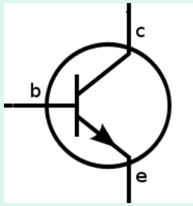
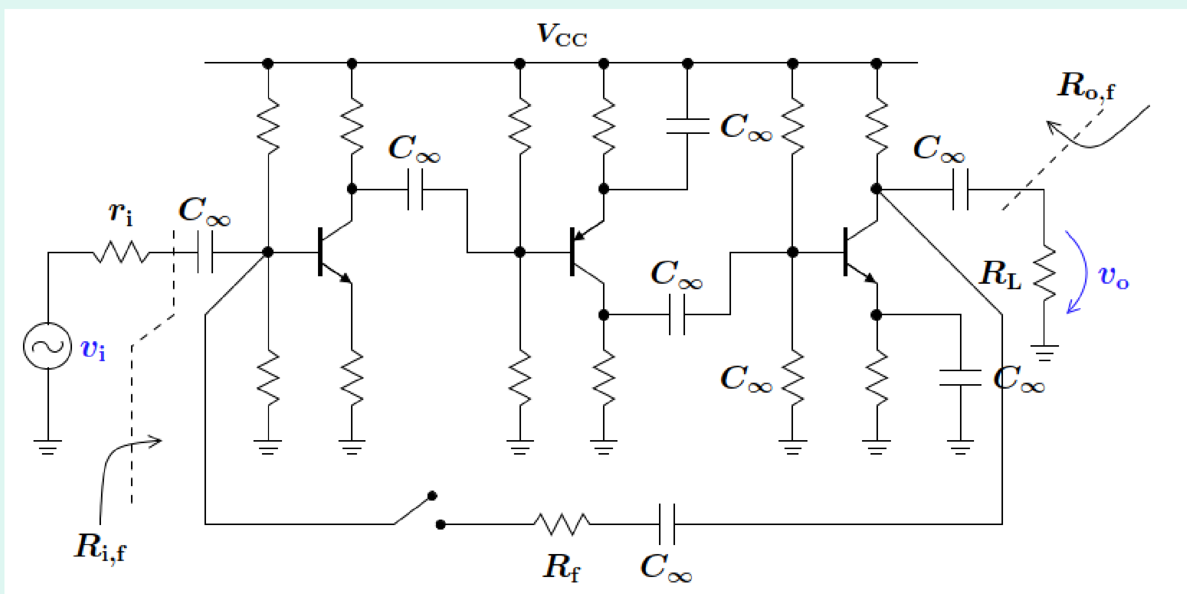
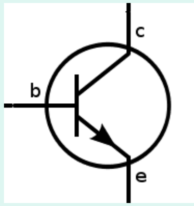


ELEC 301 - Feedback circuit analysis

L23 - Nov 03

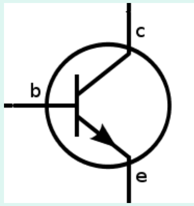
Instructor: Edmond Cretu





Last time

- From feedback in signal flows (information flow) to feedback in circuits (energy flow) - effects on gain, R_{in}, R_{out}
- Ideal feedback networks - 4 topologies
- Non-ideal feedback networks - reduce to the ideal feedback case by “loading” the amplifier with the non-ideal components from the source, load and feedback network

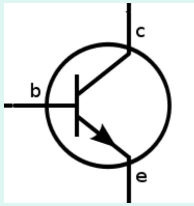


Four feedback topologies

- Summary of closed-loop parameters

Topology	Closed-Loop Gain A_f	Input Resistance R_{if}	Output Resistance R_{of}
Voltage-Sampling Series-Mixing	$A/(1+A\beta)$	$R_i(1+A\beta)$	$R_o/(1+A\beta)$
Current-Sampling Series-Mixing	$A/(1+A\beta)$	$R_i(1+A\beta)$	$R_o(1+A\beta)$
Voltage-Sampling Shunt-Mixing	$A/(1+A\beta)$	$R_i/(1+A\beta)$	$R_o/(1+A\beta)$
Current-Sampling Shunt-Mixing	$A/(1+A\beta)$	$R_i/(1+A\beta)$	$R_o(1+A\beta)$

Source: Roberts+Sedra [1997]Spice, 2nd ed.

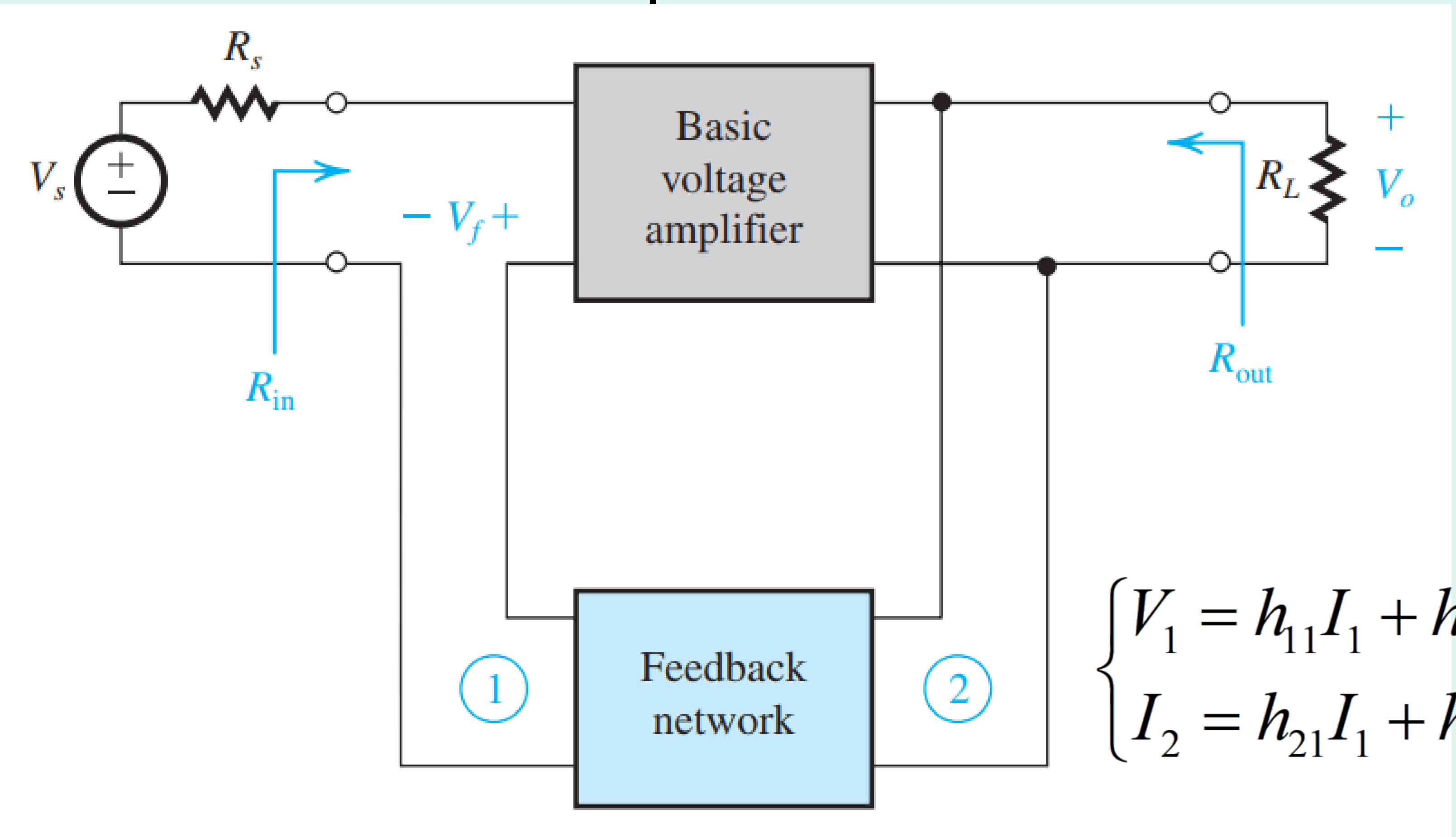


Systematic approach

- Procedure:
  1. Identify the forward path, the feedback path (A and β subsystems), and the type of feedback
  2. Build the equivalent diport model for the feedback network (usually neglect the forward path parameter)
  3. Transform the feedback network into an ideal one, by loading the forward path
  4. Compute A', R_i', R_o' (equivalent diport parameters for the loaded amplifier, neglecting the inner feedback path) and β
  5. Apply (ideal) feedback formulas to find A_f', R_{if}', R_{of}'

Series-shunt topology (voltage amplifier)

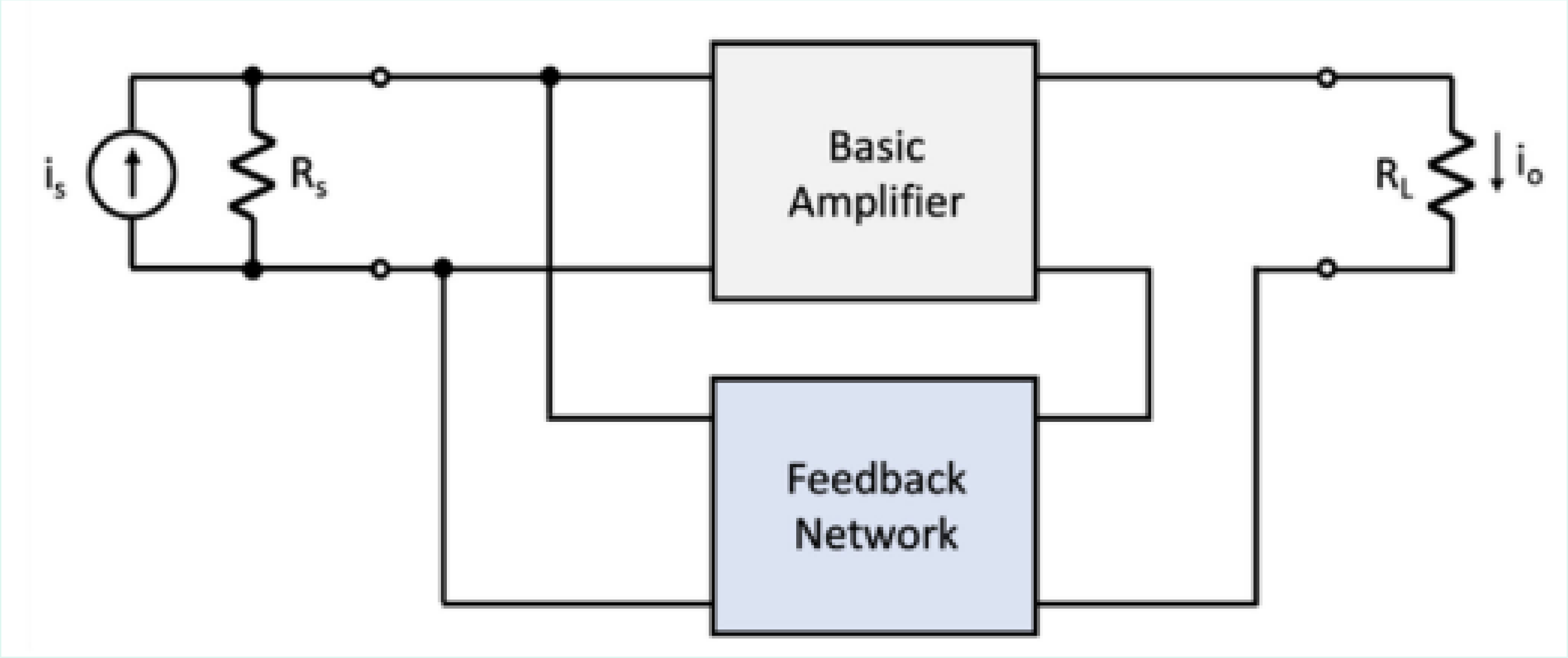
- Series-shunt → h-parameters



$$\begin{cases} V_1 = h_{11} I_1 + h_{12} V_2 \\ I_2 = h_{21} I_1 + h_{22} V_2 \end{cases}$$

Shunt-series topology (current amplifier)

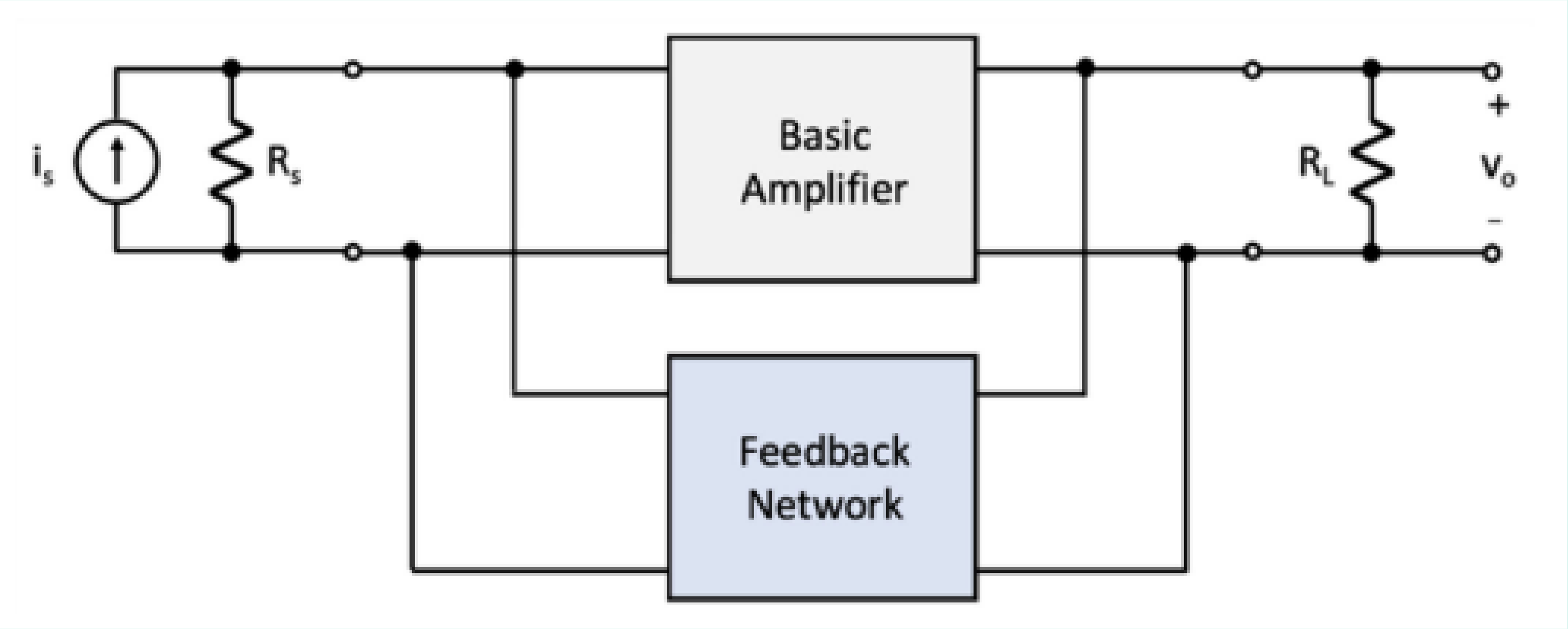
- Shunt-series→ g-parameters



$$g-parameters:\begin{cases} I_1 = g_{11}V_1 + g_{12}I_2 \\ V_2 = g_{21}V_1 + g_{22}I_2 \end{cases}$$

Shunt-shunt topology (transimpedance amplifier)

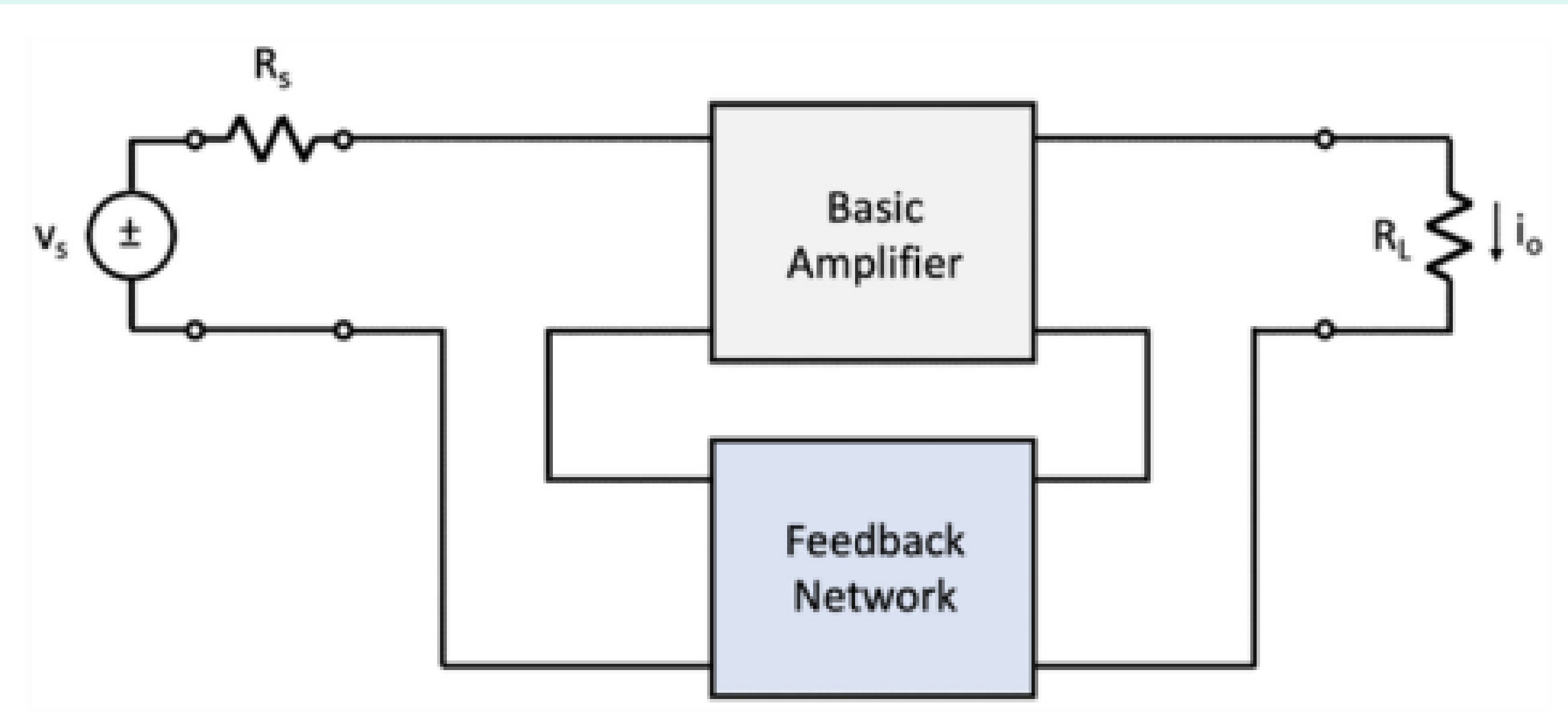
- Shunt-shunt → y-parameters



$$y-parameters:\begin{cases} I_1 = y_{11}V_1 + y_{12}V_2 \\ I_2 = y_{21}V_1 + y_{22}V_2 \end{cases}$$

Series-series topology (Transadmittance amplifier)

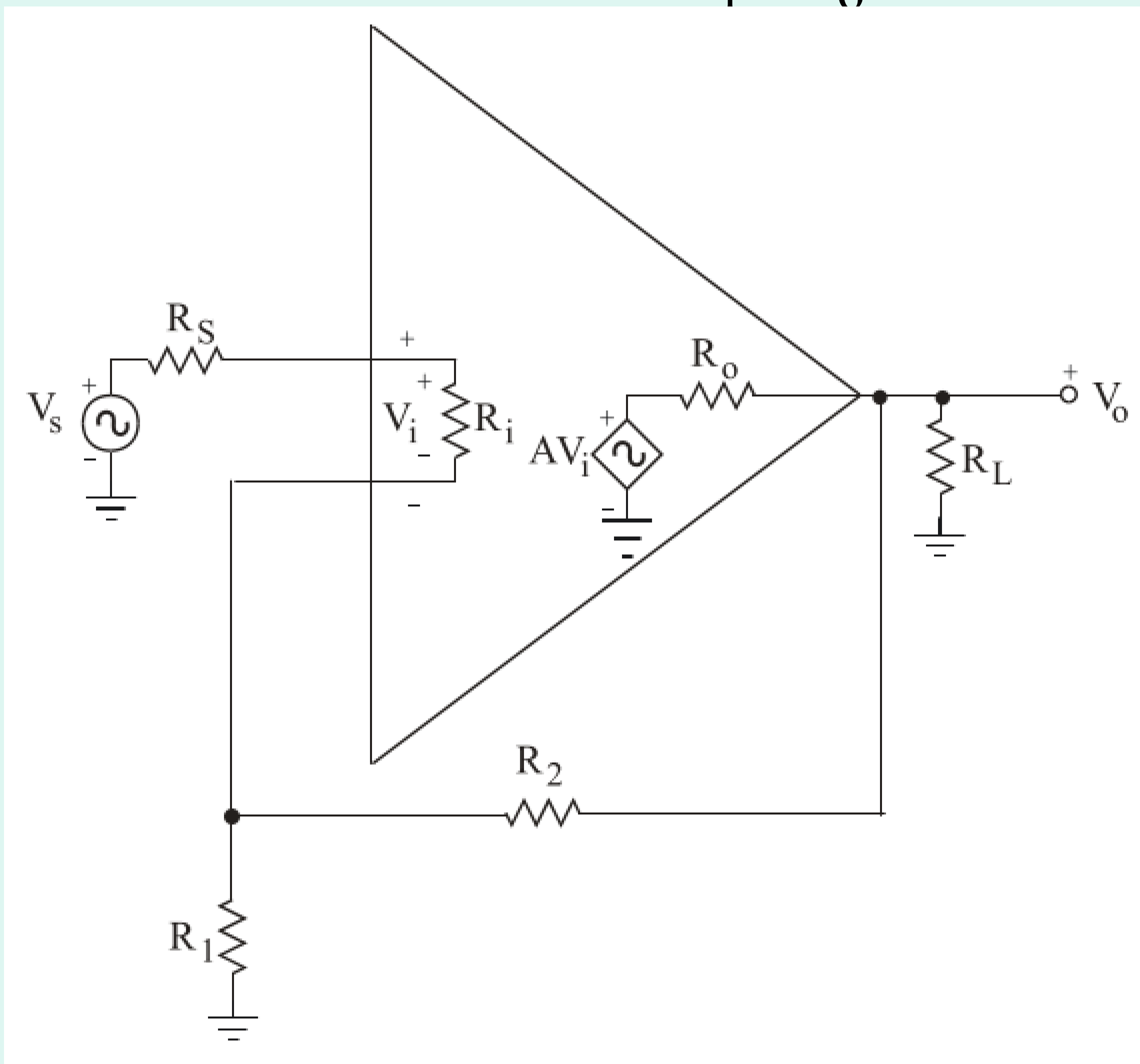
- series-series → z-parameters

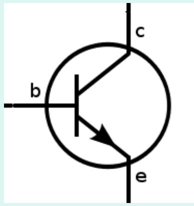


$$z - parameters : \begin{cases} V_1 = z_{11} I_1 + z_{12} I_2 \\ V_2 = z_{21} I_1 + z_{22} I_2 \end{cases}$$

Example: non-inverting amplifier

- Introduce non-idealities: R_i, R_o

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