FEEDBACK AMPLIFIERS

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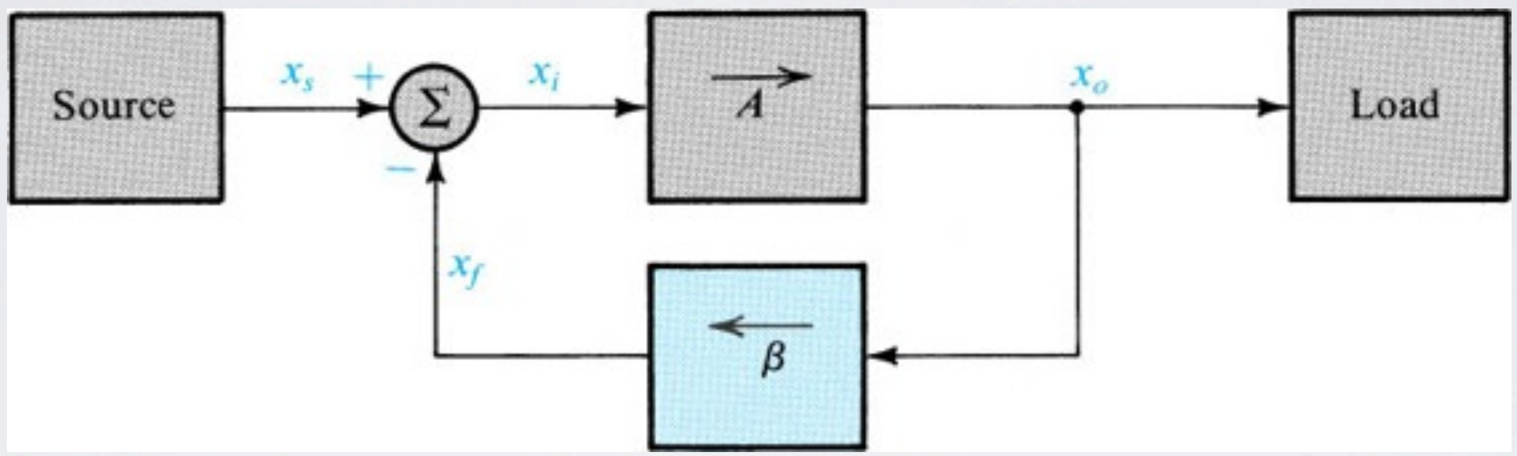

Figure 8.1 General structure of the feedback amplifier. This is a signal-flow diagram, and the quantities x represent either voltage or current signals.

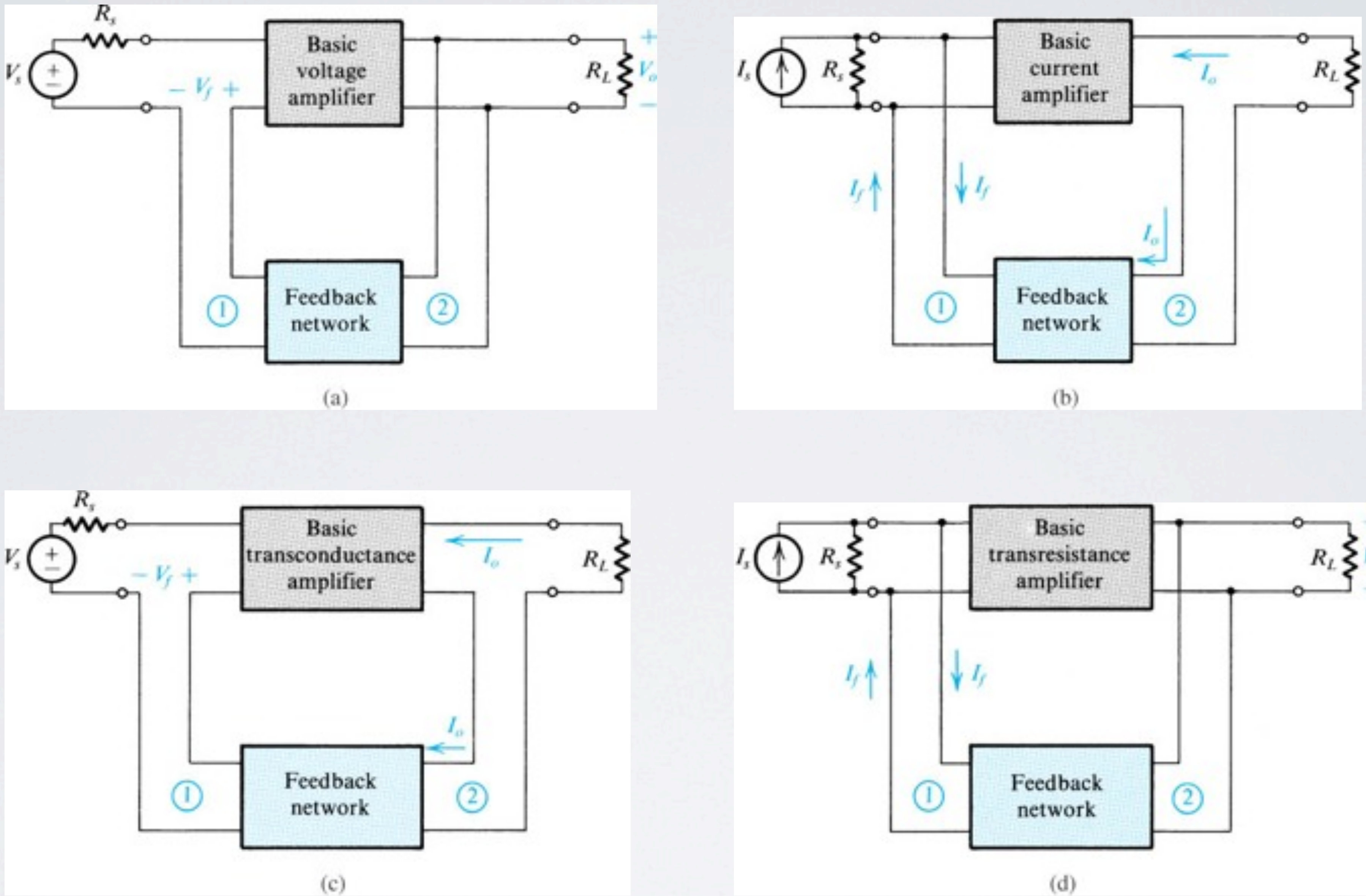

Figure 8.4 The four basic feedback topologies: **(a)** voltage-mixing voltage-sampling (series–shunt) topology; **(b)** current-mixing current-sampling (shunt–series) topology; **(c)** voltage-mixing current-sampling (series–series) topology; **(d)** current-mixing voltage-sampling (shunt–shunt) topology.

TABLE 8.1 Summary of Relationships for the Four Feedback Amplifier Topologies

Feedback Amplifier	x_i	x_o	x_f	x_s	A	β	A_f	Source Form	Loading of Feedback Network Is Obtained: At Input	Loading of Feedback Network Is Obtained: At Output	To Find β, Apply to Port 2 of Feedback Network	Z_{if}	Z_{of}	Refer to Figs.
Series–shunt (voltage amplifier)	V_i	V_o	V_f	V_s	$\frac{V_o}{V_i}$	$\frac{V_f}{V_o}$	$\frac{V_o}{V_s}$	Thévenin	By short-circuiting port 2 of feedback network	By open-circuiting port 1 of feedback network	a voltage, and find the open-circuit voltage at port 1	$Z_i(1 + A\beta)$	$\frac{Z_o}{1 + A\beta}$	8.4(a) 8.8 8.10 8.11
Shunt–series (current amplifier)	I_i	I_o	I_f	I_s	$\frac{I_o}{I_i}$	$\frac{I_f}{I_o}$	$\frac{I_o}{I_s}$	Norton	By open-circuiting port 2 of feedback network	By short-circuiting port 1 of feedback network	a current, and find the short-circuit current at port 1	$\frac{Z_i}{1 + A\beta}$	$Z_o(1 + A\beta)$	8.4(b) 8.22 8.23 8.24
Series–series (transconductance amplifier)	V_i	I_o	V_f	V_s	$\frac{I_o}{V_i}$	$\frac{V_f}{I_o}$	$\frac{I_o}{V_s}$	Thévenin	By open-circuiting port 2 of feedback network	By open-circuiting port 1 of feedback network	a current, and find the open-circuit voltage at port 1	$Z_i(1 + A\beta)$	$Z_o(1 + A\beta)$	8.4(c) 8.13 8.15 8.16
Shunt–shunt (transresistance amplifier)	I_i	V_o	I_f	I_s	$\frac{V_o}{I_i}$	$\frac{I_f}{V_o}$	$\frac{V_o}{I_s}$	Norton	By short-circuiting port 2 of feedback network	By short-circuiting port 1 of feedback network	a voltage, and find the short-circuit current at port 1	$\frac{Z_i}{1 + A\beta}$	$\frac{Z_o}{1 + A\beta}$	8.4(d) 8.18 8.19 8.20

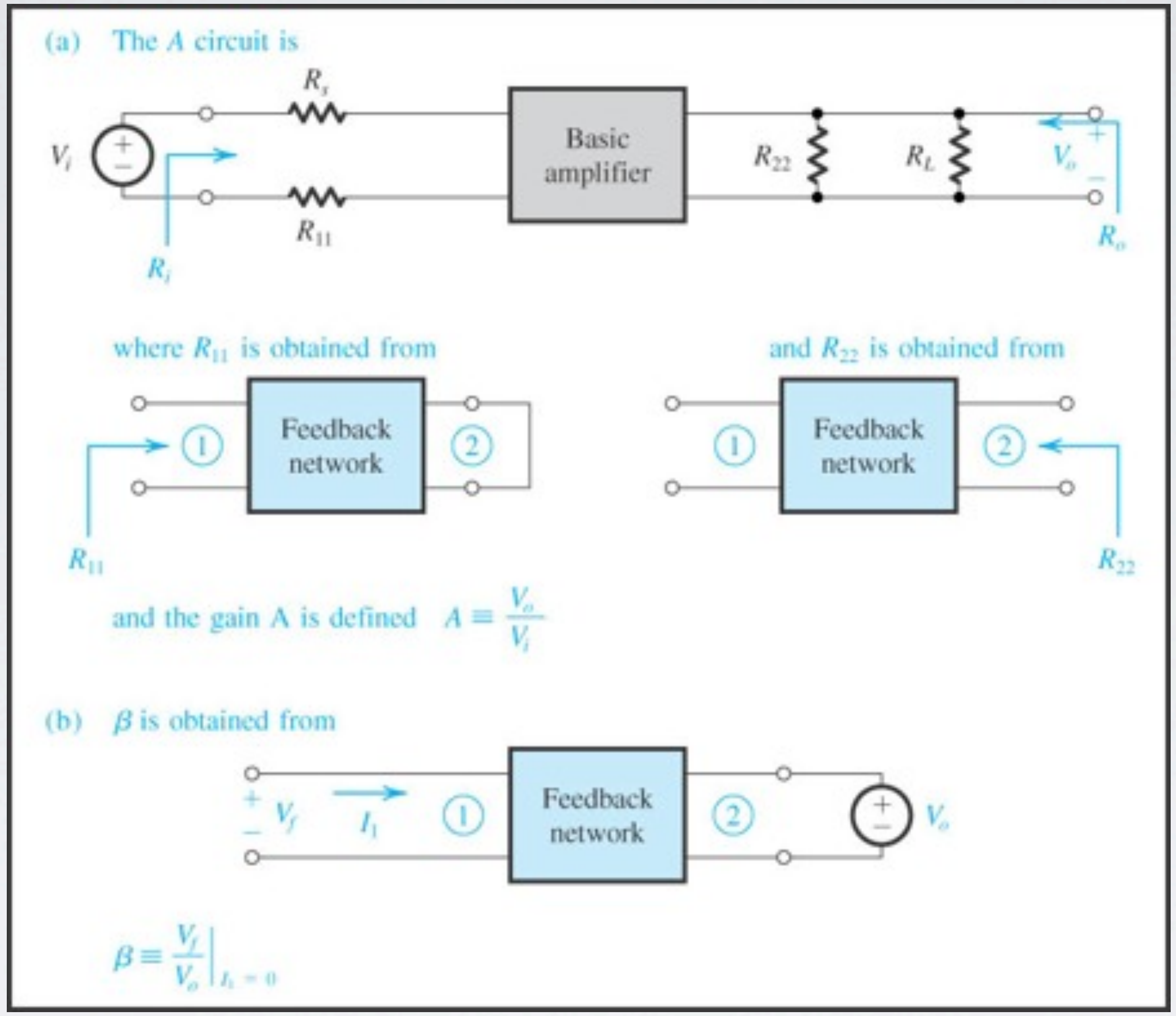

Figure 8.11 Summary of the rules for finding the *A* circuit and β for the voltage-mixing voltage-sampling case of Fig. 8.10(a).

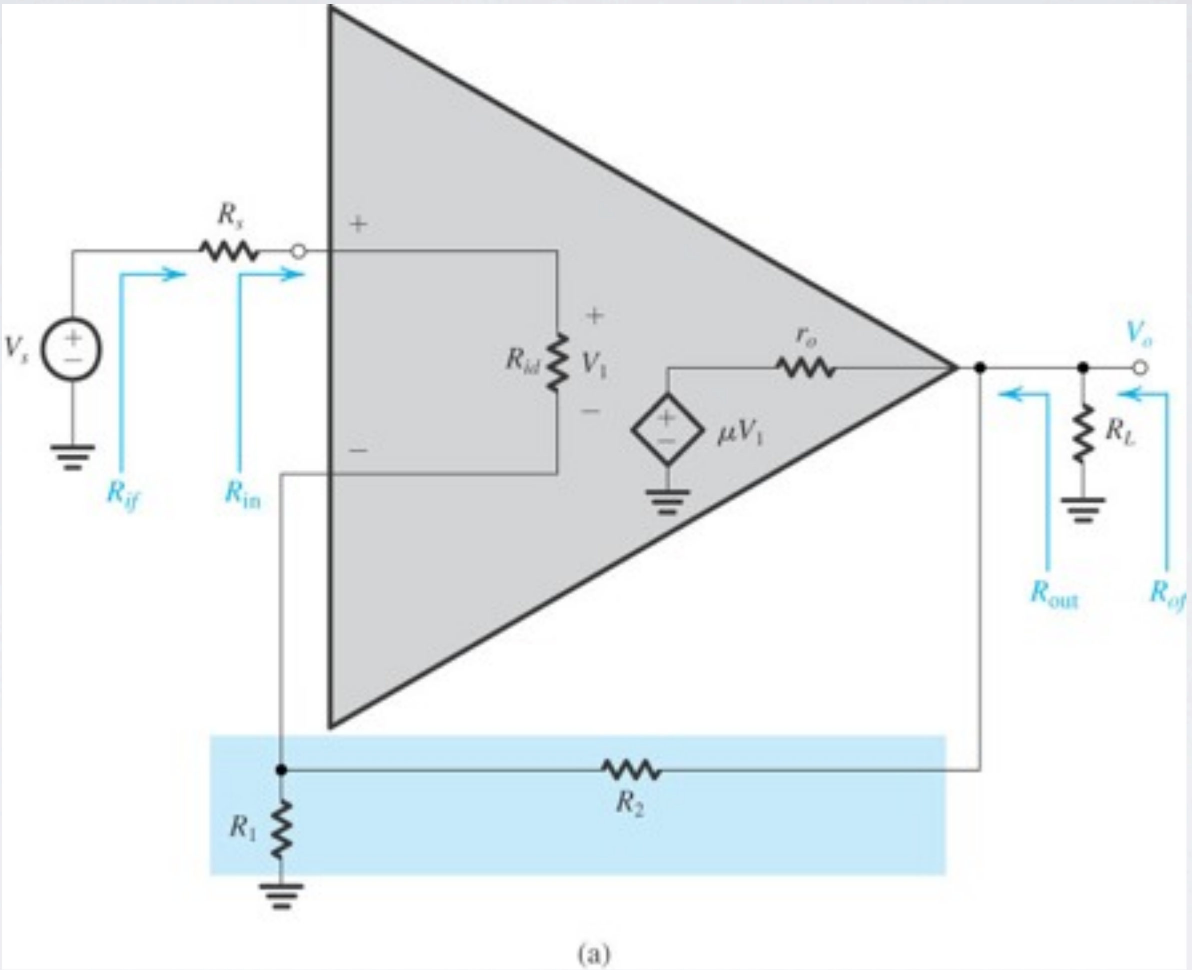

Figure 8.12 Circuits for Example 8.1.

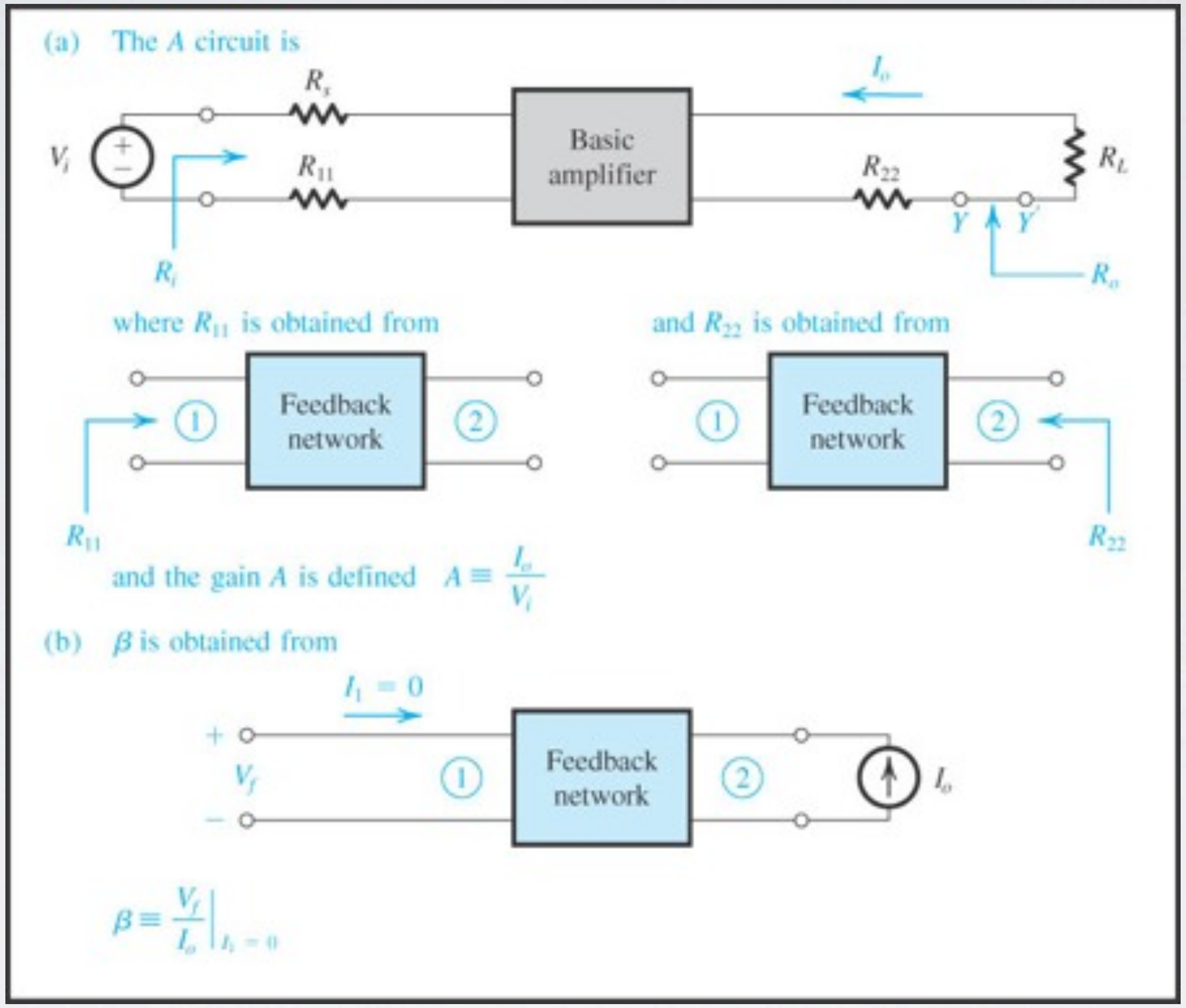

Figure 8.16 Finding the A circuit and β for the voltage-mixing current-sampling (series–series) case.

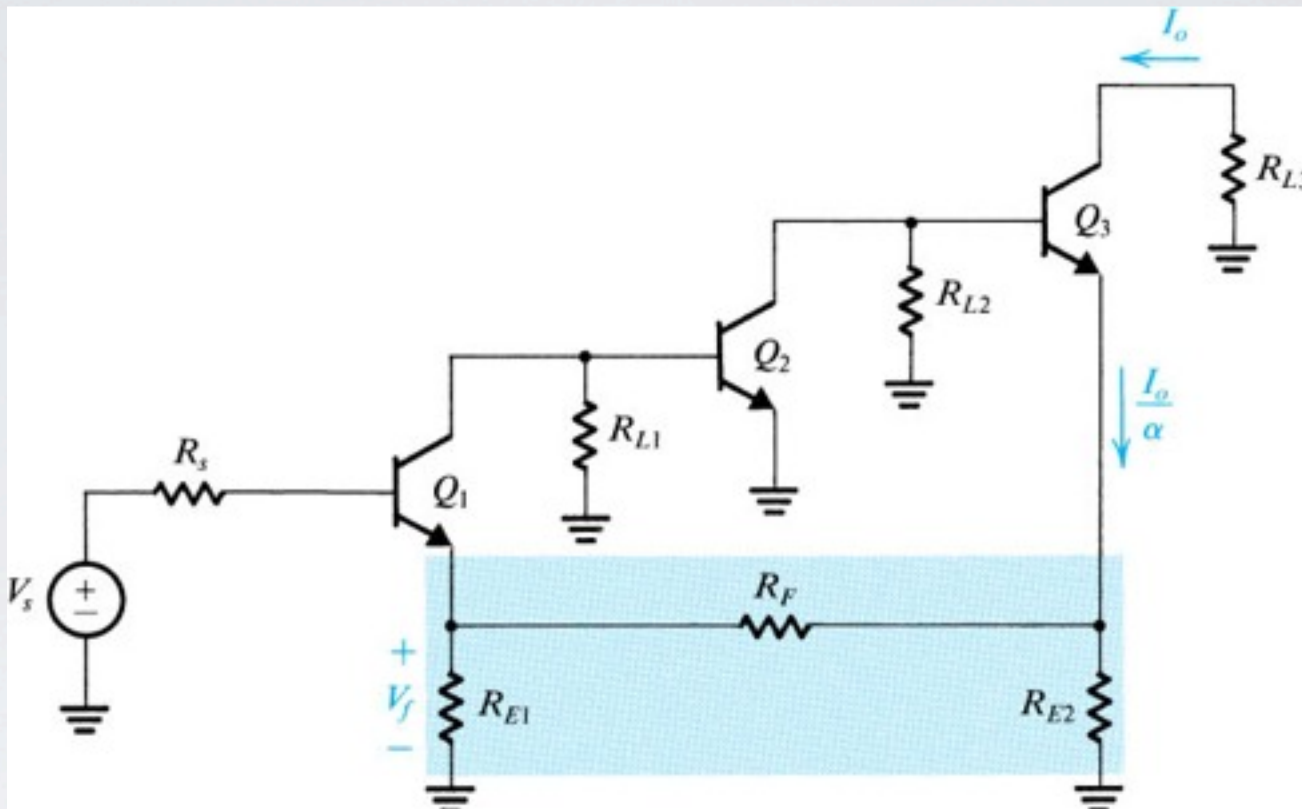

Figure 8.6 An example of the series–series feedback topology. (Biasing not shown.)

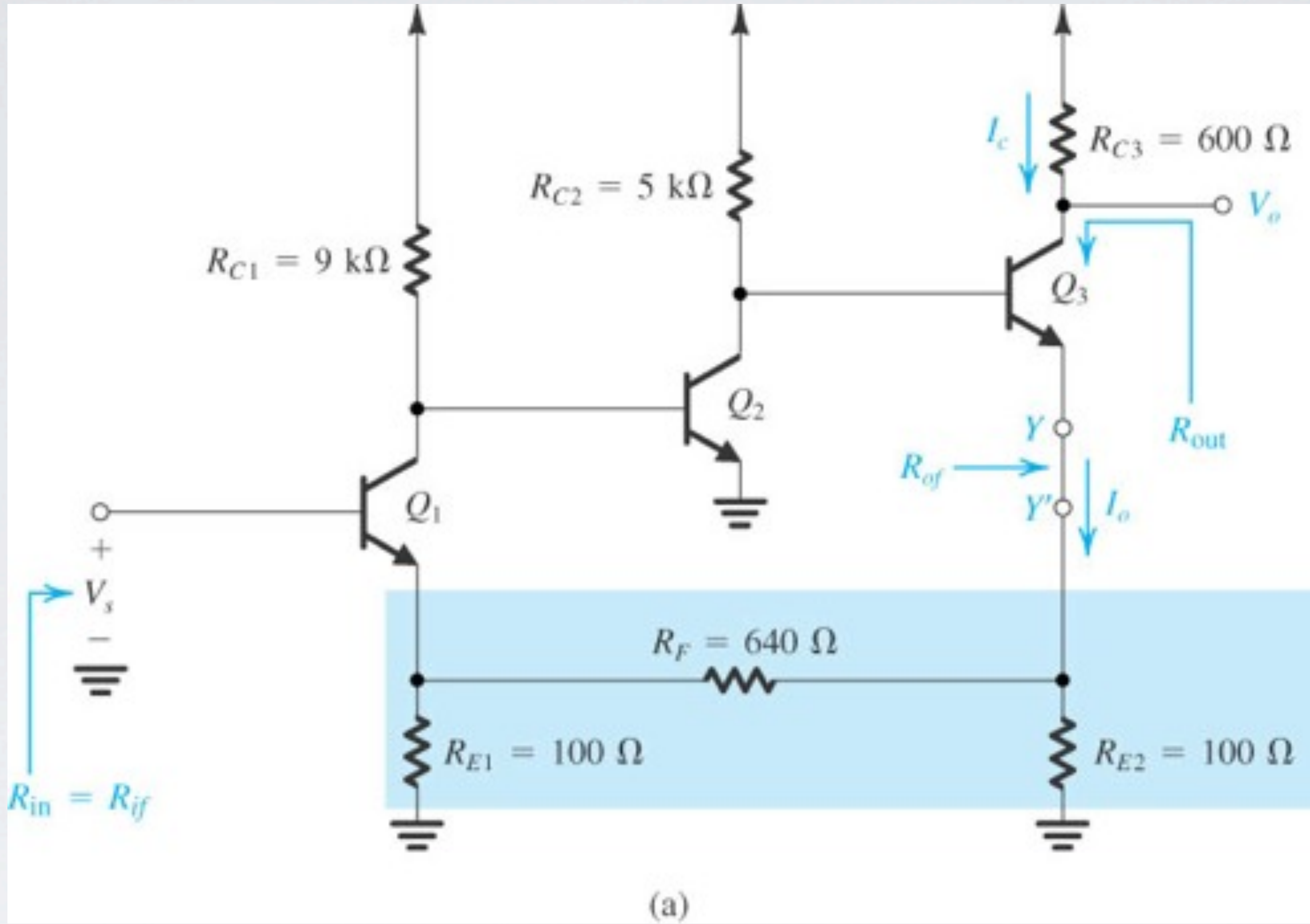

Figure 8.17 Circuits for Example 8.2.

$I_{C1} = 0.6mA, I_{C2} = 1mA, I_{C3} = 4mA, h_{fe} = 100, r_O = \infty$

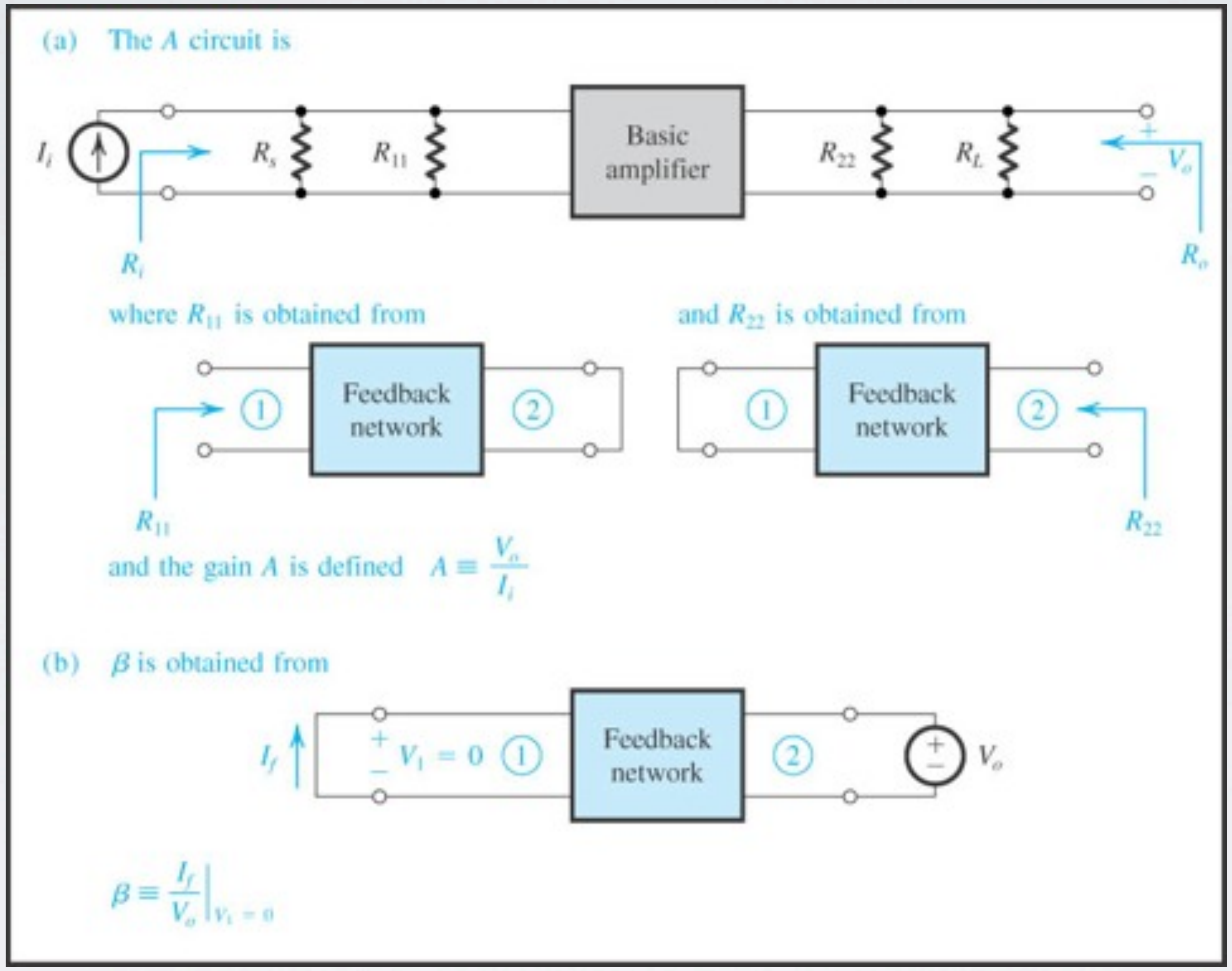

Figure 8.20 Finding the *A* circuit and β for the current-mixing voltage-sampling (shunt–shunt) feedback amplifier in Fig. 8.19.

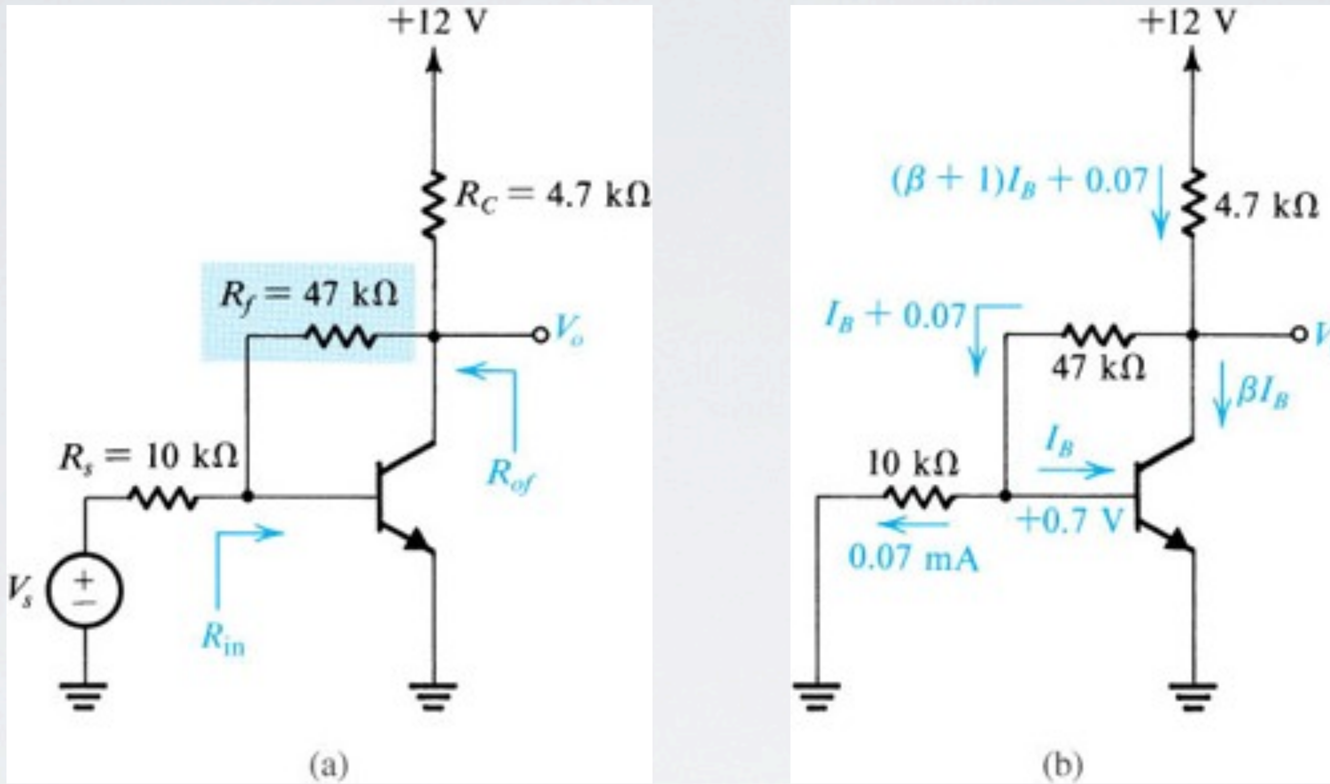

Figure 8.21 Circuits for Example 8.3.

We want to analyze the circuit of Fig. 8.21(a) to determine the small-signal voltage gain V_o/V_s, the input resistance R_{in}, and the output resistance $R_{out} = R_{of}$. The transistor has $\beta = 100$.

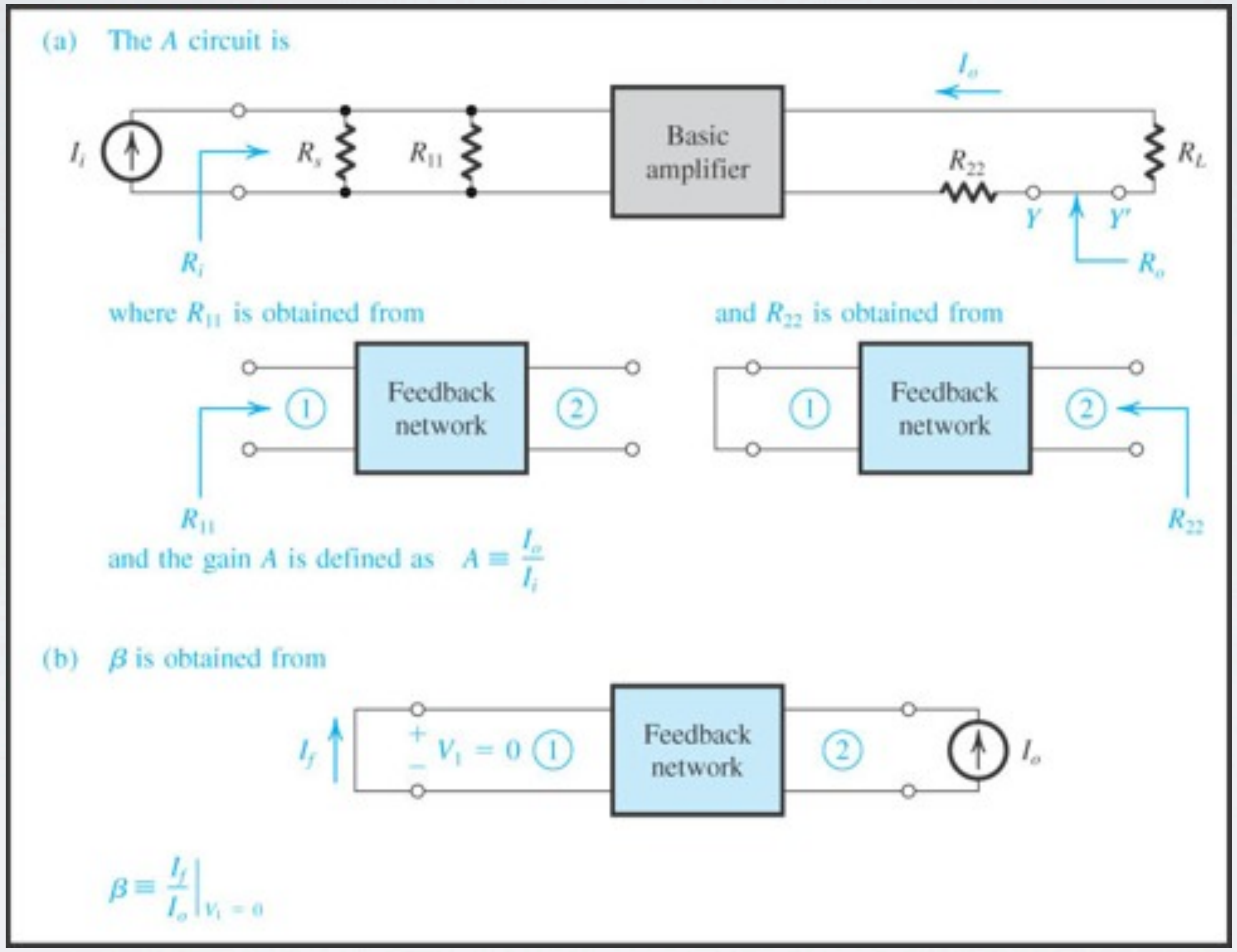

Figure 8.24 Finding the A circuit and β for the current-mixing current-sampling (shunt–series) feedback amplifier of Fig. 8.23.

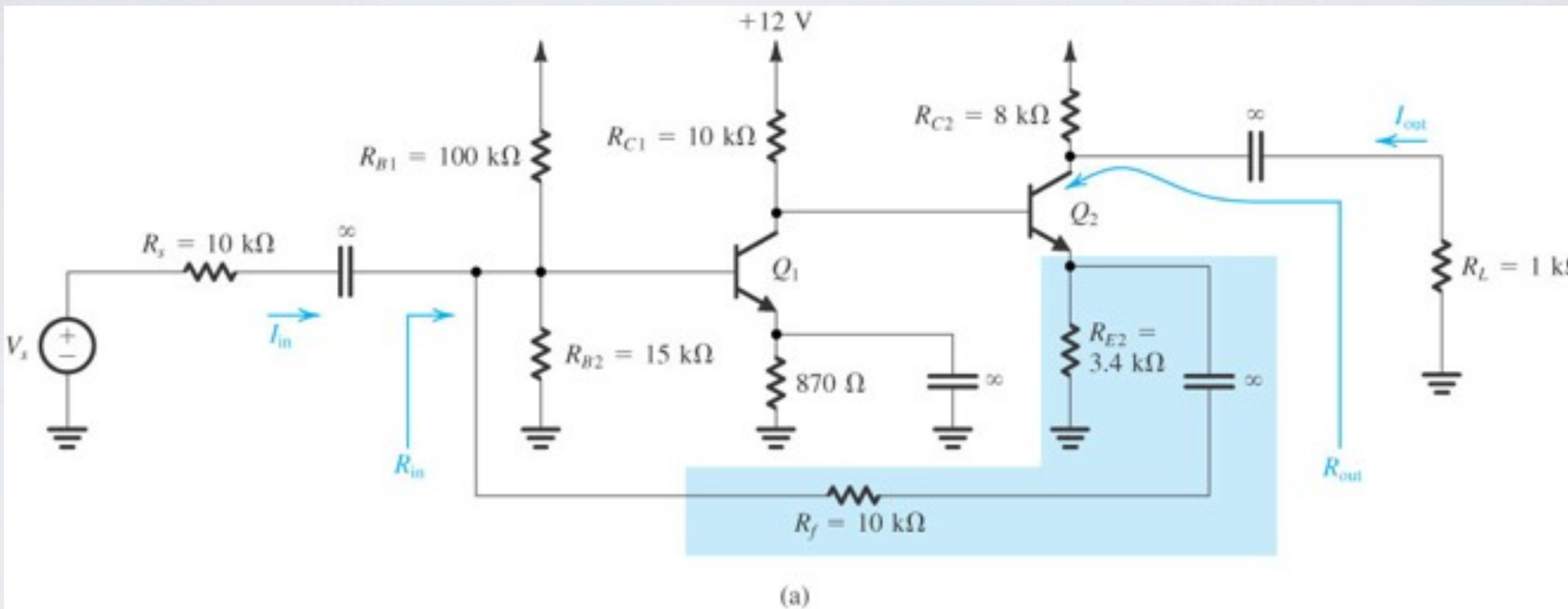

Figure 8.25 Circuits for Example 8.4.

Figure 8.25 shows a feedback circuit of the shunt–series type. Find I_{out}/I_{in}, R_{in}, and R_{out}. Assume the transistors to have $\beta = 100$ and $V_A = 75$ V.

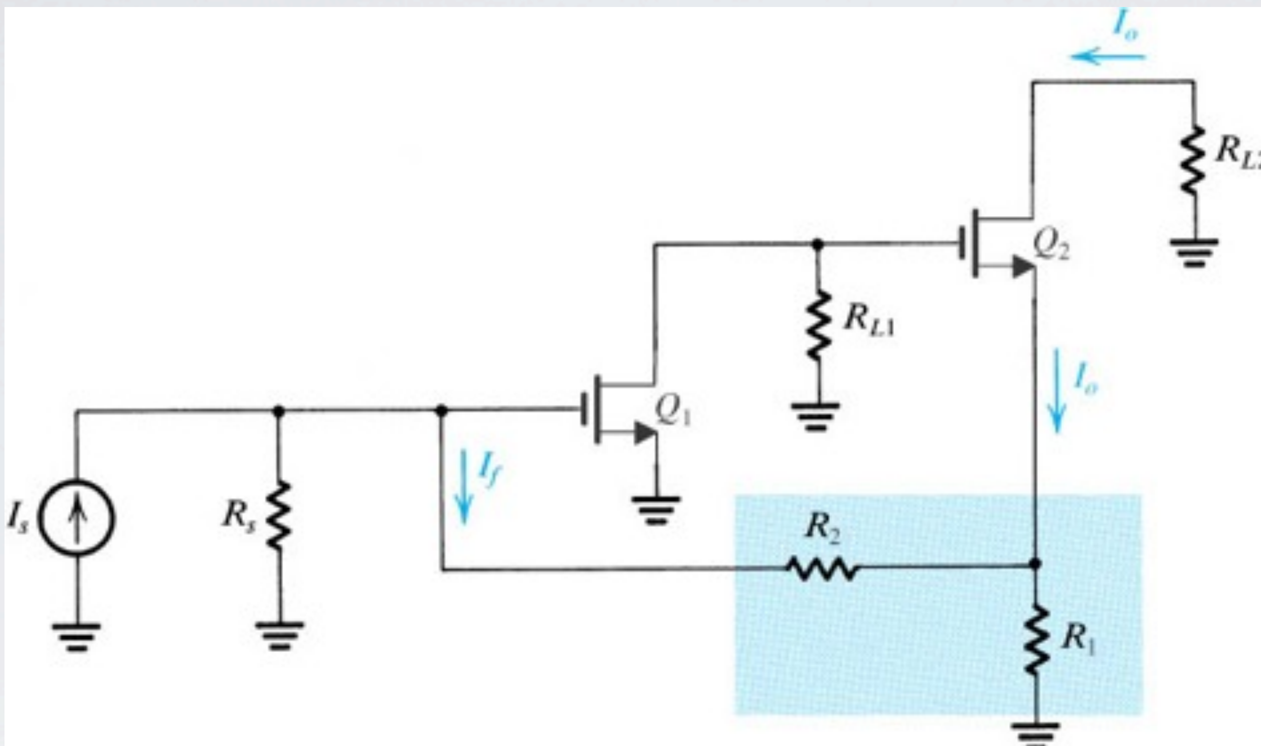

Figure 8.5 A transistor amplifier with shunt–series feedback. (Biasing not shown.)

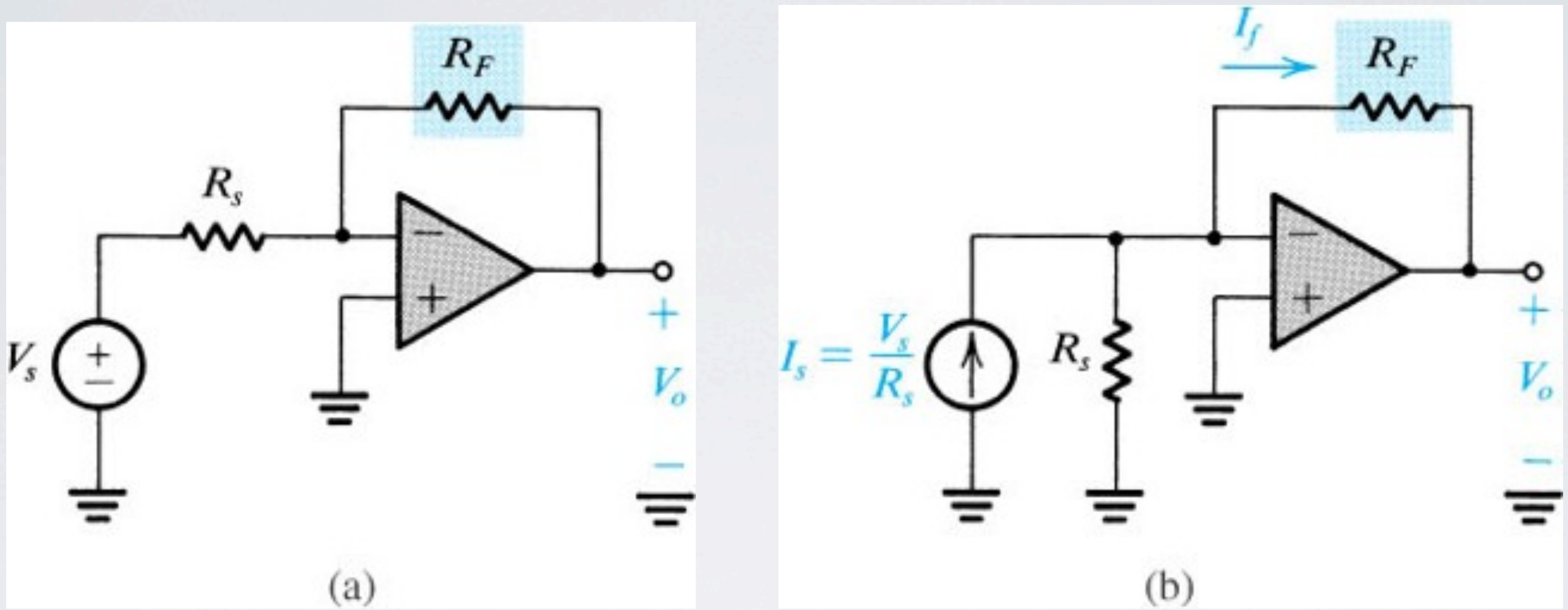

Figure 8.7 **(a)** The inverting op-amp configuration redrawn as **(b)** an example of shunt–shunt feedback.

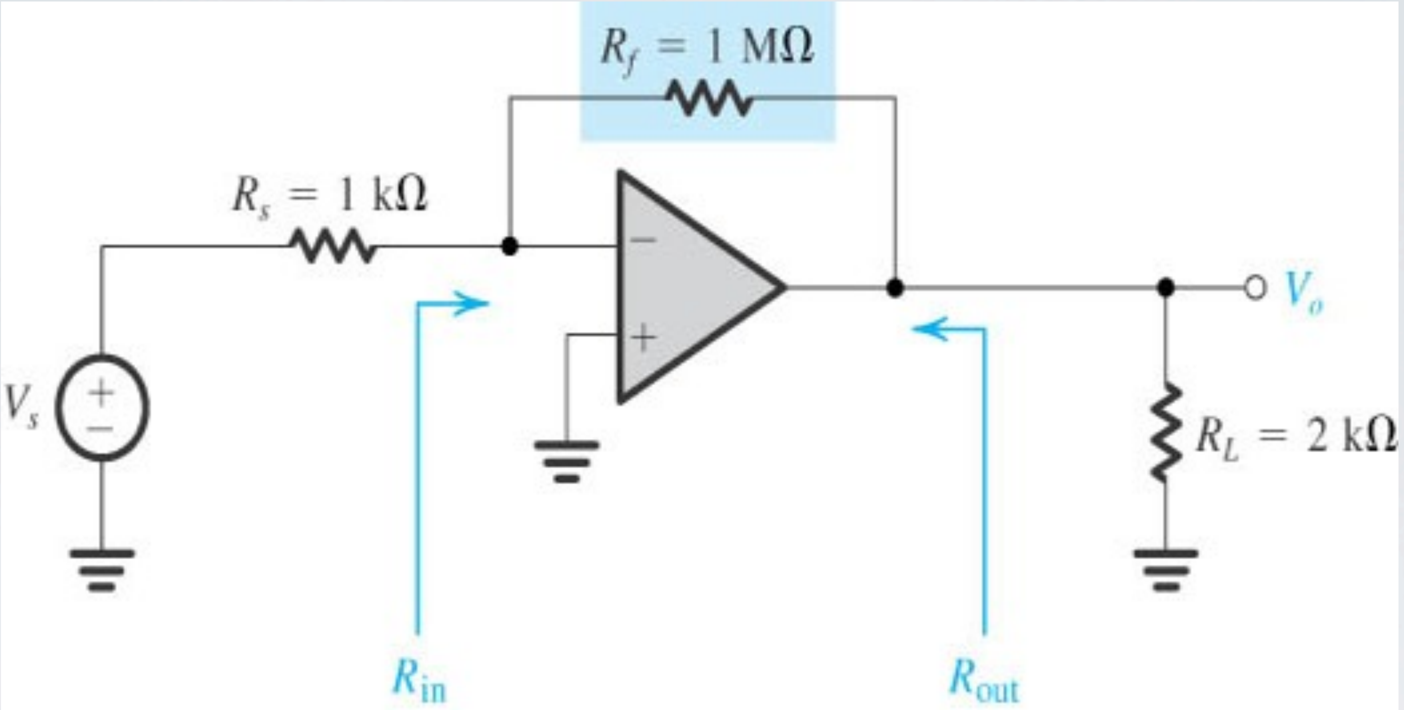

Figure E8.7

Exercise 8.7: Use the feedback method to find the voltage gain V_o/V_i, the input resistance R_{in} and the output resistance R_{out} of the above inverting op-amp configuration. Let the op-amp have open-loop gain $\mu = 10^4$ V/V, $R_{id} = 100k\Omega$, and $r_o = 1k\Omega$. (Hint: The feedback is of the shunt-shunt type.)