

Tema 5. Amplificadores Multietapa

- Acoplamiento Directo
- Acoplamiento Capacitivo

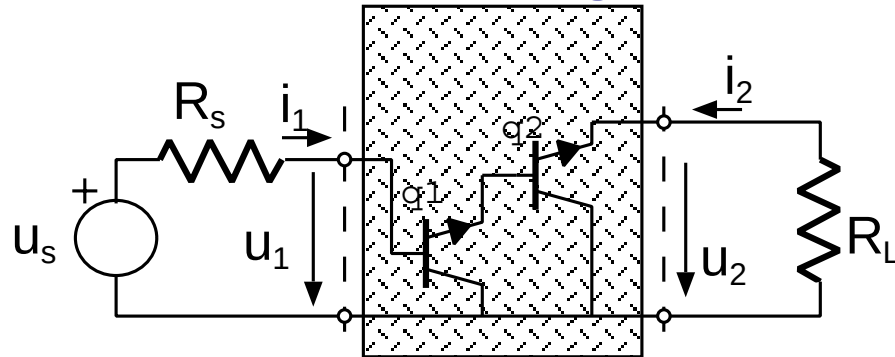
Bibliografía

“Circuitos Electronicos”, Norbert R. Malik, Prentice Hall

“Microelectrónica”, Jacob Millman & Arvin Gravel, McGraw Hill

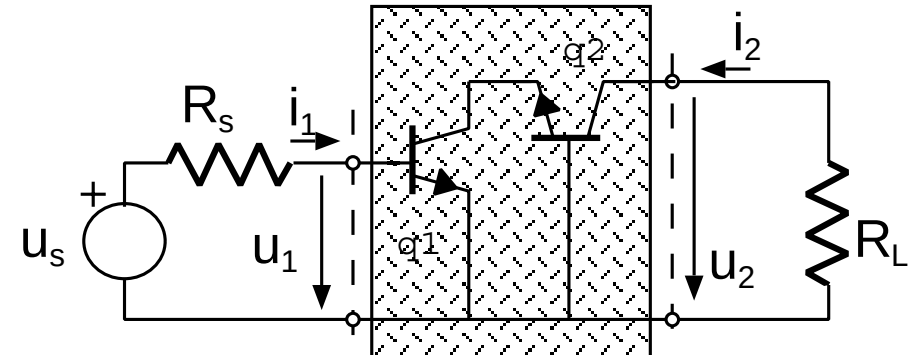
Acoplamiento Directo: *Composite Stages*

Amplificador CC-CC: Darlington Pair



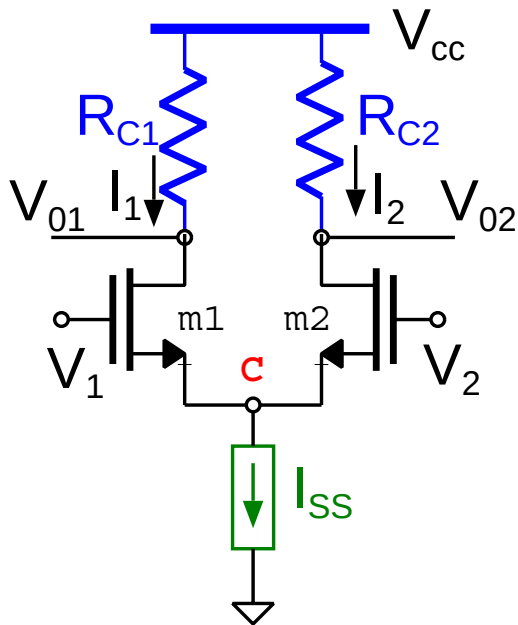
- $R_i \simeq r_{\pi 1} + h_{fe1} (r_{\pi 2} + h_{fe2} R_L)$
- $R_o \simeq \frac{r_{\pi 2}}{h_{fe2}}$
- $A_i \simeq h_{fe1} h_{fe2}$
- $A_v \simeq 1$

Amplificador EC-BC: Cascode Pair



- $R_i \simeq r_{\pi 1}$
- $R_o \simeq h_{fe2} r_{o2}$
- $A_i \simeq h_{fe1}$
- $A_v \simeq \frac{h_{fe1} R_c}{R_s + r_{\pi 1}}$

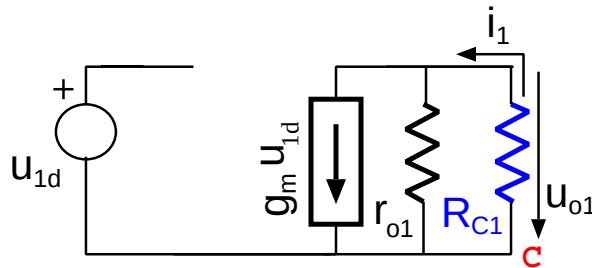
Amplificador Diferencial



Se suele imponer la **condición de simetría**: transistores idénticos y $R_{C1} = R_{C2}$.

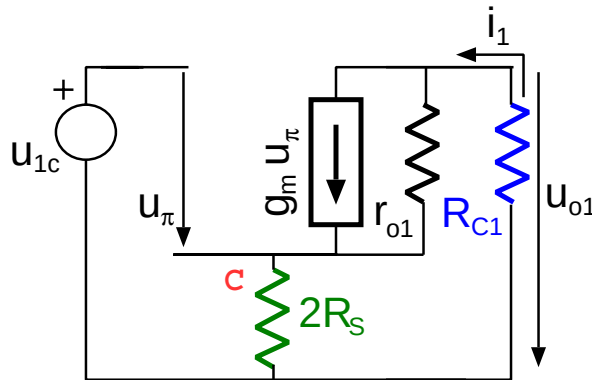
Analicemos la **polarización**, suponemos que existe simetría eléctrica: $I_1 = I_2$, $V_{GS1} = V_{GS2}$, $V_{O1} = V_{O2}$

$$\begin{aligned} I_1 + I_2 &= I_{SS} \\ V_{O1} &= V_{CC} - R_C I_1 \\ V_{O1} = V_{O2} &= V_{CC} - R_C I_{SS}/2 \end{aligned}$$



$$\begin{aligned} V_1(t) &= V_{in} + u_d(t)/2 & ; & & V_2(t) &= V_{in} - u_d(t)/2 \\ u_1(t) &= -u_2(t) & \rightarrow & & i_1(t) &= -i_2(t) \\ u_{o1} &= g_{m1}(r_{o1} \parallel R_{C1})u_1(t) \\ u_o(t) = u_{o1}(t) - u_{o2}(t) &= g_{m1}(r_{o1} \parallel R_{C1})u_d(t) \end{aligned}$$

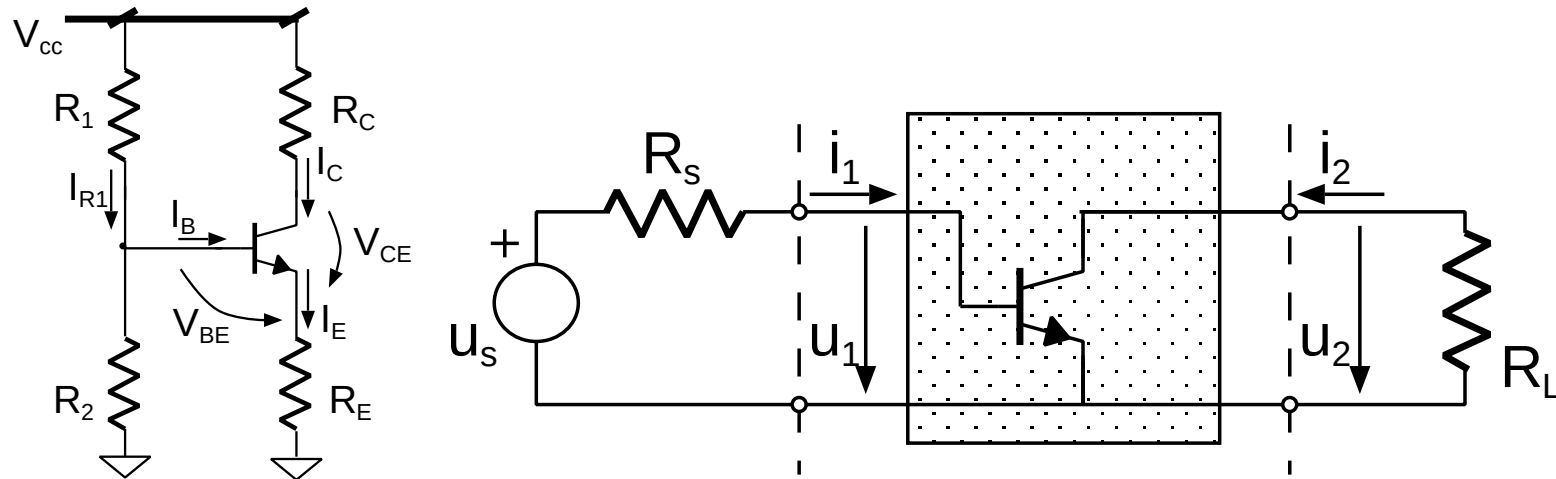
Procediendo **modo común**:



$$\begin{aligned} V_1(t) &= V_{in} + u_c(t) & ; & & V_2(t) &= V_{in} + u_c(t) \\ u_{o1}(t) &\simeq \frac{R_{C1}}{2 R_s} u_c(t) \end{aligned}$$

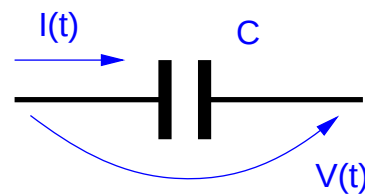
Comportamiento dinámico en **modo diferencial**:

Acoplamiento Capacitivo: *Capacitive Coupling*

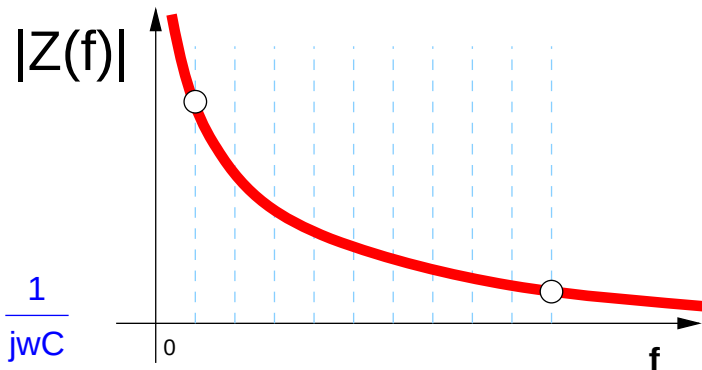


- Polarización transistor (comp. estático: DC)

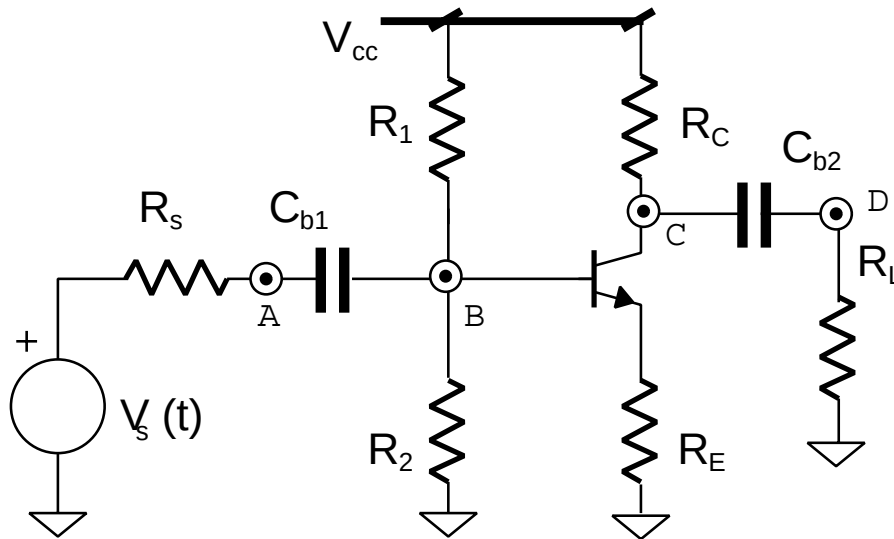
- Señal/Carga conectada (comp. dinámico: AC)



$$Z = \frac{V(j\omega)}{I(j\omega)} = \frac{1}{j\omega C}$$



Acoplamiento Capacitivo: *Capacitive Coupling*



- AC: Capacidad acoplo
- DC: Capacidad bloqueo

