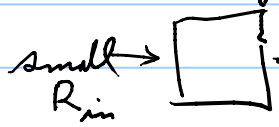
EE 302
01/27/05

Electronics:

transistors = transfer resistor

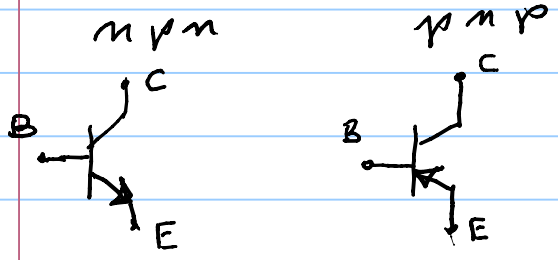


allows power transfer

symbols

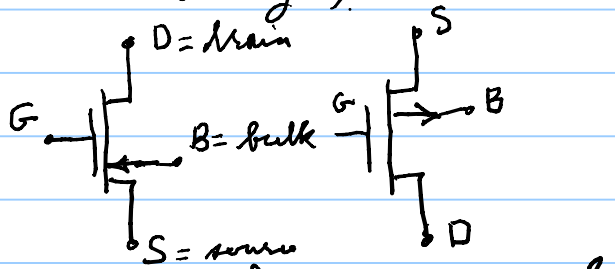
BJT = bipolar junction transistor

two kinds



MOS = metal oxide silicon

two (of 4) kinds

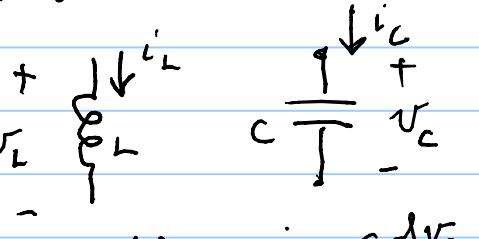


n-channel p-channel

enhancement mode

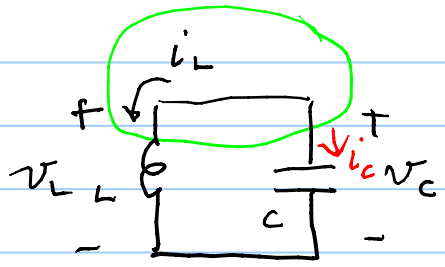
(other two are "depletion")

an oscillator:



$v_L = L\frac{di_L}{dt} = L\dot{i}_L$

$i_C = C\frac{dv_C}{dt} = C\dot{v}_C$



KVL: $0 = v_C - v_L \Rightarrow v_L = v_C$

KCL: $0 = i_L + i_C \Rightarrow i_C = -i_L$

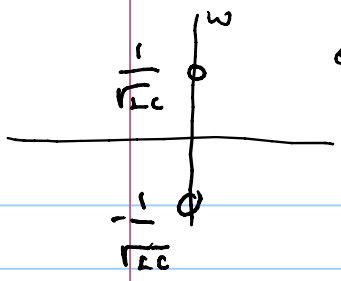
1) $L\dot{i}_L = v_C$

2) $C\dot{v}_C = -i_L$

2) → 1) $L\frac{d}{dt}(-C\dot{v}_C) = v_C$

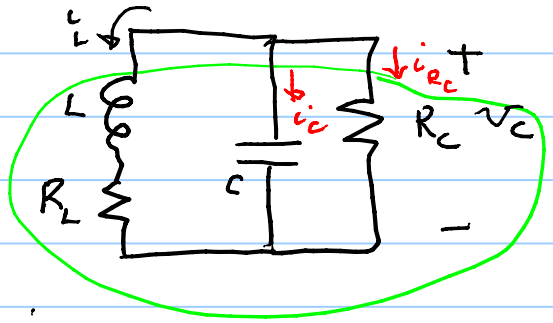
3) $LC\ddot{v}_C + v_C = 0$

3) → $(LC\alpha^2 + 1)v_C = 0 \Rightarrow LC\alpha^2 + 1 = 0 \Rightarrow \alpha_{1,2} = \pm j\frac{1}{\sqrt{LC}}$



$\sigma + j\omega = s$

But a real circuit has loss:



$G_C = \frac{1}{R_C}$

1') $v_C = s L i_L + R_L i_L$

2') $i_L = -sC v_C - G_C v_C$

$\dot{x} = Ax$

choose $\begin{bmatrix} v_C \\ i_L \end{bmatrix} = x$ = state vector

$$\begin{bmatrix} sC & 0 \\ 0 & sL \end{bmatrix} \begin{bmatrix} v_C \\ i_L \end{bmatrix} = \begin{bmatrix} -G_C & -1 \\ 1 & -R_L \end{bmatrix} \begin{bmatrix} v_C \\ i_L \end{bmatrix}$$

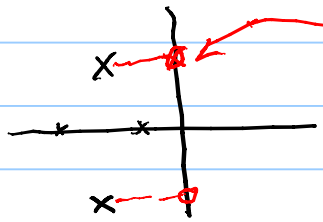
$$\Rightarrow \quad s \begin{bmatrix} v_C \\ i_L \end{bmatrix} = \begin{bmatrix} -G_C/C & -1/C \\ 1/L & -R_L/L \end{bmatrix} \begin{bmatrix} v_C \\ i_L \end{bmatrix}$$

$$\begin{bmatrix} s & 0 \\ 0 & s \end{bmatrix} x = s 1_2 x = Ax \Rightarrow (s 1_2 - A) x = 0$$

$\det[s 1_2 - A] = 0$ allows a nonzero x

$$\det \begin{bmatrix} s + \frac{G_C}{C} & 1/C \\ -1/L & s + \frac{R_L}{L} \end{bmatrix} = \left(s + \frac{G_C}{C}\right)\left(s + \frac{R_L}{L}\right) + \frac{1}{LC} = s^2 + \left(\frac{G_C}{C} + \frac{R_L}{L}\right) s + \frac{1}{LC} = 0$$

$+ \frac{G_C R_L}{CL}$



if $\frac{G_C}{C} = -\frac{R_L}{L}$ then can get an oscillator

i.e. $R_L = -\frac{L}{C} \cdot G_C$

added 02/01/05