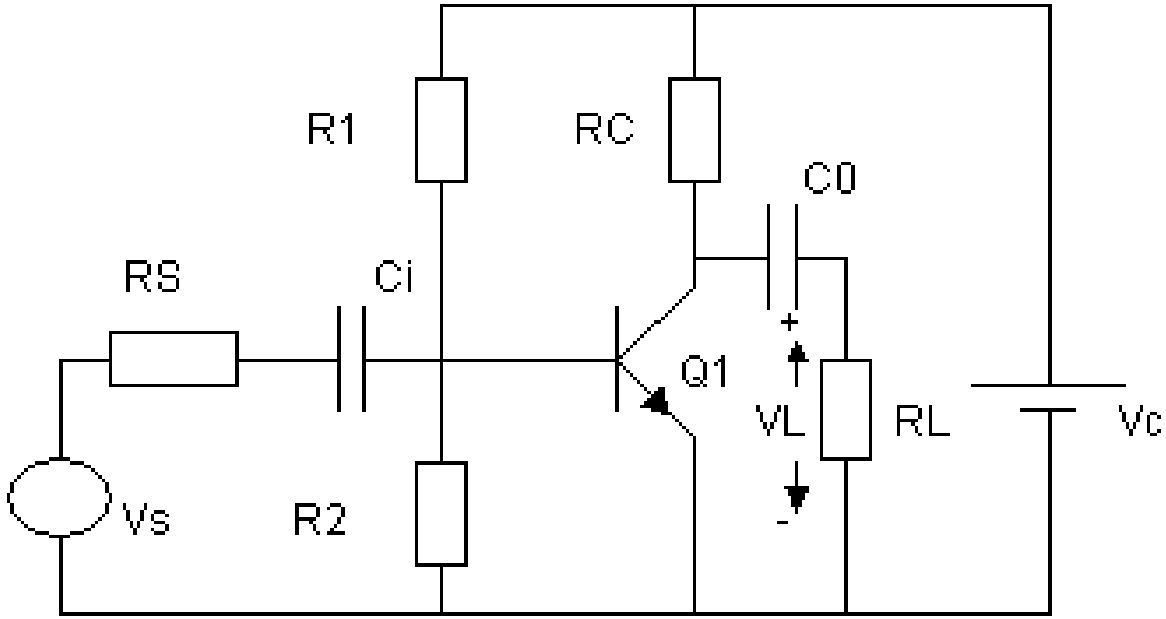
AMPLIFICADOR CONVENCIONAL



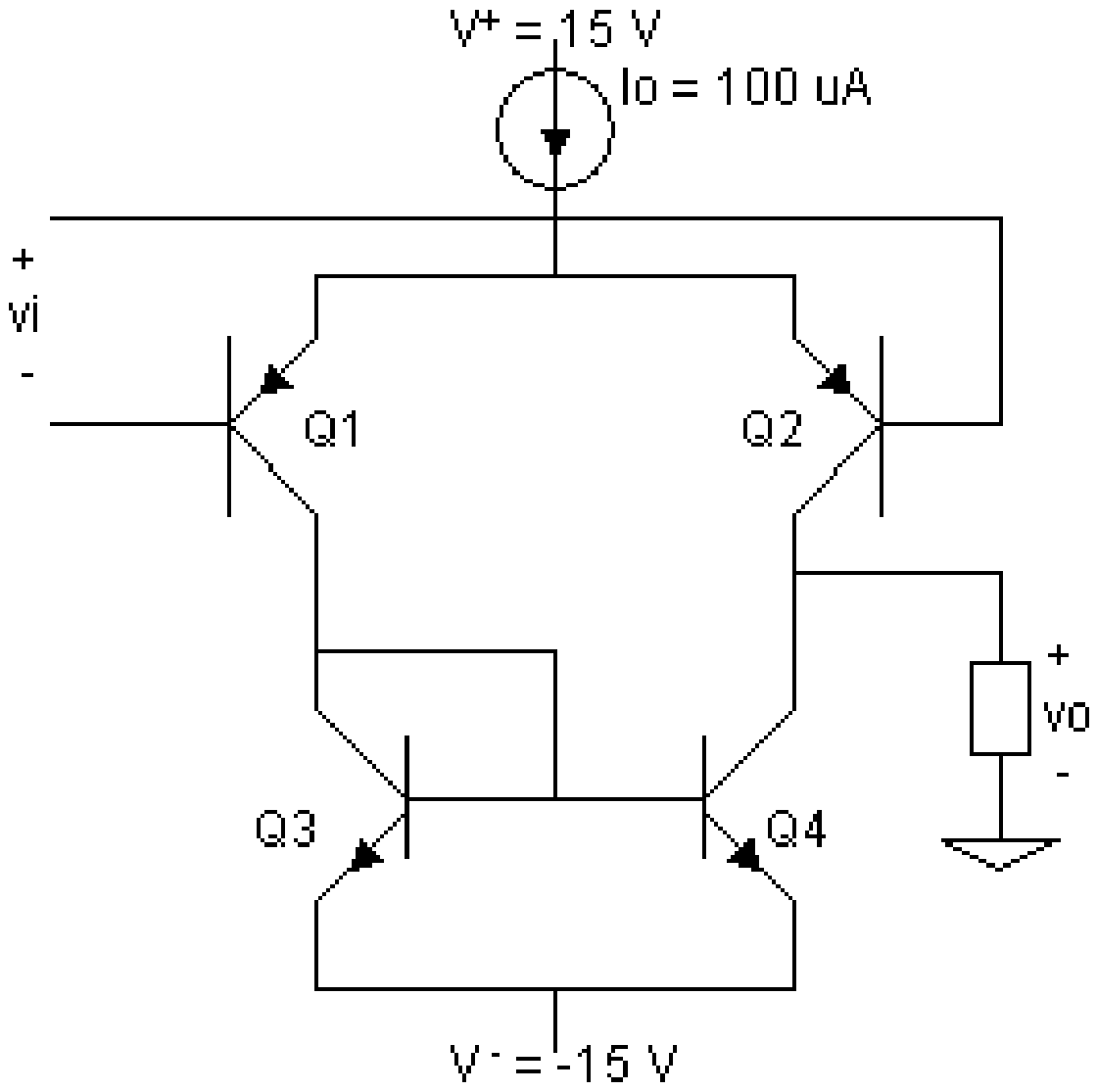
Ganancia de Tensión ➡ $A_V = -g_m \times (R_L \,//\, R_C \,//\, r_0)$

Resistencia de Entrada ➡ $R_i = (R_1 \,//\, R_2 \,//\, r_\pi)$

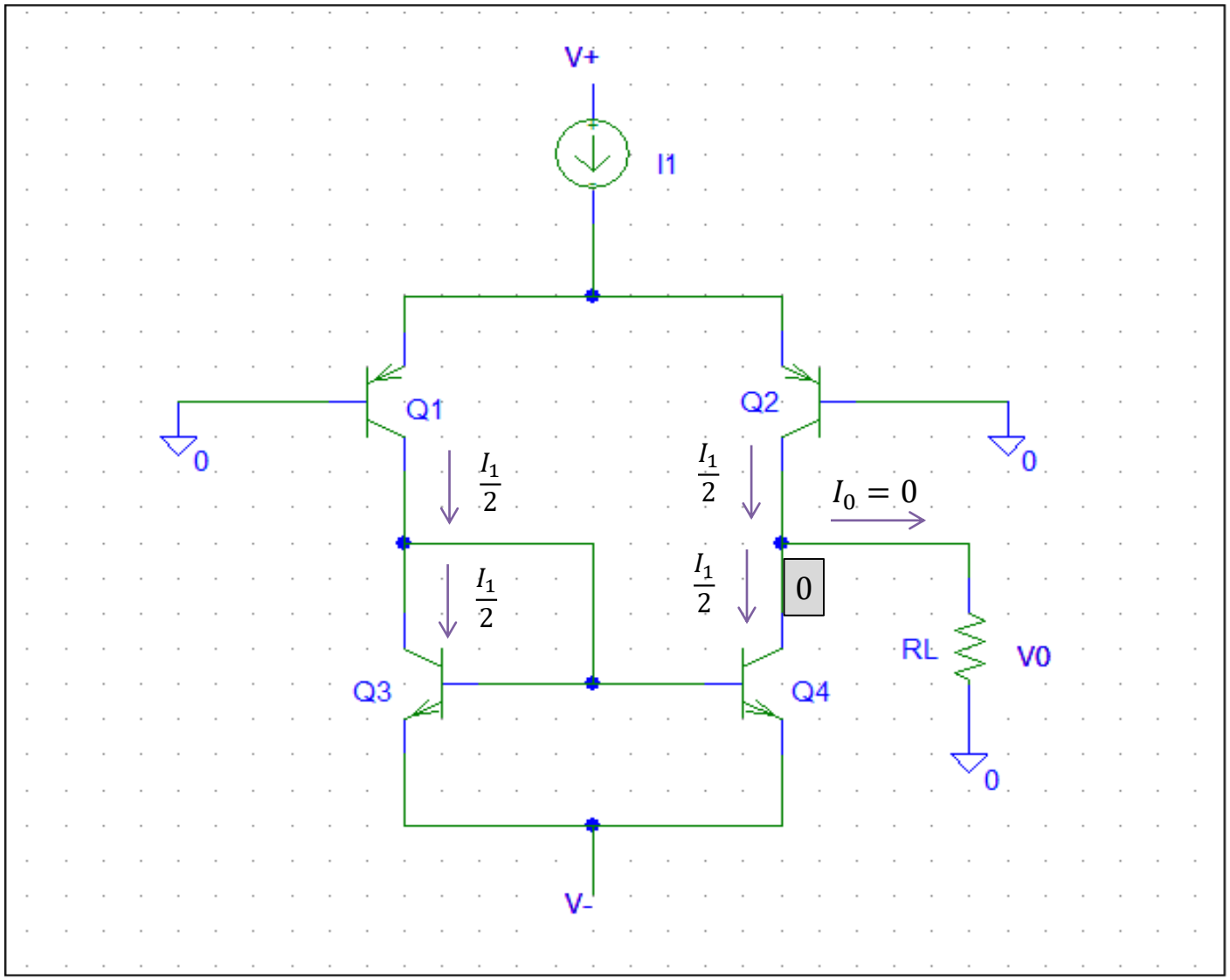
Resistencia de Salida ➡ $R_0 = (R_C \,//\, r_0)$

AMPLIFICADOR DIFERENCIAL

CON CARGA ACTIVA



AMPLIFICADOR DIFERENCIAL



$$V_d = 0$$

$$V_{BE1} = V_{BE2}$$

$$Q_1 \equiv Q_2$$

$$I_{C1} = I_{C2} = \frac{I_1}{2}$$

$$V_{BE3} = V_{BE4}$$

$$Q_3 \equiv Q_4$$

$$I_{C3} = I_{C4} = \frac{I_1}{2}$$

Corrientes del nodo 0

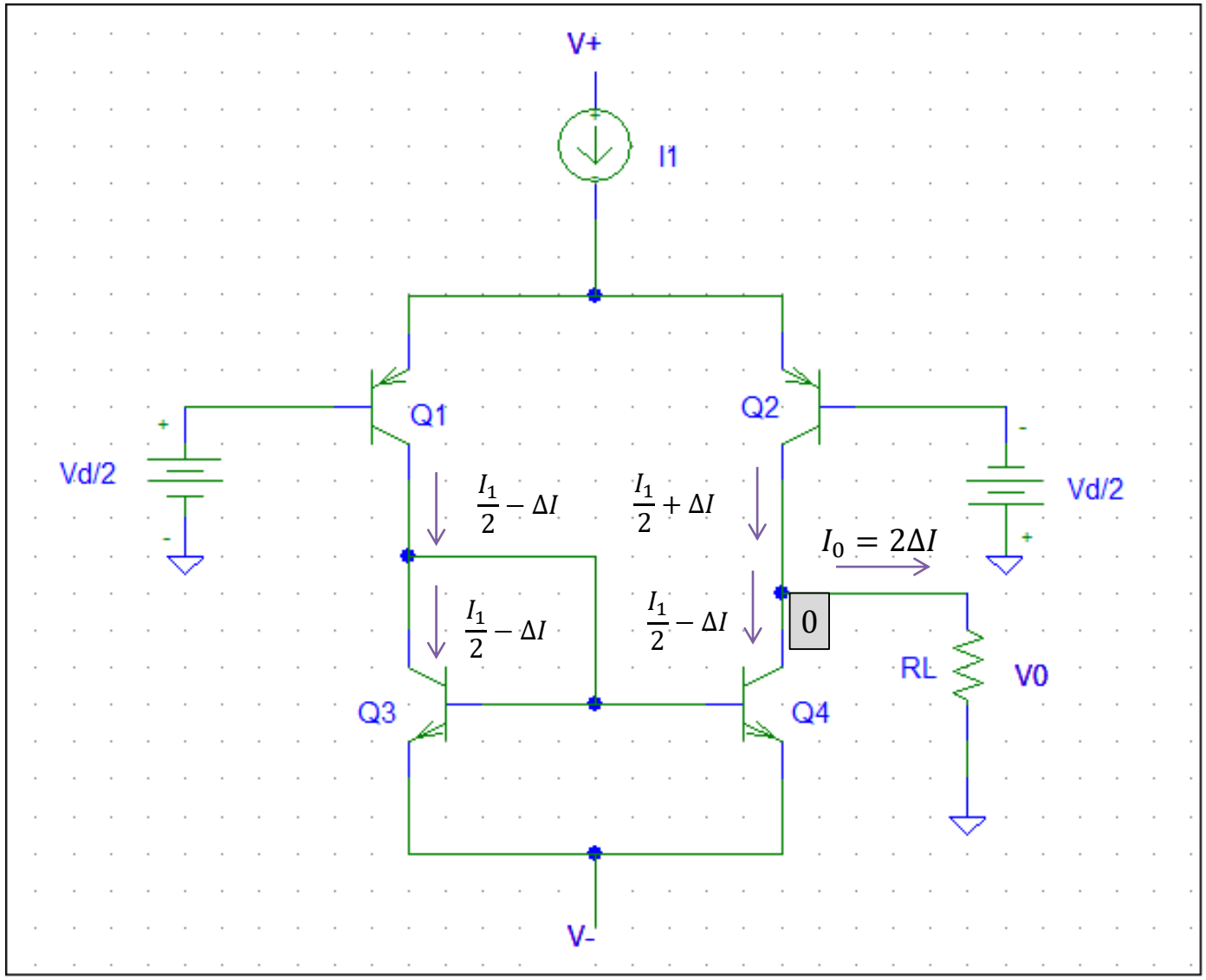
$$I_{C2} - I_{C4} - I_0 = 0$$

$$I_0 = I_{C2} - I_{C4}$$

$$I_0 = 0$$

$$V_0 = I_0 \times R_L \qquad V_0 = 0$$

AMPLIFICADOR DIFERENCIAL



$$V_d \neq 0$$

$$V_{BE1} \neq V_{BE2}$$

$$Q_1 \equiv Q_2$$

$$I_{C1} = \frac{I_1}{2} - \Delta I$$

$$I_{C2} = \frac{I_1}{2} + \Delta I$$

$$V_{BE3} = V_{BE4}$$

$$Q_3 \equiv Q_4$$

$$I_{C3} = I_{C4} = \frac{I_1}{2} - \Delta I$$

Corrientes del nodo 0

$$I_{C2} - I_{C4} - I_0 = 0$$

$$I_0 = I_{C2} - I_{C4}$$

$$I_0 = 2\Delta I$$

$$V_0 = I_0 \times R_L$$

$$V_0 = 2\Delta I \times R_L$$

$$\Delta I = g_m \times \frac{V_d}{2}$$

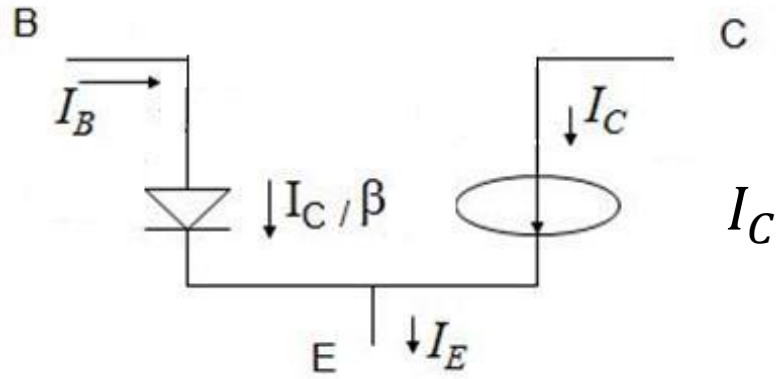
$$V_0 = V_d \times g_m \times R_L$$

$$\boxed{A_V = g_m \times R_L}$$

Modelo de polarización del TBJ

(Zona activa directa)

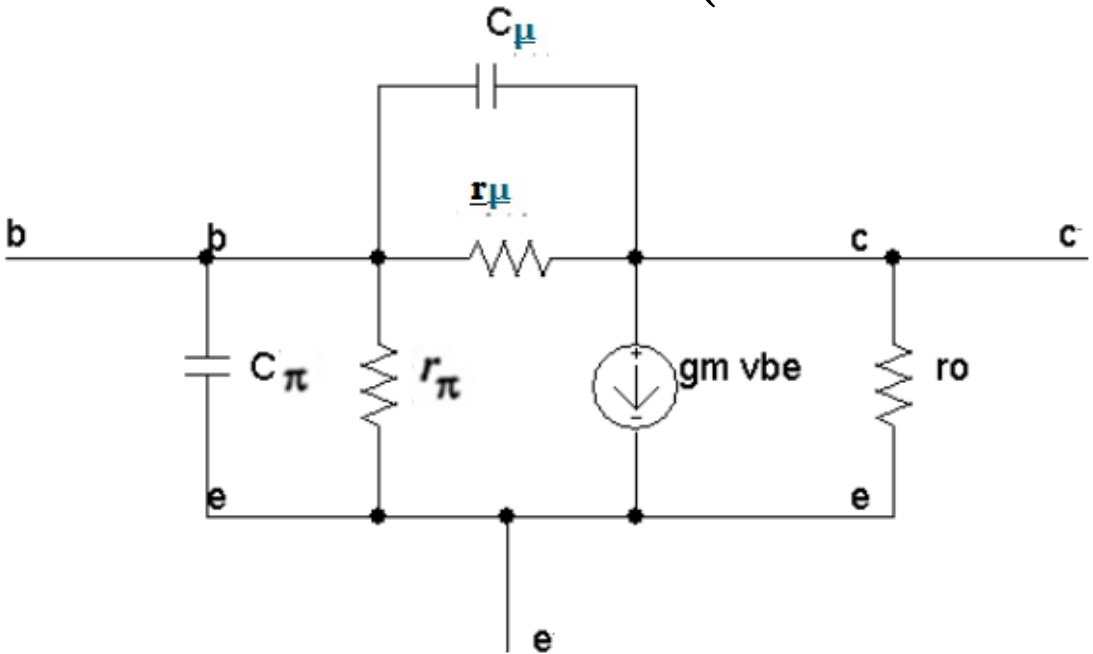
$$I_B = \frac{I_C}{\beta}$$



$$I_C = \left(1 + \frac{V_{CE}}{V_A}\right) I_S e^{\left(\frac{V_{BE}}{U_T}\right)}$$

Modelo de pequeña señal del TBJ

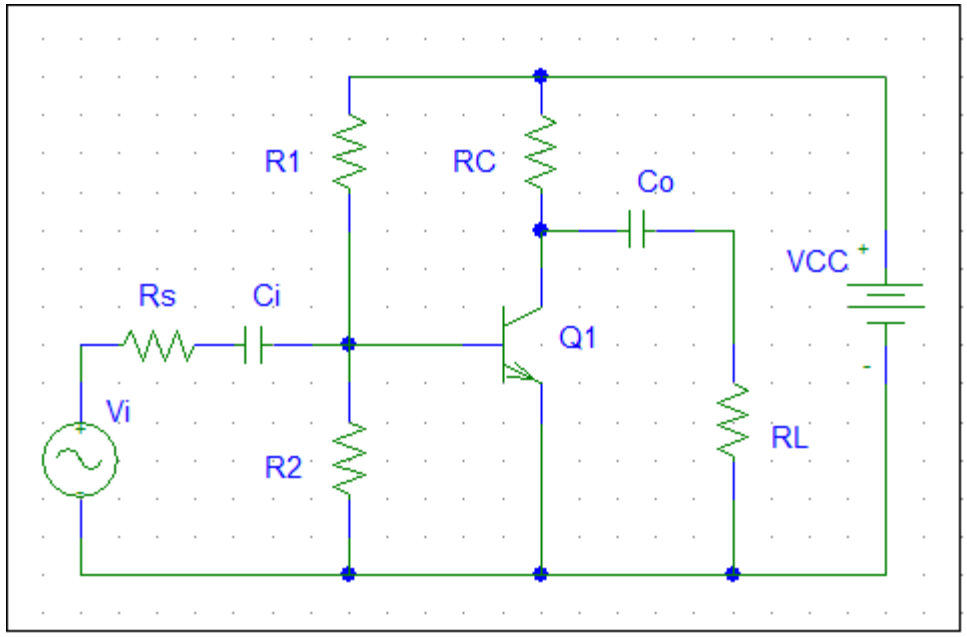
(Zona Activa Directa)



$$g_m = \frac{I_{Cp}}{U_T} \qquad r_\pi = \beta \frac{U_T}{I_{Cp}}$$

$$r_0 = \frac{V_A}{I_{Cp}} \qquad r_\mu = \beta \frac{V_A}{I_{Cp}}$$

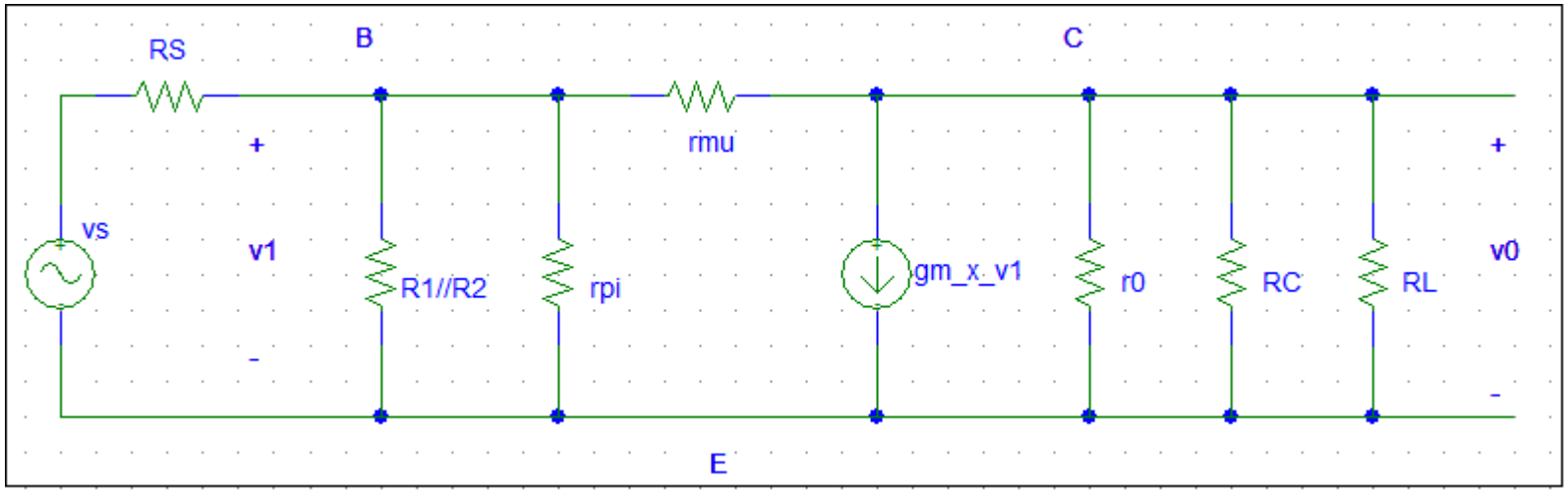
Amplificador con TBJ (Emisor Común)



$$g_m = \frac{I_{Cp}}{U_T} \qquad r_\pi = \beta \frac{U_T}{I_{Cp}}$$

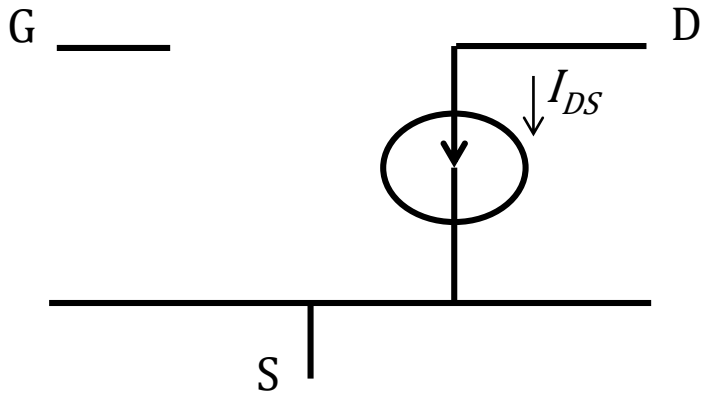
$$r_0 = \frac{V_A}{I_{Cp}} \qquad r_\mu = \beta \frac{V_A}{I_{Cp}}$$

$$A_v = -g_m(r_0 \,//\, R_C \,//\, R_L)\left[\frac{(R_1 \,//\, R_2 \,//\, r_\pi)}{R_s + (R_1 \,//\, R_2 \,//\, r_\pi)}\right]$$



Modelo de polarización del JFET

(Zona Saturación)



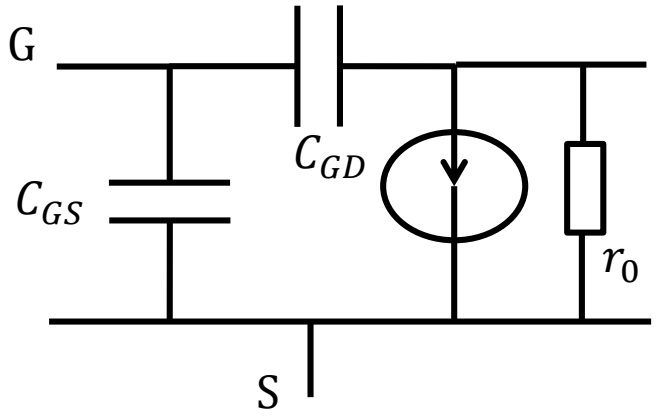
|VGS| < |VP|

VDS – VGS > VP

$$I_{DS} = (1 + \lambda V_{DS})\, I_{DSS} \left(1 - \frac{V_{GS}}{V_P}\right)^2$$

Modelo de pequeña señal del JFET

(Zona Saturación)

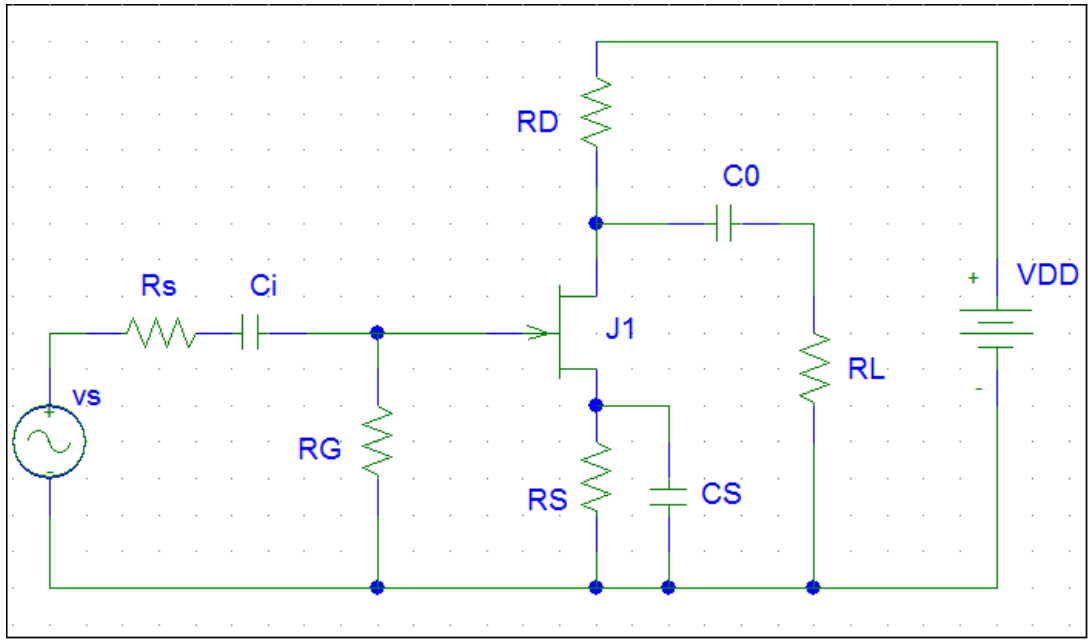


$$i_{DS} = g_m v_{GS}$$

$$g_m = -2\frac{I_{DSS}}{V_P}\left(1 - \frac{V_{GSp}}{V_P}\right)$$

$$r_0 = \frac{1}{\lambda \times I_{DSp}}$$

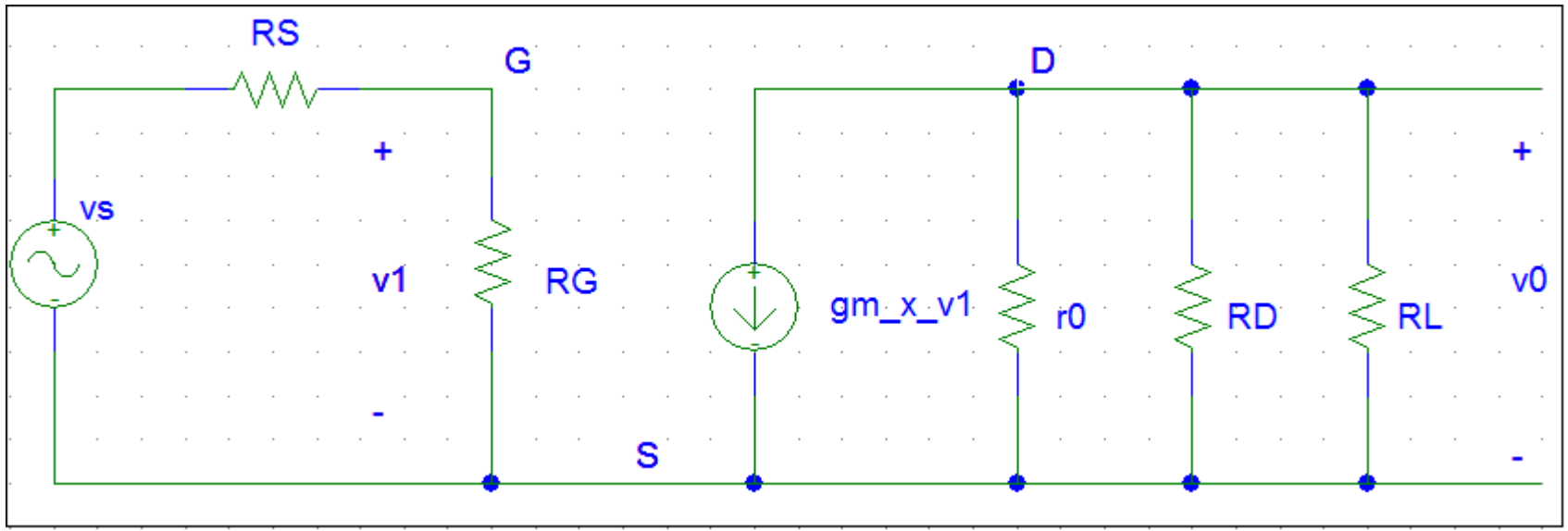
Amplificador con JFET (Fuente Común)



$$g_m = -2\frac{I_{DSS}}{V_P}\left(1 - \frac{V_{GSp}}{V_P}\right)$$

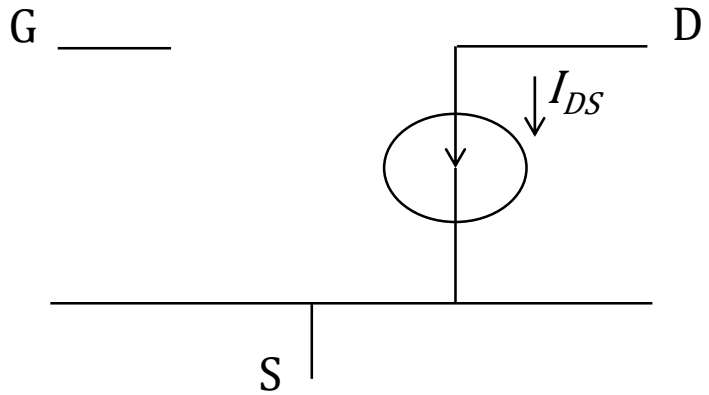
$$r_0 = \frac{1}{\lambda \times I_{DSp}}$$

$$A_v = -g_m(r_0 \,//\, R_D \,//\, R_L)\left[\frac{R_G}{R_s + R_G}\right]$$



Modelo de polarización del MOSFET

(Zona Saturación)



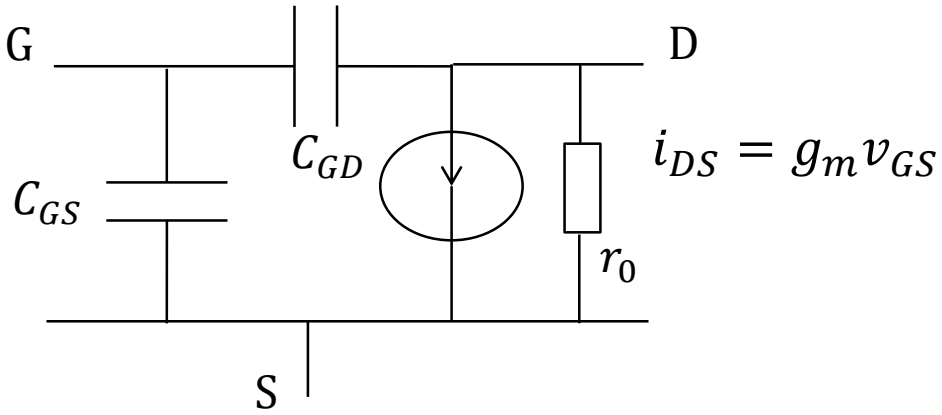
$$V_{GS} \geq V_{TH}$$

$$V_{GS} - V_{DS} \leq V_{TH}$$

$$I_{DS} = (1 + \lambda V_{DS}) \frac{\beta}{2} (V_{GS} - V_{TH})^2$$

Modelo de pequeña señal del MOSFET

(Zona Saturación)

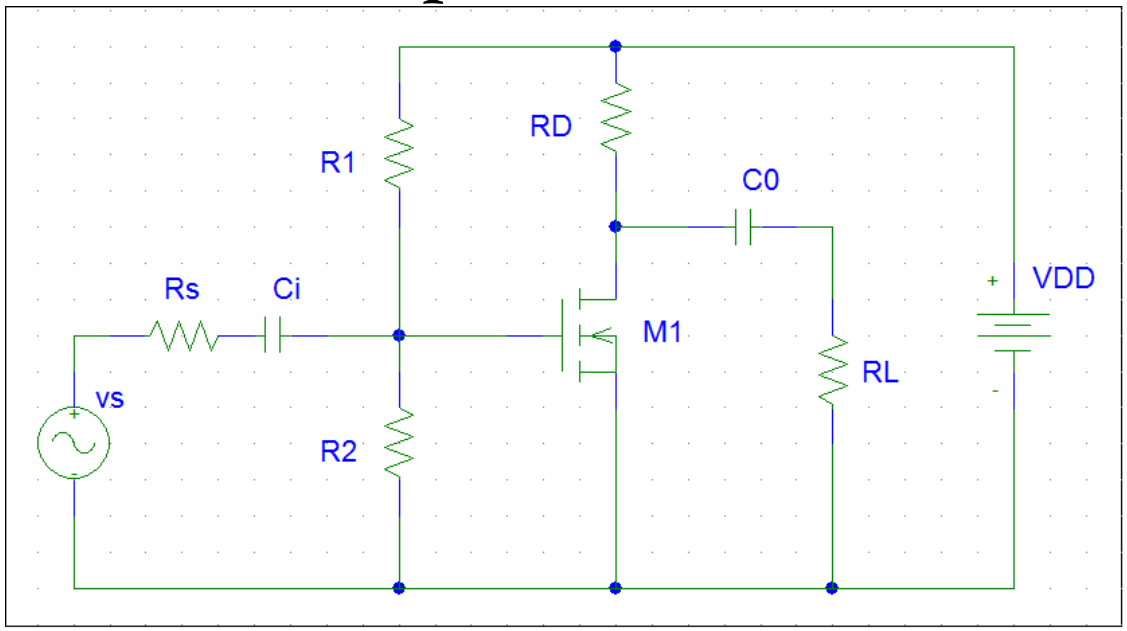


$$i_{DS} = g_m v_{GS}$$

$$g_m = \beta\left(V_{GSp} - V_{TH}\right)$$

$$r_0 = \frac{1}{\lambda \times I_{DSp}}$$

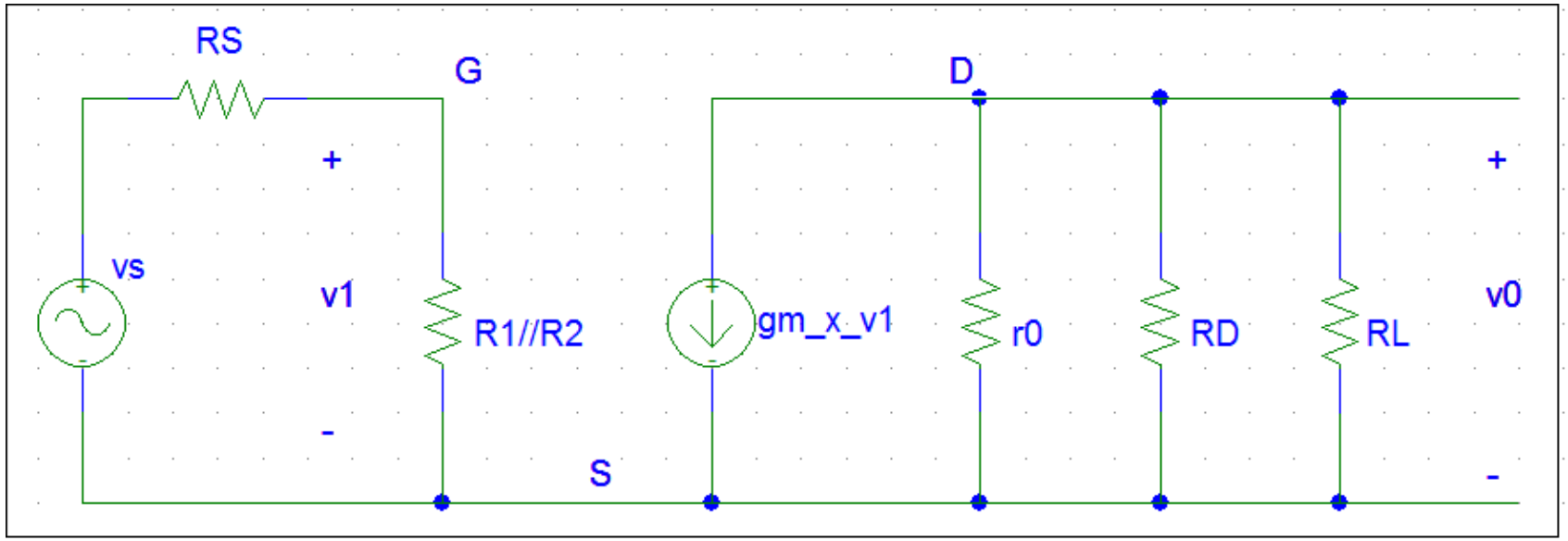
Amplificador con MOSFET (Fuente Común)



$$g_m = \beta\left(V_{GSp} - V_{TH}\right)$$

$$r_0 = \frac{1}{\lambda \times I_{DSp}}$$

$$A_v = -g_m(r_0 \,//\, R_D \,//\, R_L)\left[\frac{(R_1 \,//\, R_2)}{R_s + (R_1 \,//\, R_2)}\right]$$



Comparación de Amplificadores TBJ – JFET - MOSFET

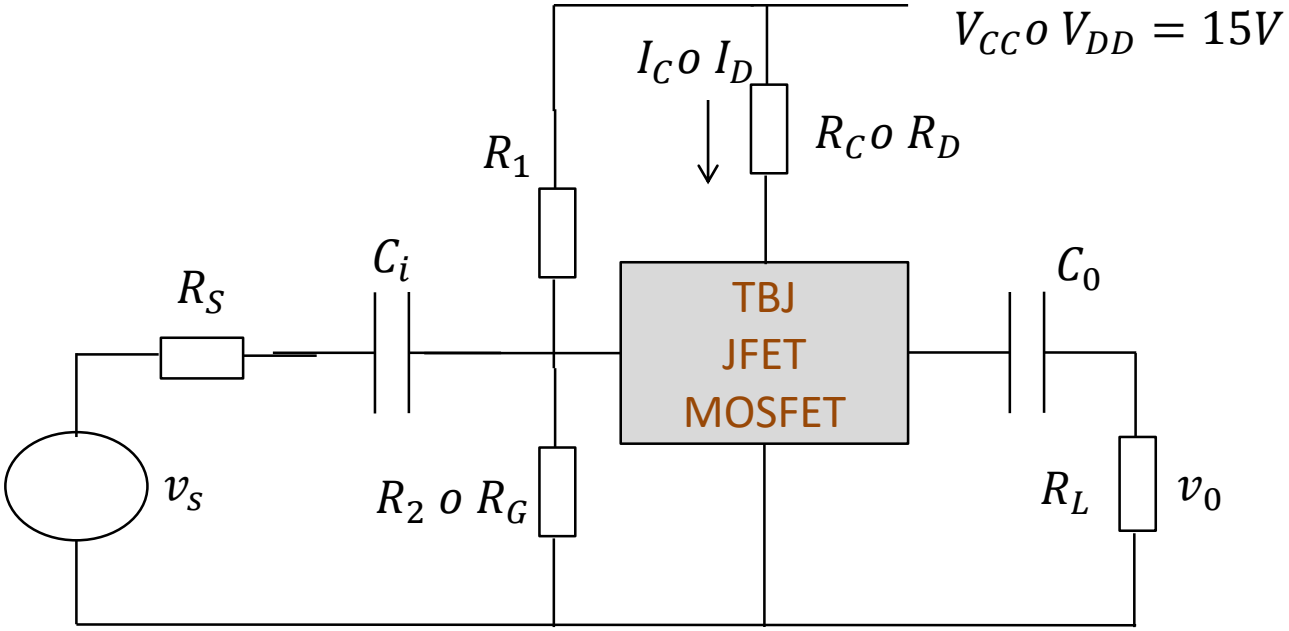
Tensión alimentación (VCC o VDD) = 15 V

Corriente de polarización (IC o ID)= 1mA

Resistencia RL = 10 KΩ

Tensión polarización (VCE o VDS) = 5 V

Resistencia RS = 1 KΩ



Comparación de Amplificadores TBJ – JFET - MOSFET

PARAMETROS

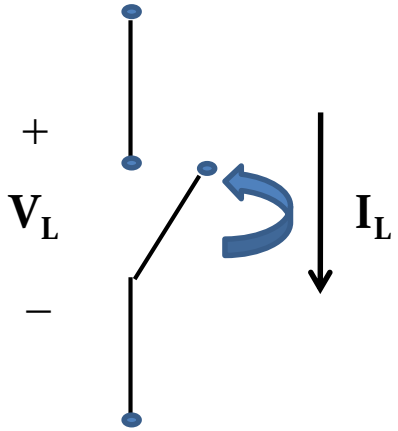
	β	I_S (A)	V_A (V)
TBJ	100	10^{-12}	100

	V_P (V)	I_{DSS} (A)	λ
JFET (N)	-4	2×10^{-3}	0,01

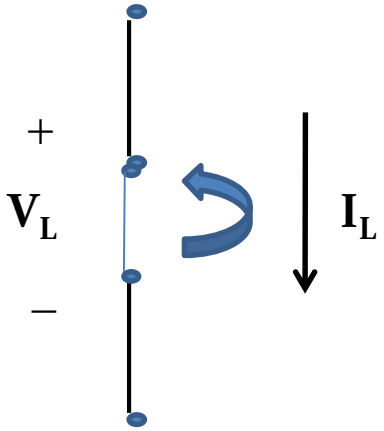
	V_{TH} (V)	$\beta \left(A/V^2\right)$	λ
MOSFET (N)	4	1×10^{-3}	0,01

	TBJ	JFET	MOSFET
Av	-84	-3.3	-5.7
Ri	1.7KΩ	1MΩ	1MΩ
R0	10KΩ//100KΩ	8.8KΩ//100KΩ	10KΩ//100KΩ

Llave Ideal



OFF



ON

$R_{OFF} = \infty \Rightarrow I_L = 0$

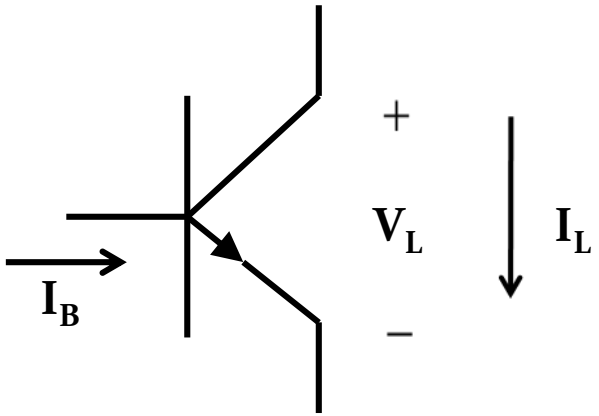
$R_{ON} = 0 \Rightarrow V_L = 0$

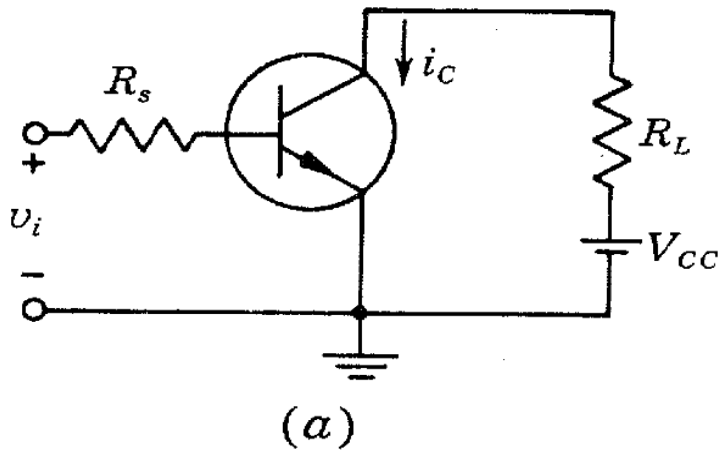
No disipa Potencia $V_L \times I_L = 0$

$t_{ON} = t_{OFF} = 0$ → Tiempo de Conmutación

Energía de Accionamiento = 0

TRANSISTOR COMO LLAVE





(a)

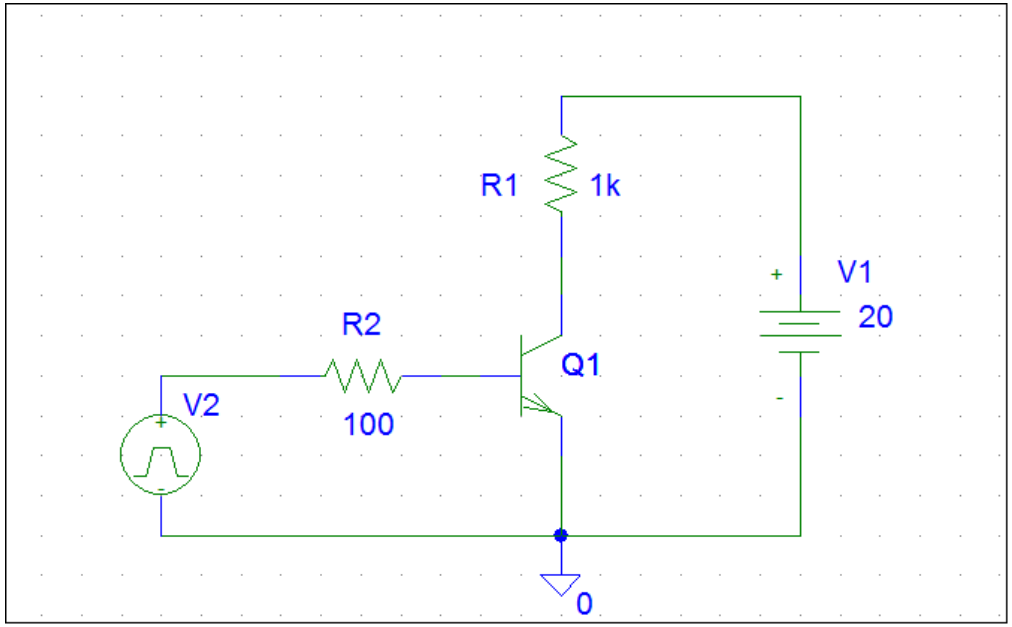
OFF:: $I_B = o \Rightarrow I_L = I_{CBo} \approx \mu A \Rightarrow$ Junturas Inversas

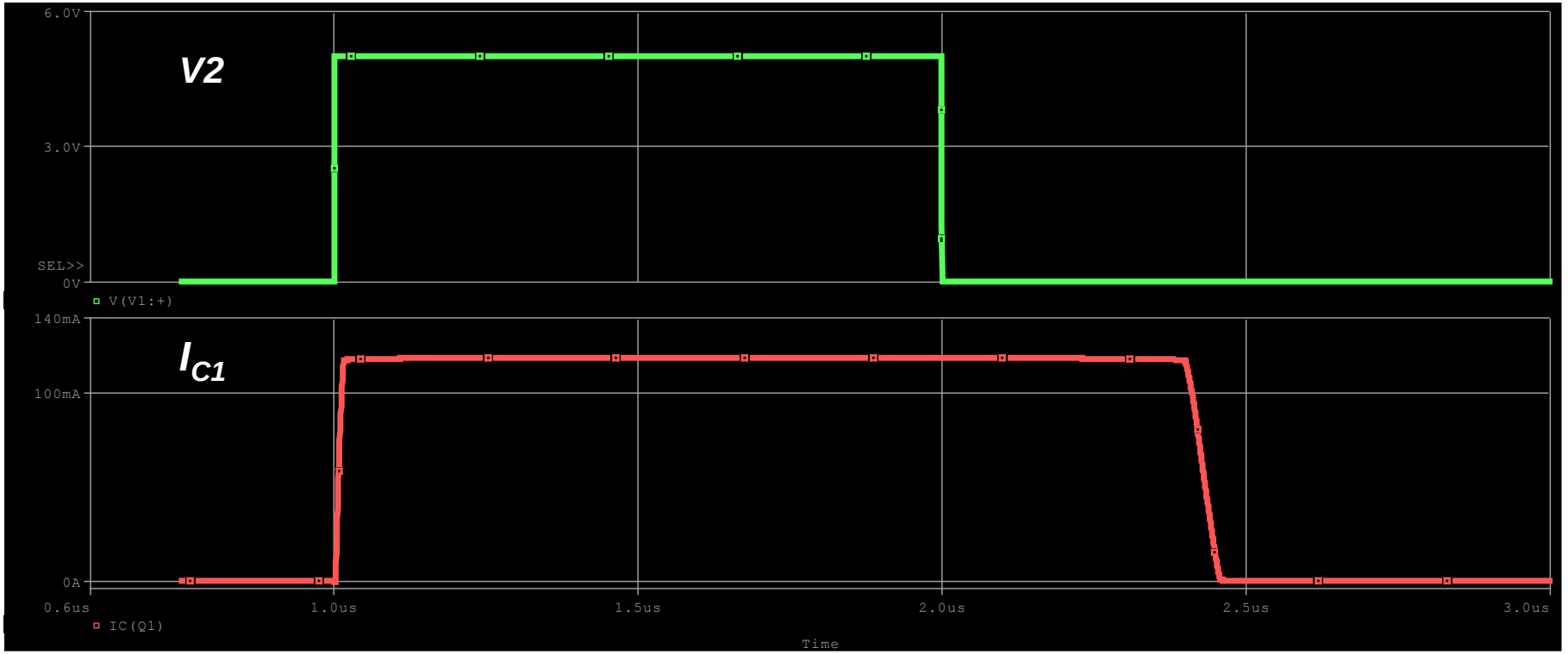
ON: $I_B \neq o \Rightarrow V_L = V_{CESAT} \approx 0{,}1\ V \Rightarrow$ Junturas Directas

ON a OFF => Saturación a Corte

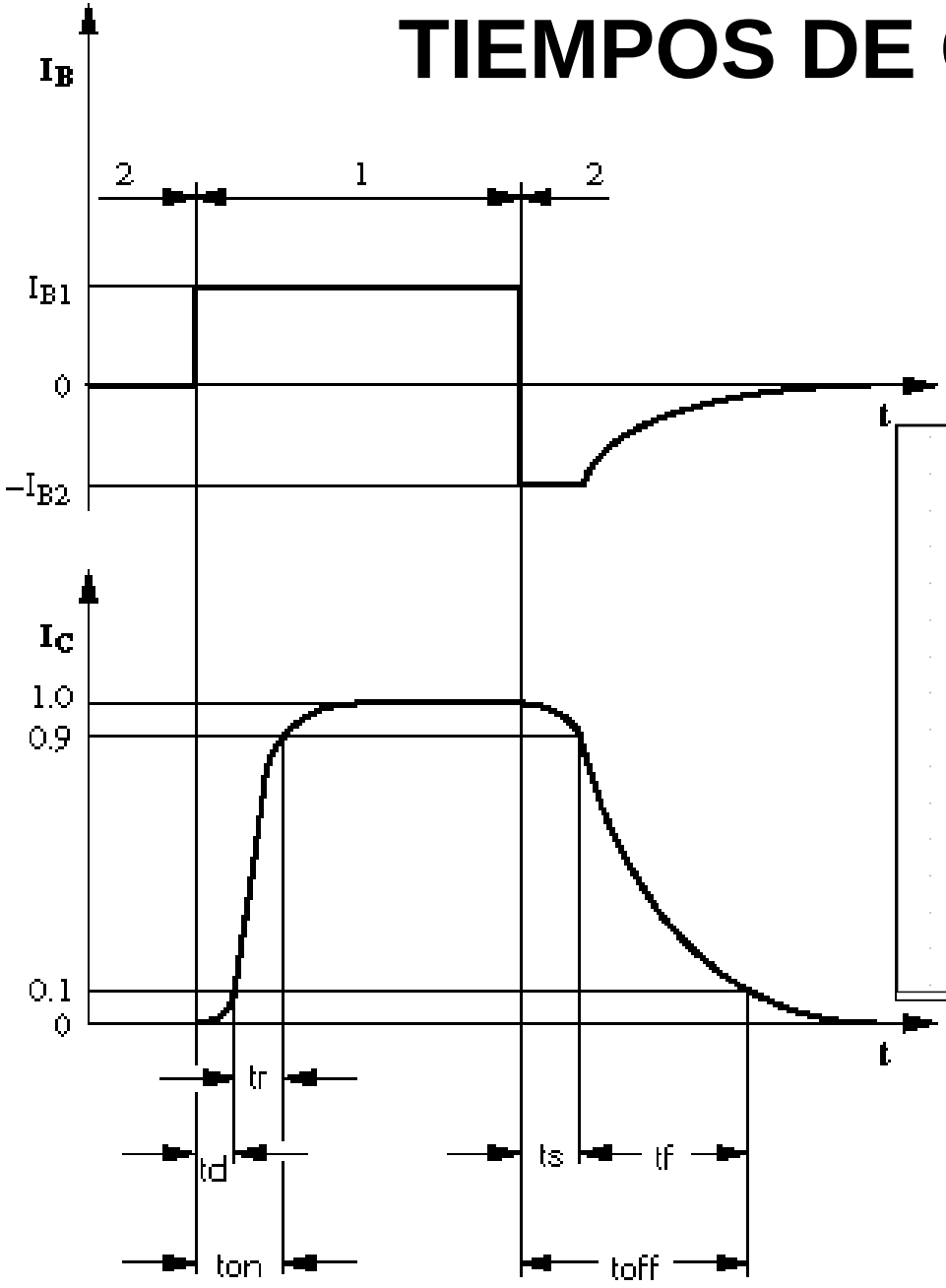
OFF a ON => Corte a Saturación

TIEMPOS DE CONMUTACION

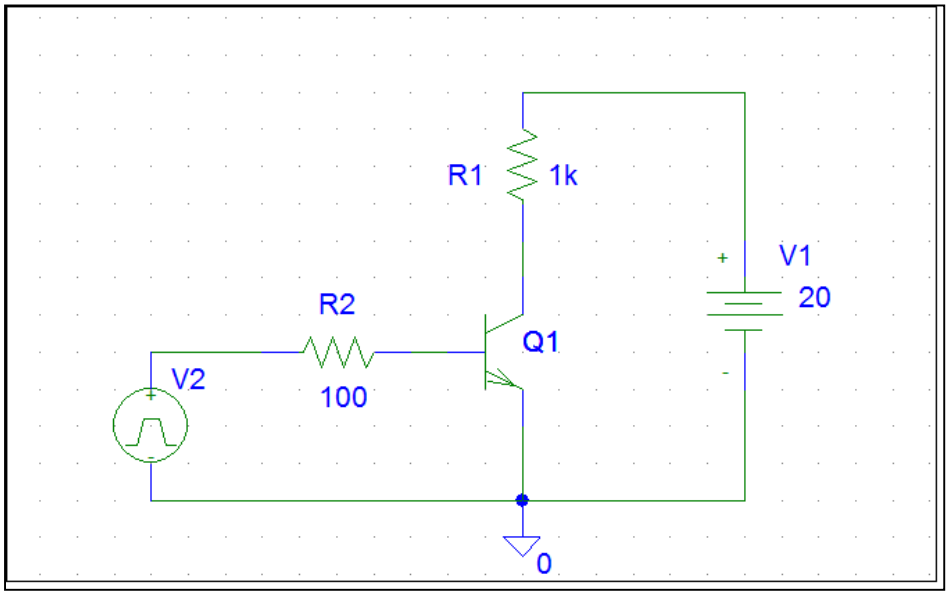




TIEMPOS DE CONMUTACION



I_c vs I_B



TBJ - Saturación