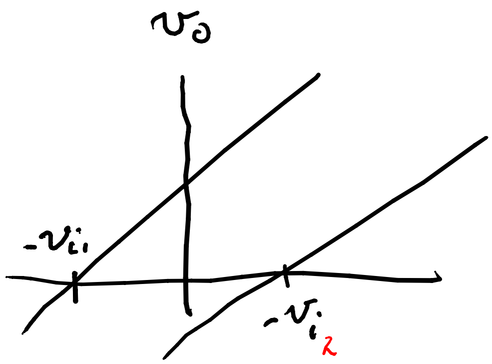
add $$0 = R_1 i_1 + R_2 i_1 + v_o \quad (3)$$

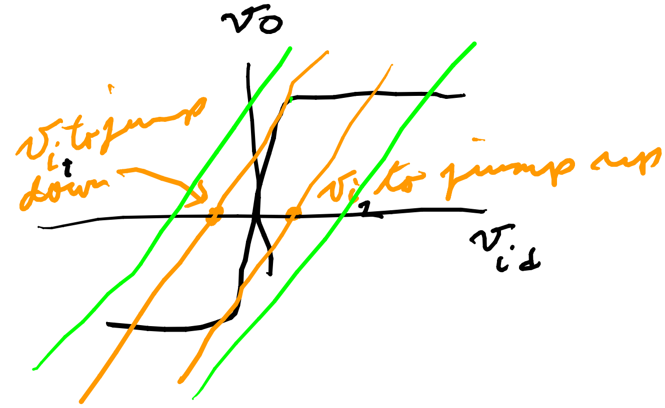
$$\Rightarrow i_1 = -\frac{v_o}{R_1+R_2} \quad (3')$$

$(3') \to (1) \Rightarrow 0 = -v_o \times \frac{R_1}{R_1+R_2} + v_{id} + v_i$

$$v_o = \left(1 + \frac{R_2}{R_1}\right)(v_{id} + v_i)$$




$\Rightarrow$


won't converge as a DC run in Spice (as multiple Q points)

$\therefore$ do a transient analysis with slowly varying triangle waves.