

Feedback Amplifiers

INEL4202 9/24/09

Table 12.1

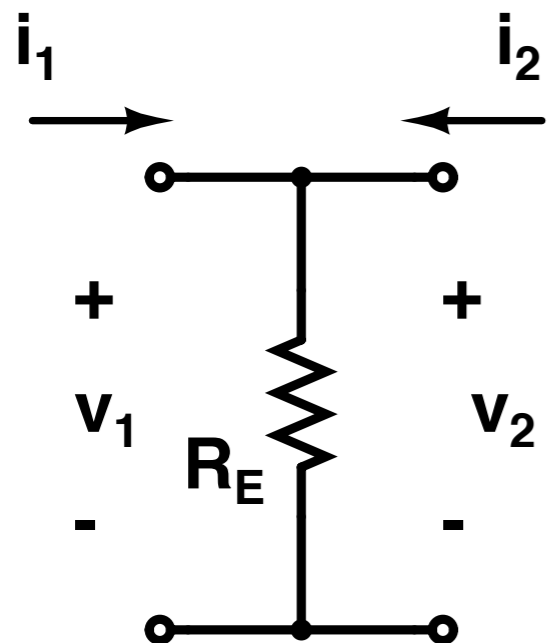
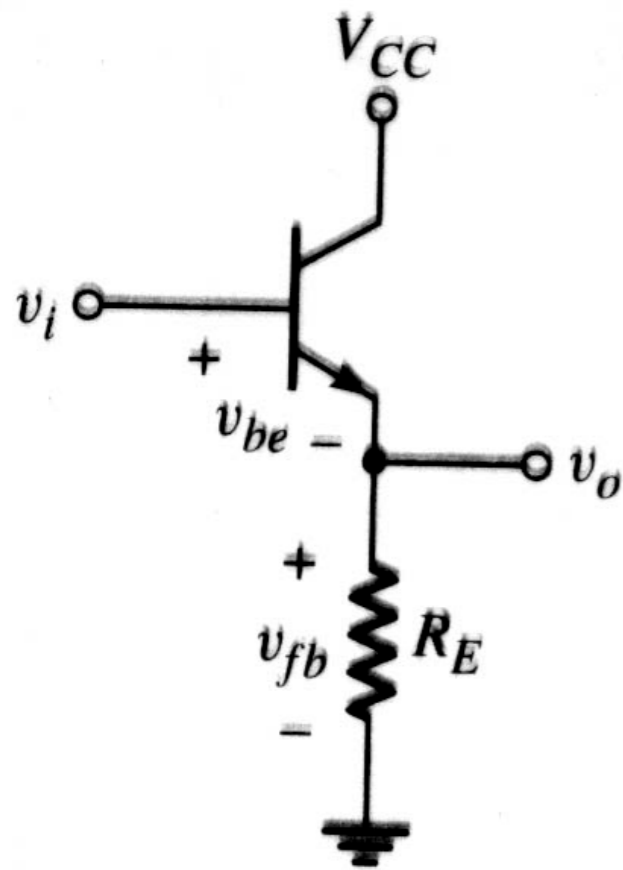
Summary results of feedback amplifier functions for the ideal feedback circuit

Feedback amplifier	Source signal	Output signal	Transfer function	Input resistance	Output resistance
Series–shunt (voltage amplifier)	Voltage	Voltage	$A_{vf} = \frac{V_o}{V_i} = \frac{A_v}{(1 + \beta_v A_v)}$	$R_i(1 + \beta_v A_v)$	$\frac{R_o}{(1 + \beta_v A_v)}$
Shunt–series (current amplifier)	Current	Current	$A_{if} = \frac{I_o}{I_i} = \frac{A_i}{(1 + \beta_i A_i)}$	$\frac{R_i}{(1 + \beta_i A_i)}$	$R_o(1 + \beta_i A_i)$
Series–series (transconductance amplifier)	Voltage	Current	$A_{gf} = \frac{I_o}{V_i} = \frac{A_g}{(1 + \beta_z A_g)}$	$R_i(1 + \beta_z A_g)$	$R_o(1 + \beta_z A_g)$
Shunt–shunt (transresistance amplifier)	Current	Voltage	$A_{zf} = \frac{V_o}{I_i} = \frac{A_z}{(1 + \beta_g A_z)}$	$\frac{R_i}{(1 + \beta_g A_z)}$	$\frac{R_o}{(1 + \beta_g A_z)}$

	series-shunt	series-series	shunt-series	shunt-shunt
input source	Thevenin	Thevenin	Norton	Norton
output source	Norton	Thevenin	Thevenin	Norton
R_{11}	$\frac{v_1}{i_1} \mid v_2=0$	$\frac{v_1}{i_1} \mid i_2=0$	$\frac{v_1}{i_1} \mid i_2=0$	$\frac{v_1}{i_1} \mid v_2=0$
β	$\frac{v_1}{v_2} \mid i_1=0$	$\frac{v_1}{i_2} \mid i_1=0$	$\frac{i_1}{i_2} \mid v_1=0$	$\frac{i_1}{v_2} \mid v_1=0$
R_{22}	$\frac{v_2}{i_2} \mid i_1=0$	$\frac{v_2}{i_2} \mid i_1=0$	$\frac{v_2}{i_2} \mid v_1=0$	$\frac{v_2}{i_2} \mid v_1=0$

Series-shunt (voltage amplifier)

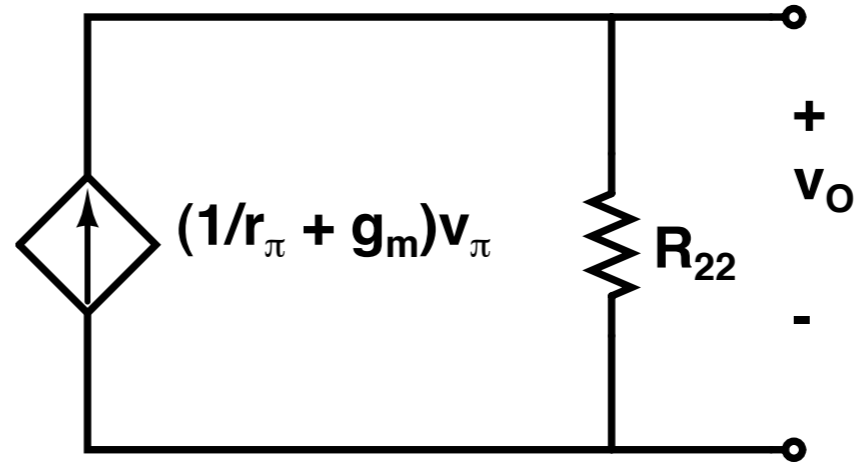
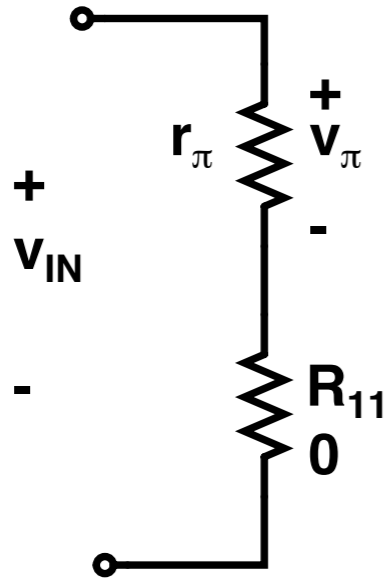
- Es mas fácil analizarlo como hasta ahora
- No es un buen ejemplo de analisis de “feedback”



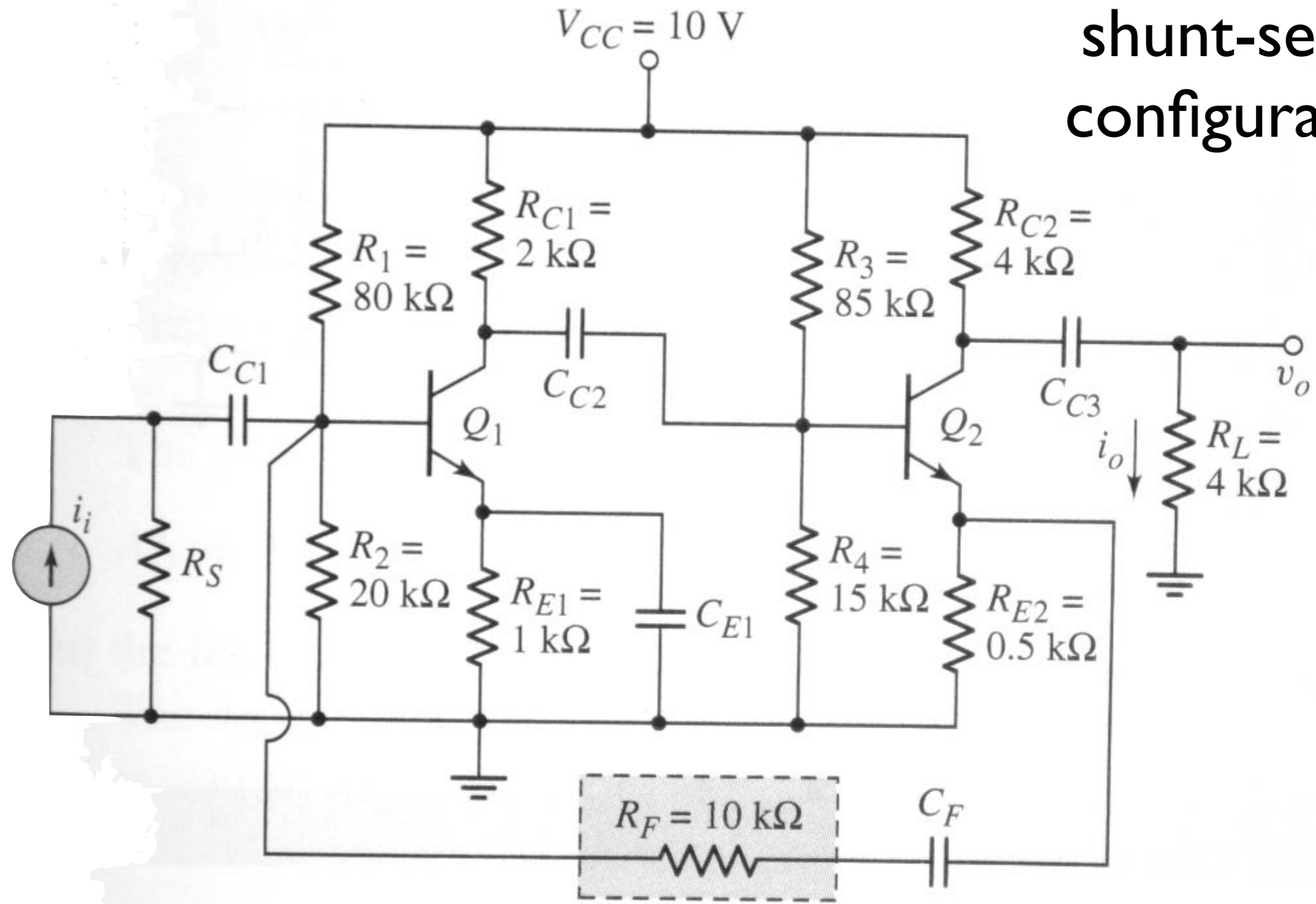
$$\beta_v = \frac{v_1}{v_2} \Big|_{i_1=0} = 1$$

$$R_{11} = \frac{v_1}{i_1} \Big|_{v_2=0} = 0$$

$$R_{22} = \frac{v_2}{i_2} \Big|_{i_1=0} = R_E$$

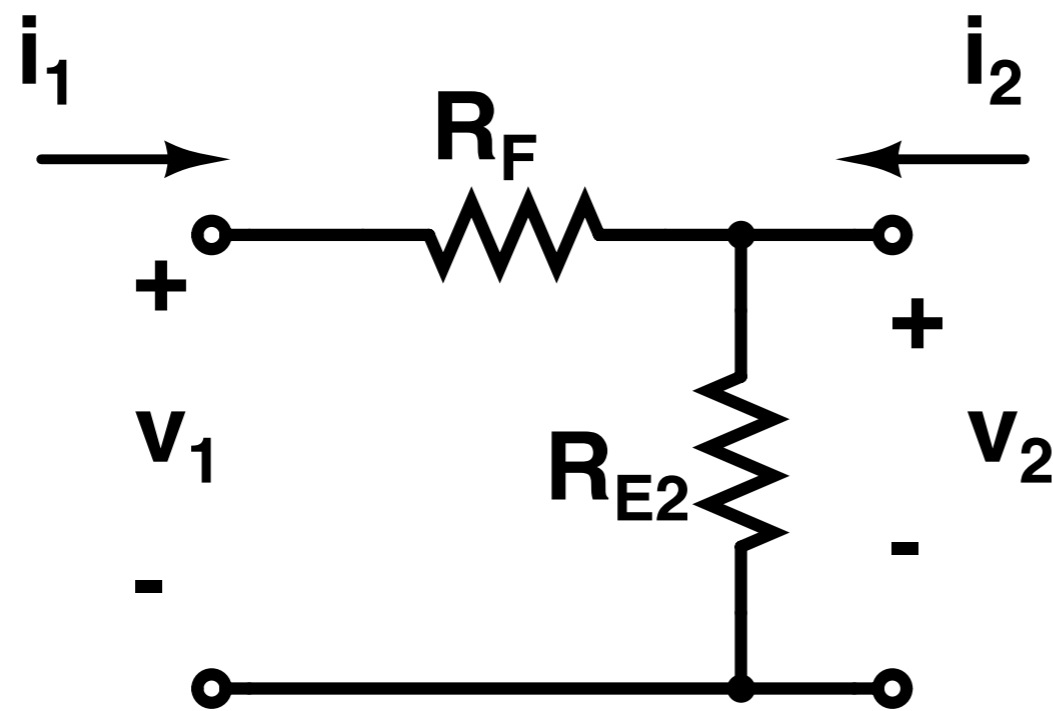


shunt-series configuration



Use i_{c2} as output

$$i_o = -i_{C2} \frac{R_{C2}}{R_{C2} + R_L}$$



$$i_{C1} = 1.11mA$$

$$r_{\pi_1} = 2.34k\Omega$$

$$i_{C2} = 1.26mA$$

$$r_{\pi_2} = 2056\Omega$$

$$\beta_i = \frac{i_1}{i_2} \Big|_{v_1=0} = -\frac{R_{E2}}{R_{E2} + R_F} = -\frac{1}{21}$$

$$R_{11} = \frac{v_1}{i_1} \Big|_{i_2=0} = R_{E2} + R_F = 10.5k\Omega$$

$$R_{22} = \frac{v_2}{i_2} \Big|_{v_1=0} = R_{E2} \parallel R_F = 476\Omega$$

Series-series configuration

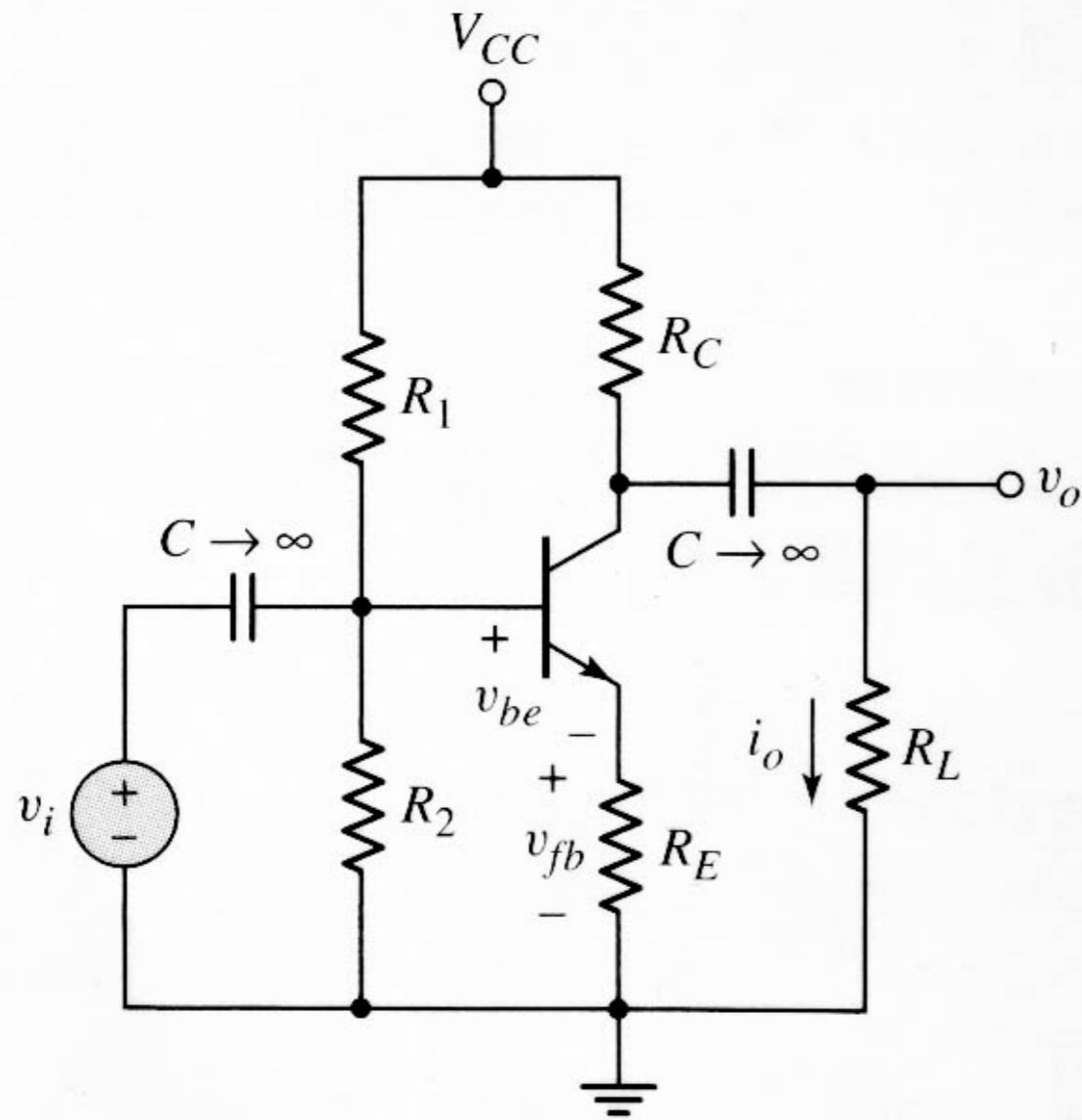
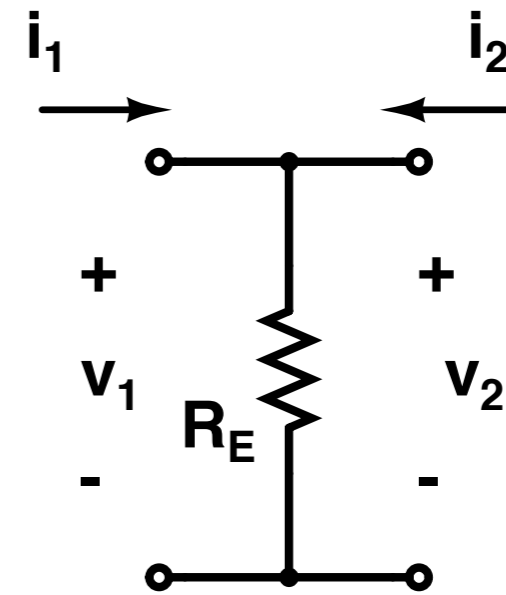


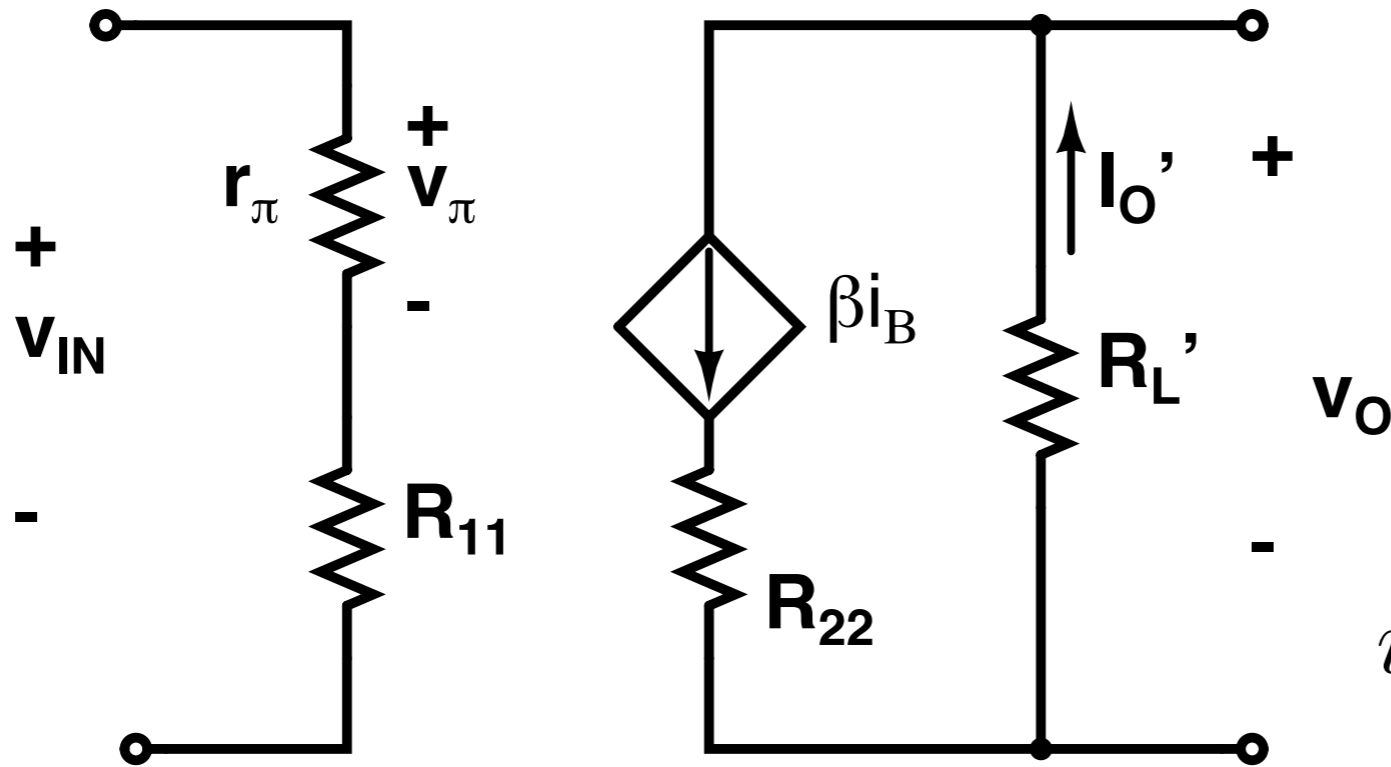
Figure 12.29 Example of a discrete transistor series-series feedback circuit



$$\beta_i = \frac{v_1}{i_2} \Big|_{i_1=0} = R_E$$

$$R_{11} = \frac{v_1}{i_1} \Big|_{i_2=0} = R_E$$

$$R_{22} = \frac{v_2}{i_2} \Big|_{i_1=0} = R_E$$



Taking i_c as
the output
current

$$i_O = -i_O' \frac{R_C}{R_C + R_L}$$

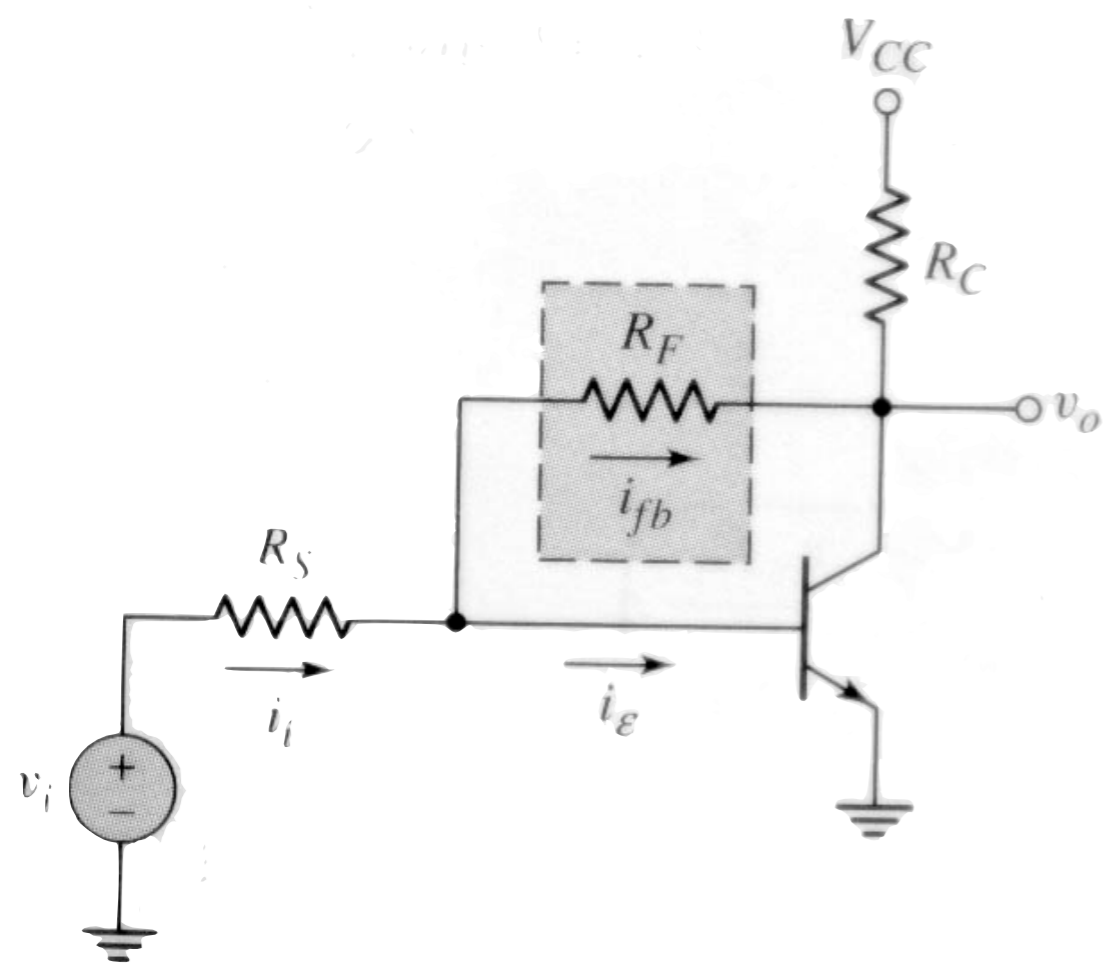
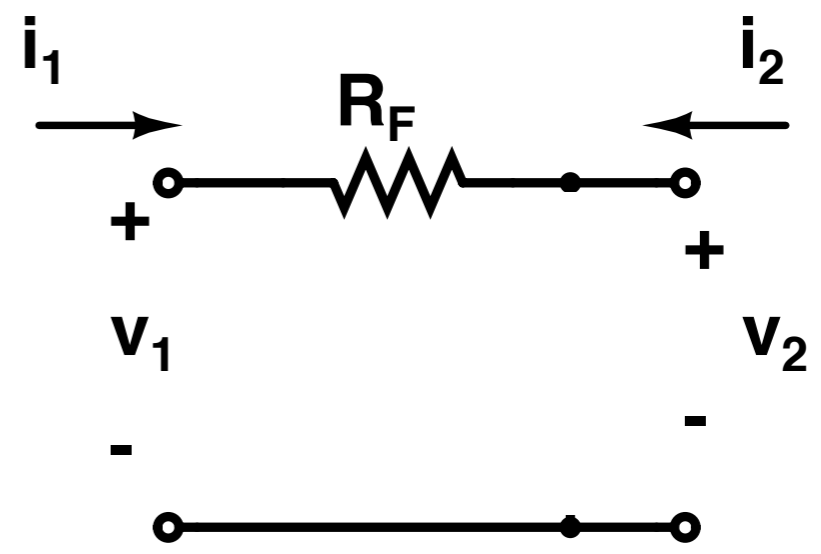


Figure 12.35 Example of a discrete transistor shunt-shunt feedback circuit



$$\beta = \frac{i_1}{v_2} \Big|_{v_1=0} = -\frac{1}{R_F}$$

$$R_{11} = \frac{v_1}{i_1} \Big|_{v_2=0} = R_F$$

$$R_{22} = \frac{v_2}{i_2} \Big|_{v_1=0} = R_F$$

*12.34 Consider the voltage amplifier in Figure P12.34. The op-amp parameters are $A_v = 5 \times 10^3$, $R_i = 10 \text{ k}\Omega$, and $R_o = 1 \text{ k}\Omega$, and the transistor parameters are $h_{FE} = 100$ and $V_A = 80 \text{ V}$. Determine A_{vf} , R_{if} , and R_{of} .

12.35 The circuit in Figure P12.35 is an example of a series-shunt feedback circuit. Assume the transistor parameters are: $h_{FE} = 100$, $V_{BE(\text{on})} = 0.7 \text{ V}$, and $V_A = \infty$. (a) Determine the quiescent collector currents and the dc voltage at the output. (b) Determine the small-signal voltage gain $A_{vf} = v_o/v_i$.

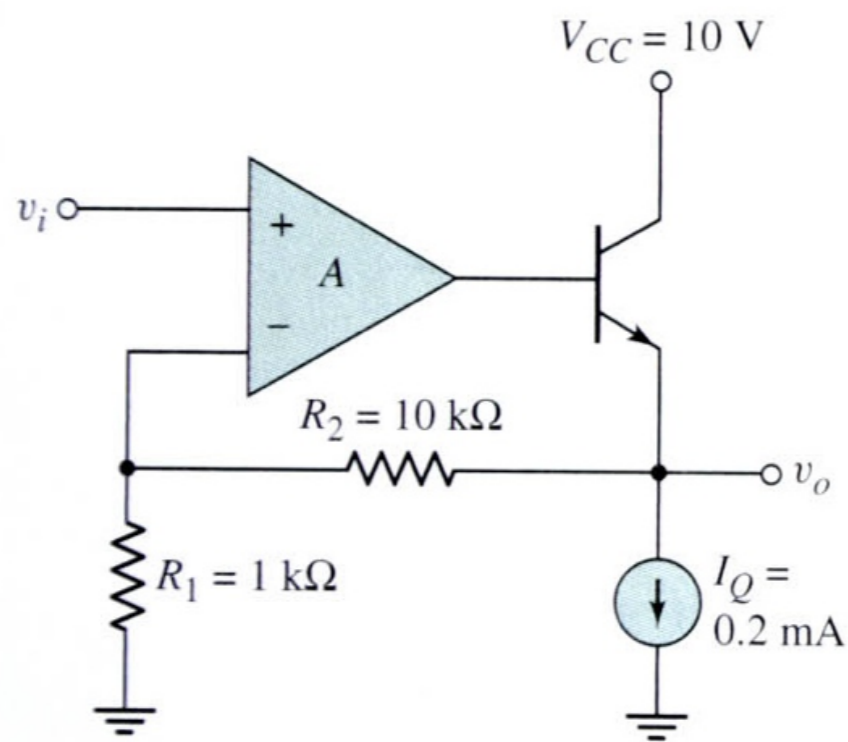


Figure P12.34

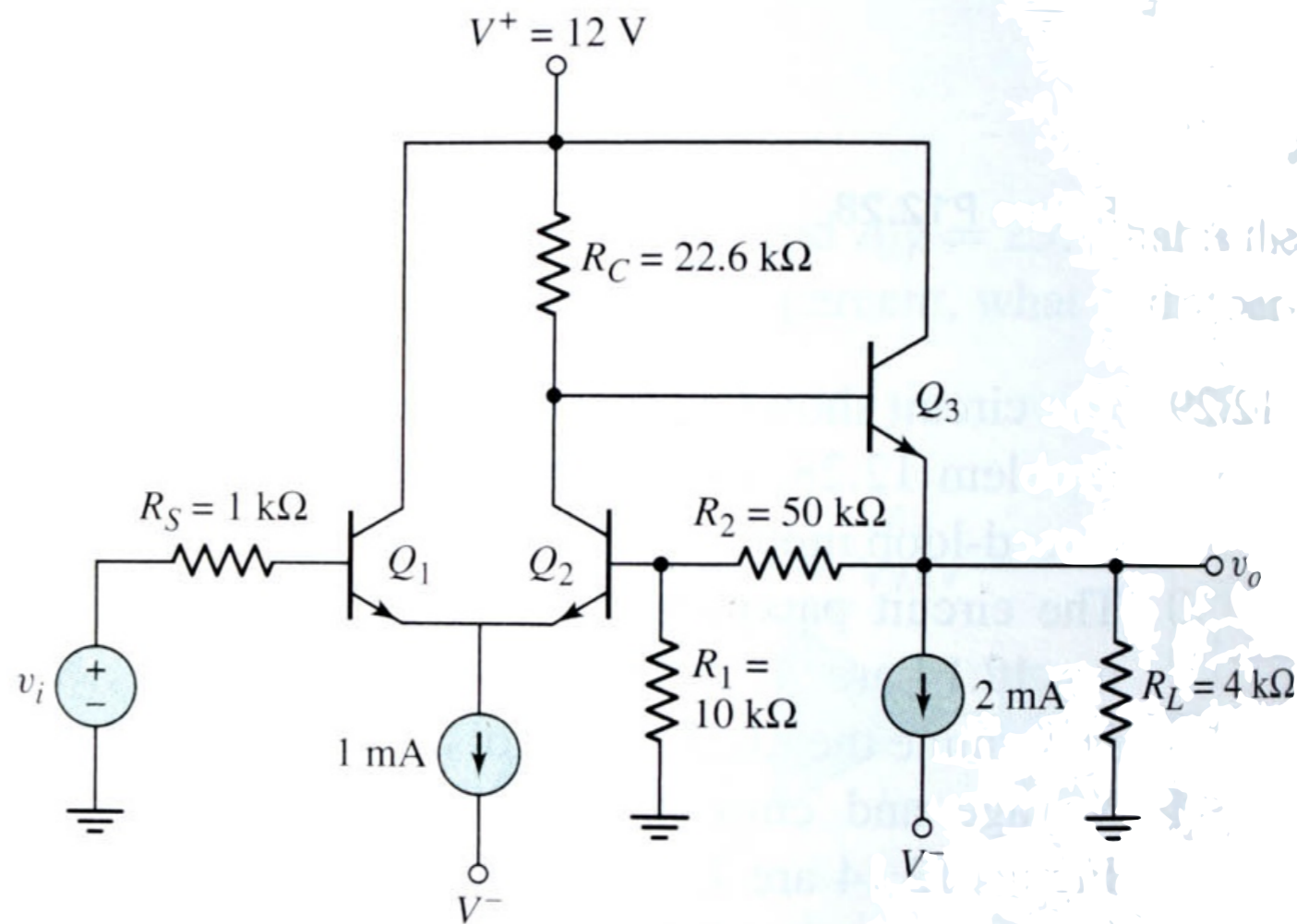


Figure P12.35