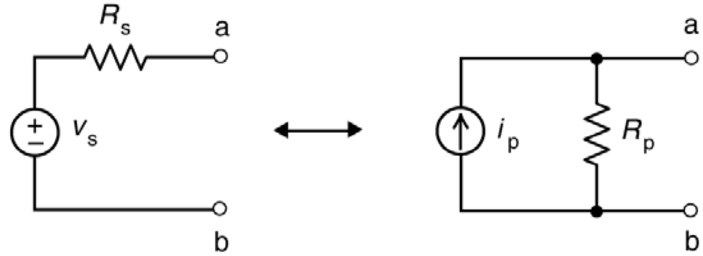
Equivalent Circuits

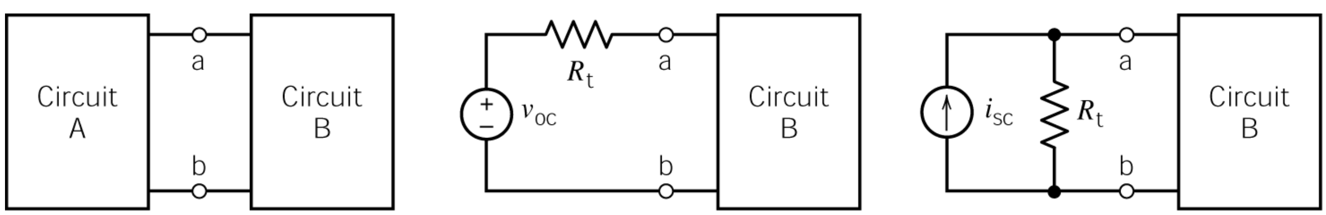
1. Source Transformations



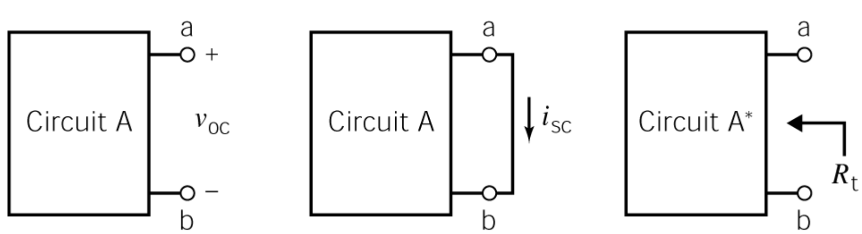
$v_s = R_p i_p$ and $R_s = R_p$ $\quad\quad$ $i_p = \frac{v_s}{R_s}$ and $R_p = R_s$

2. Circuit Analysis using Source Transformations and Equivalent Circuits
   a) Reduce the size of the “original circuit”
      i) using Source Transformations
      ii) by replacing series or parallel elements with equivalent elements.
   b) Analyze the “equivalent circuit” .
   c) Identify currents or voltages in the “original circuit” that are equal to the corresponding currents or voltages in the “equivalent circuit”.
   d) Analyze the “original circuit” …

3. Thevenin and Norton Equivalent circuits

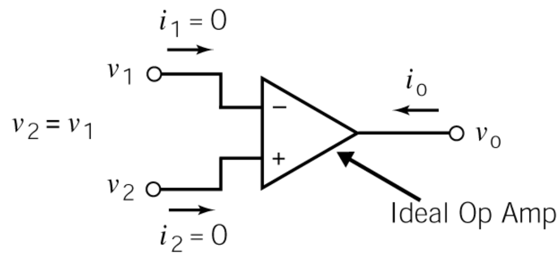


   a) v_{oc}, i_{sc} and R_t:



   b) Reducing a circuit to it’s Thevenin and Norton equivalent using Source Transformations and Equivalent Circuits.
   c) Applications of the Thevenin and Norton equivalent circuit
      i) First-order circuits
      ii) Maximum power transfer.
      iii) Many more

Op Amp Circuits

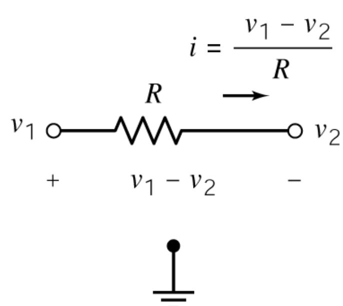


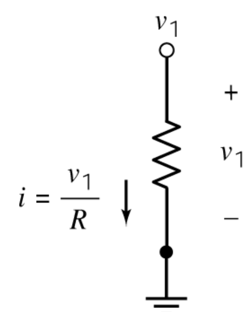
ideal op amp

To obtain the node equations representing an op amp circuit:

1. Express …
    a. voltage-source voltages
    b. ideal op amp voltages and currents
    c. resistor currents

   … in terms of the node voltages





2. Apply KCL at each node except
    a. the reference node
    b. the other node of a grounded voltage source
    c. the output node of **an op amp**
    d. either node of an ungrounded voltage source. Instead, apply KCL to the supernode corresponding to that voltage source.

After writing and solving the node equations, apply KCL at the output node of a op amp to determine the output current of that op amp.

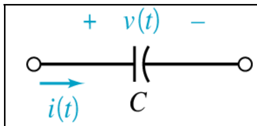
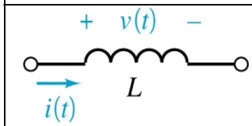
The power supplied by an op amp is the product of the output current directed out of the op amp and node voltage at the output node of the op amp.

Applications

1. Amplifiers: inverting, noninverting, voltage divider with voltage follower.
2. y=mx+b (Superposition.)

Capacitors and Inductors

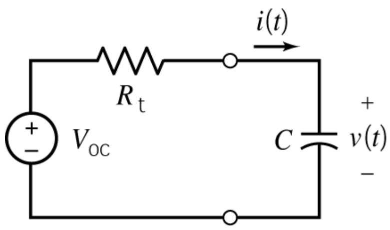
1. Element equations

	$i(t) = C\dfrac{d}{dt}v(t)$ and $v(t) = \dfrac{1}{C}\int_{-\infty}^{t} i(\tau)\,d\tau = v(0) + \dfrac{1}{C}\int_{0}^{t} i(\tau)\,d\tau$
	$v(t) = L\dfrac{d}{dt}i(t)$ and $i(t) = \dfrac{1}{L}\int_{-\infty}^{t} v(\tau)\,d\tau = i(0) + \dfrac{1}{L}\int_{0}^{t} v(\tau)\,d\tau$

2. In a dc circuit...
3. Capacitor voltages and inductor currents are continuous.
4. Series and parallel capacitors and inductors...

First-order Circuits

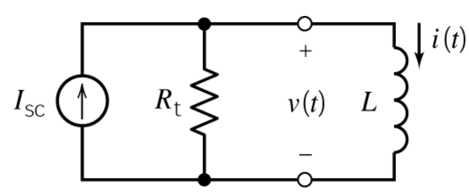
1. Identifying features:
   a. Single capacitor or single inductor.
   b. Something happened
      i. Switch
      ii. Step function
   c. Constant inputs except at t_o .
2. Find
   a. Initial condition: $t < t_o$ and steady state.
   b. Thevenin or Norton equivalent of ... after t_o .
   c. *L* or *C*
3.



$$v(t) = V_{oc} + \left(v(0) - V_{oc}\right)e^{-at} \quad \text{for } t \ge 0$$

where

$$a = \frac{1}{R_t C}$$



$$i(t) = I_{sc} + \left(i(0) - I_{sc}\right)e^{-at} \quad \text{for } t \ge 0$$

where

$$a = \frac{R_t}{L}$$

4. Find output current or voltage.