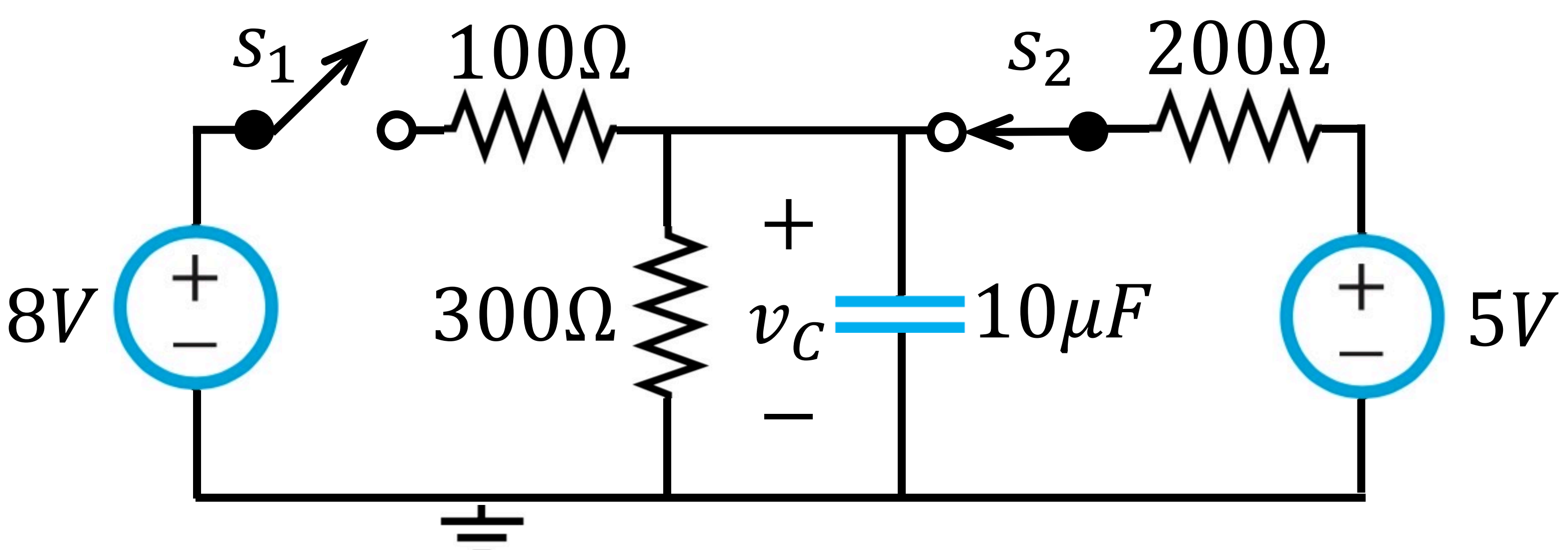
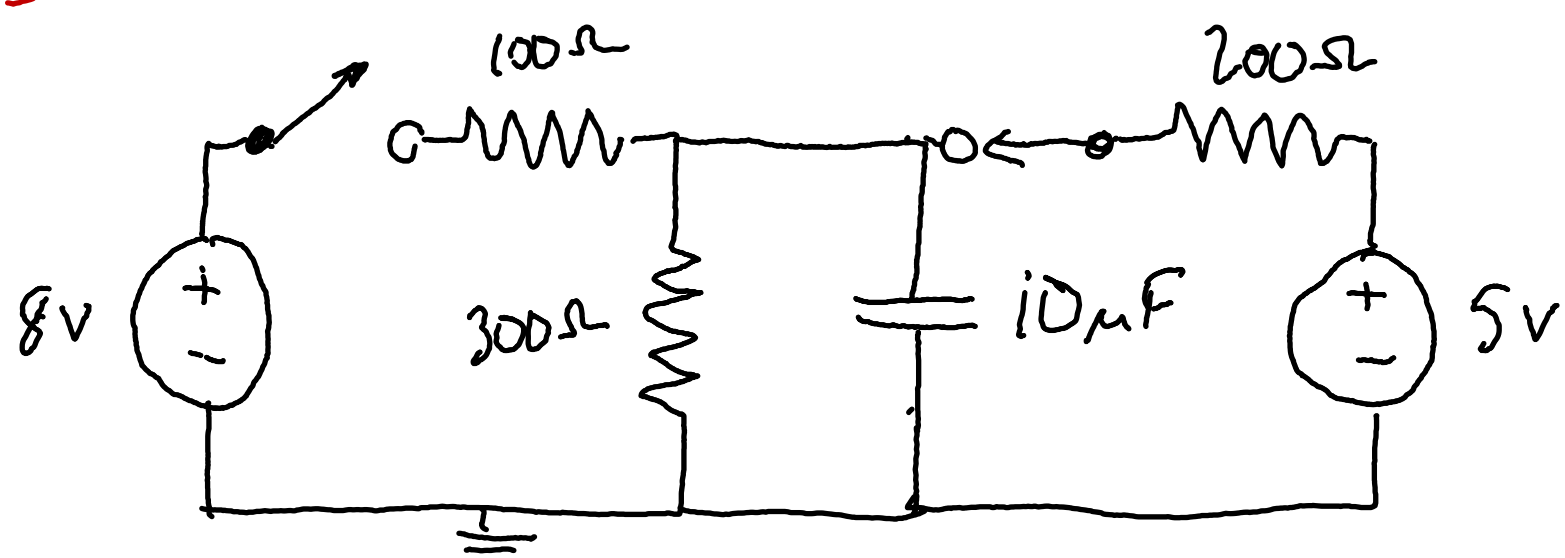
Last Class…

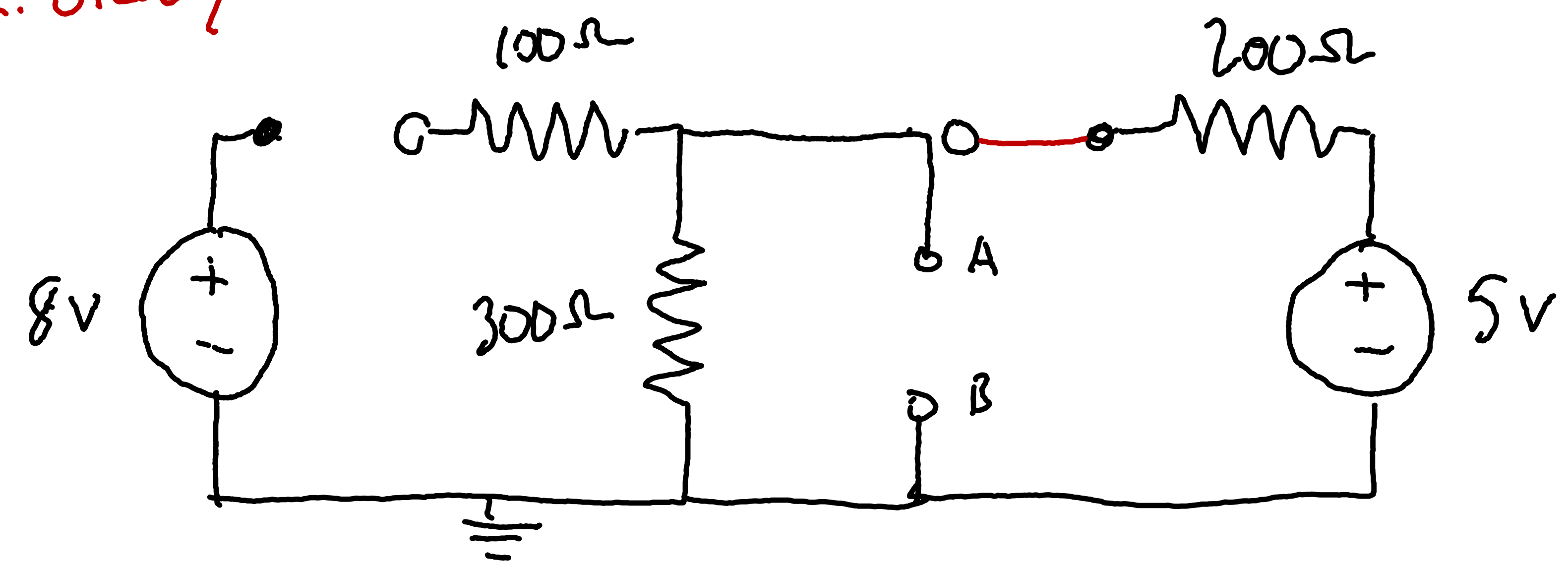
Finish example for Monday class.



Initial Conditions



2. Steady State



Voltage Division

$V_c(\infty) = \frac{300}{400} \cdot 8 = 6V$

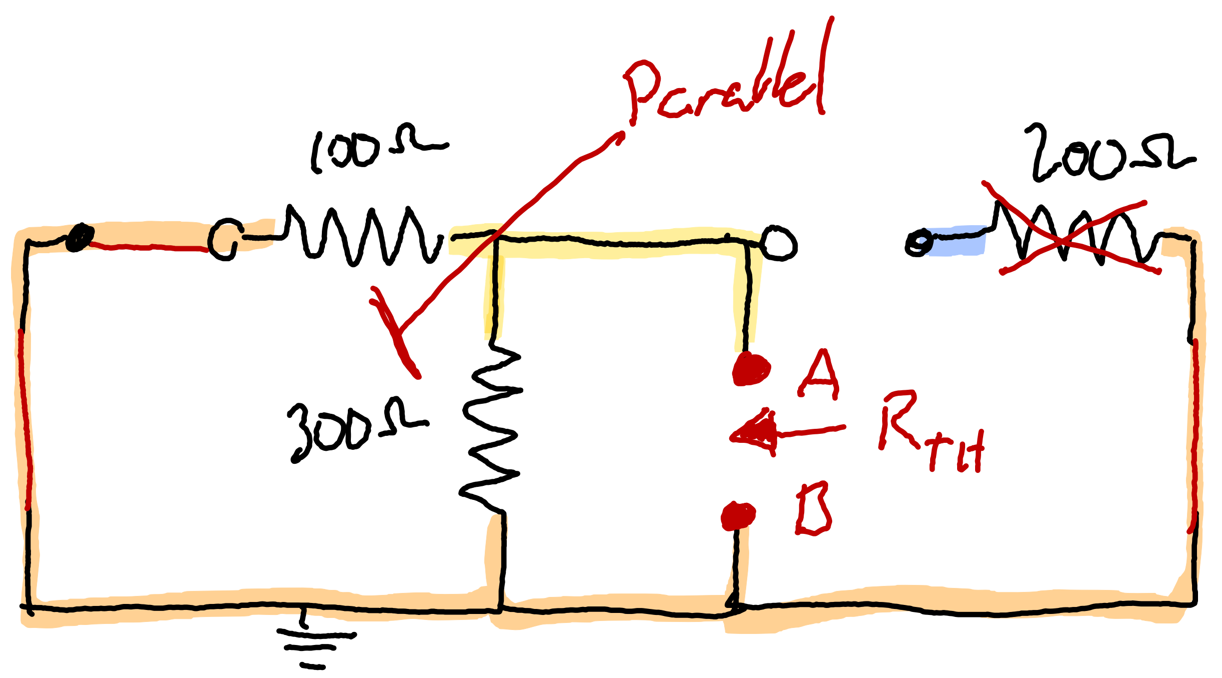
3. Transient Response

$V_c(t) = V_c(\infty) + [V_c(0) - V_c(\infty)] e^{-\frac{1}{RC}t}$ Find Thevenin Resistance

$\frac{1}{RC} = \frac{1}{75(10\times10^{-6})} = 1333.33$

$= 6 + [3 - 6] e^{-1333.33t}$

$= \boxed{6 - 3e^{-1333.33t}}$



$R_{TH} = 100 \,||\, 300 = \frac{100(300)}{400} = \frac{300}{4} = \boxed{75\Omega}$

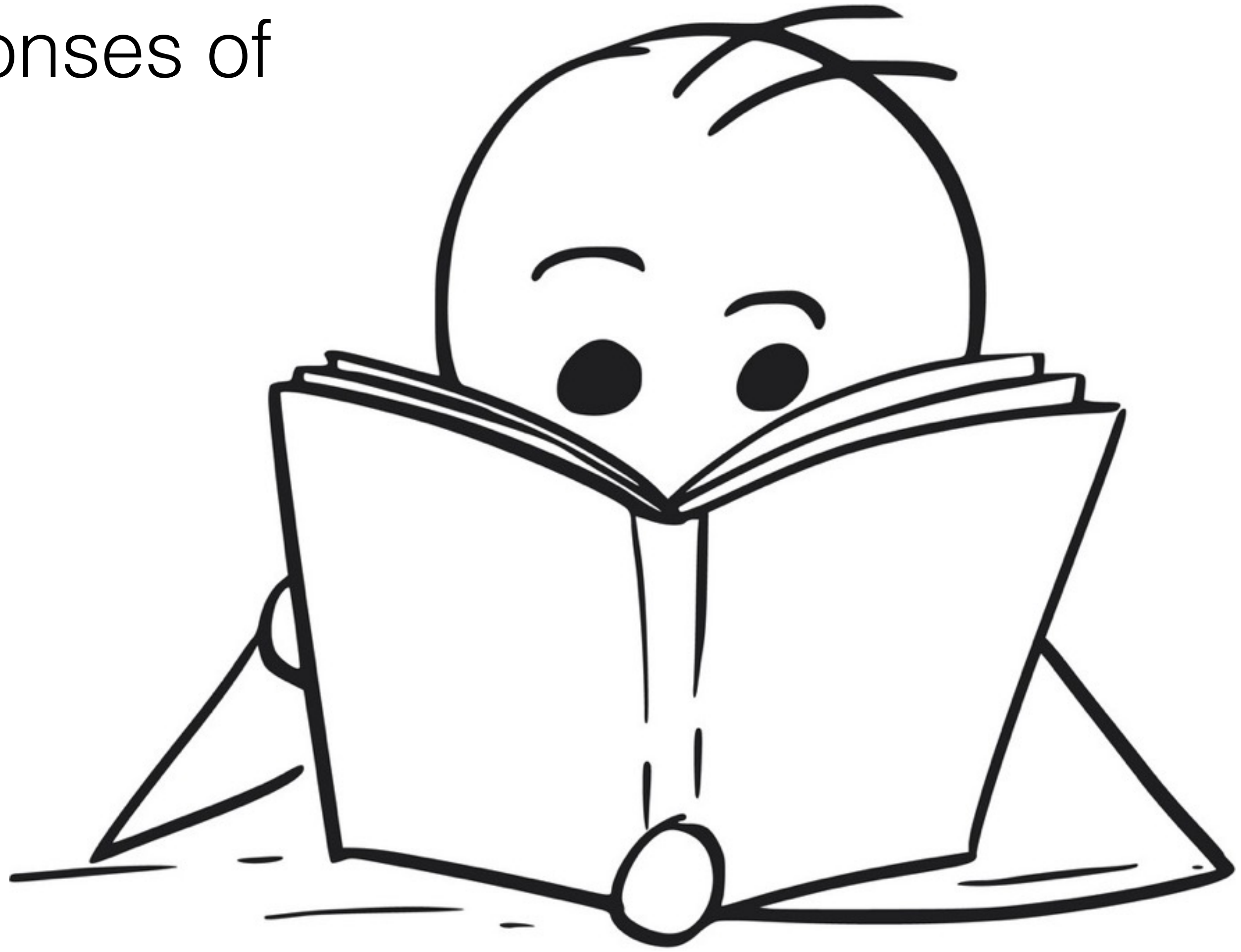
THE OHIO STATE UNIVERSITY

COLLEGE OF ENGINEERING

Transient Response of RL Circuits

Today…

- Learning Objectives:
  - Analyze the transient responses of first order RL circuits.



The Ohio State University

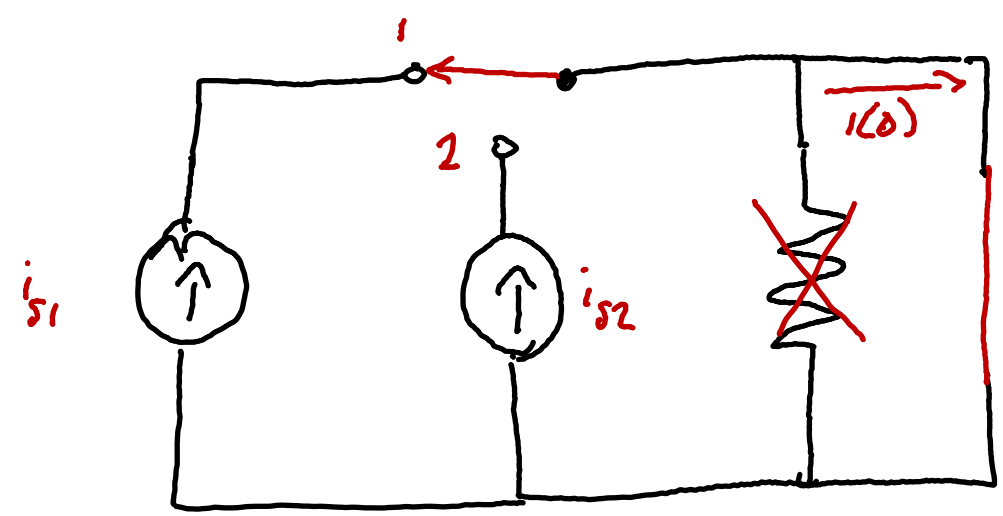
RL First-Order Circuit

1. Calculate the initial value of the inductor $i_L(0)$ (e.g., when switch at 1).

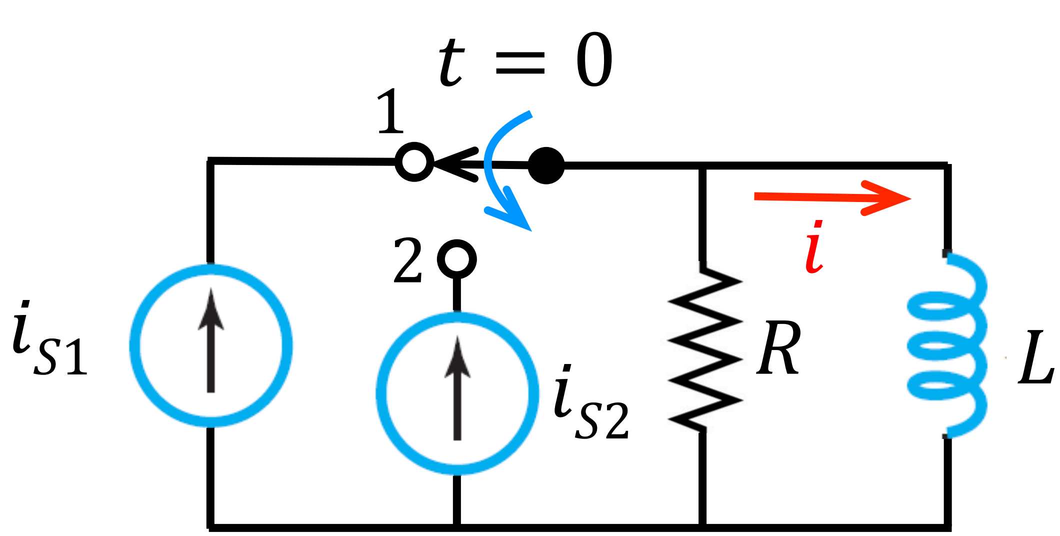
2. Calculate the steady-state response of the inductor $i_L(\infty)$ (e.g., when switch at 2).

3. Solve for transient response.

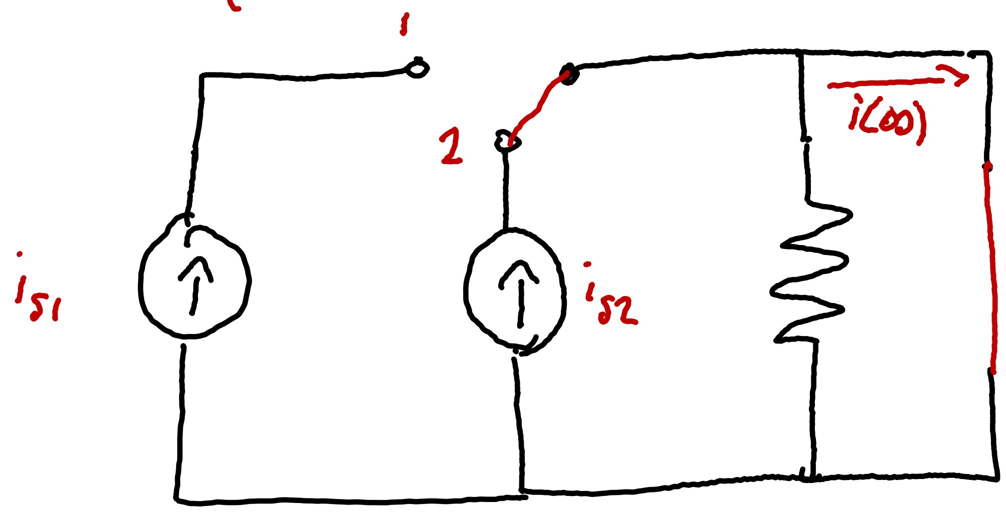
1. Initial Conditions.



$i(0) = i_{s1}$

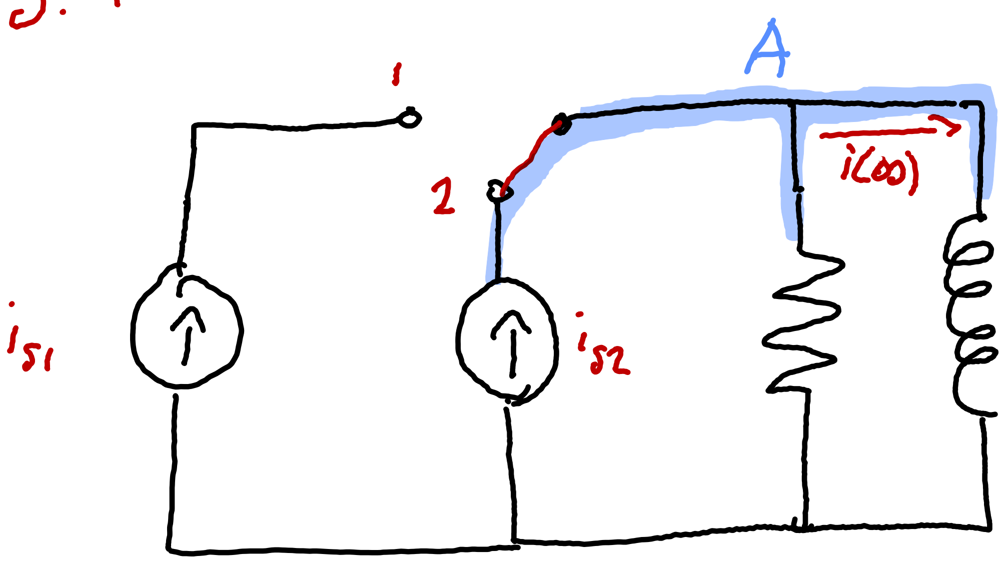


2. Steady State



$i(\infty) = i_{s2}$

3. Transient Response



KCL @ A

$i_{s2} = i_R + i_L$

$i_L(\infty) = \frac{V_R}{R} + i_L$

$i_L(\infty) = \frac{L}{R}\frac{d\,i_L(t)}{dt} + i_L(t)$

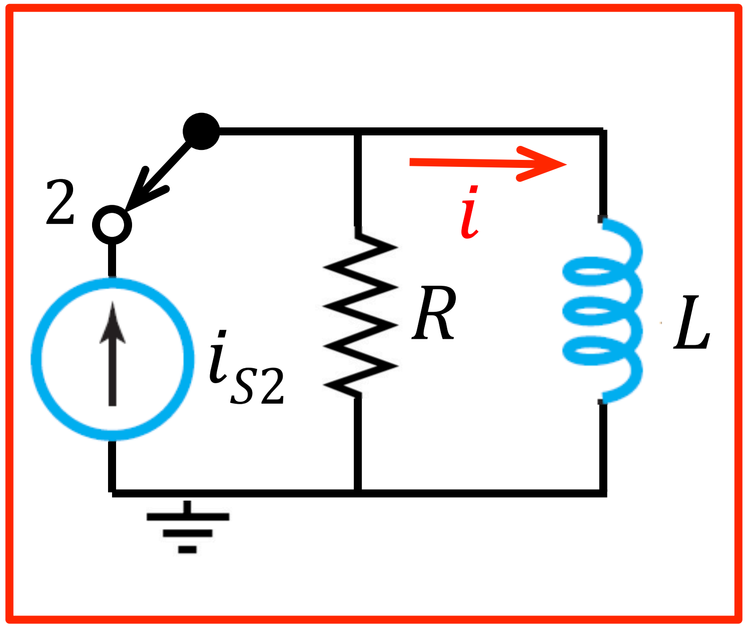
1st order diff eq.

Solution on next slide

Find Norton equivalent resistance
if inductor is the load

RL First-Order Circuit

Norton equivalent circuit
with L as the load.



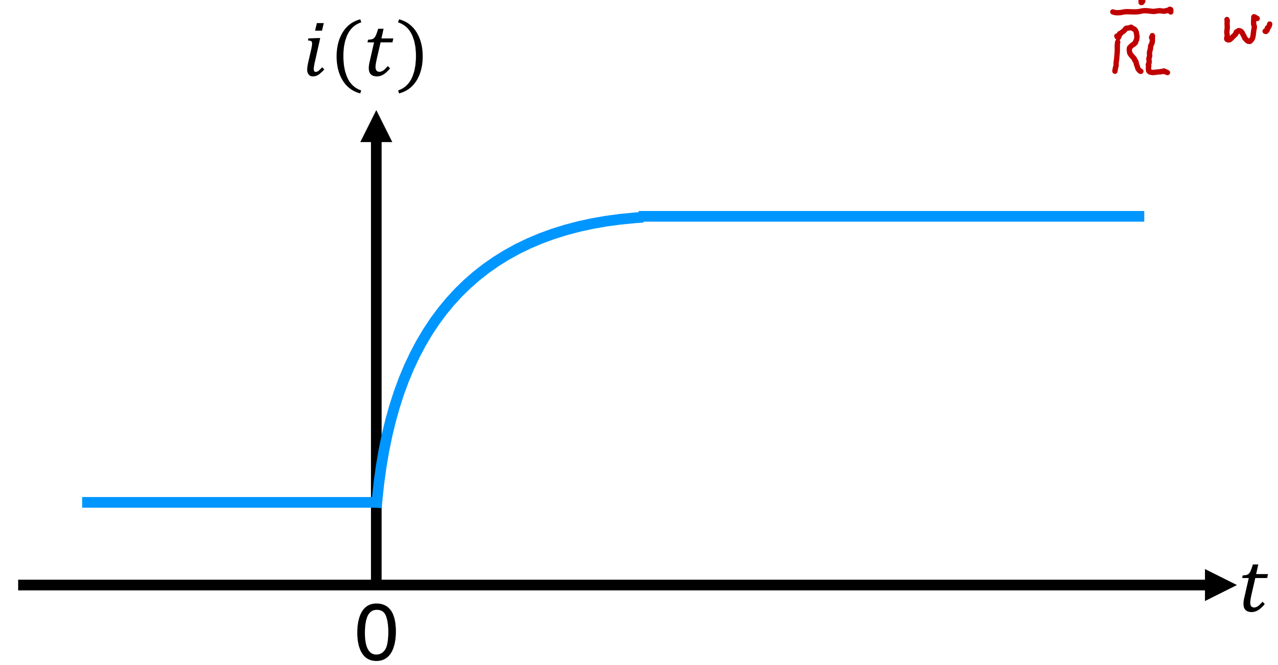
What if the circuit does
not look like this?

How do we calculate
the transient response?

Replace R with R_N

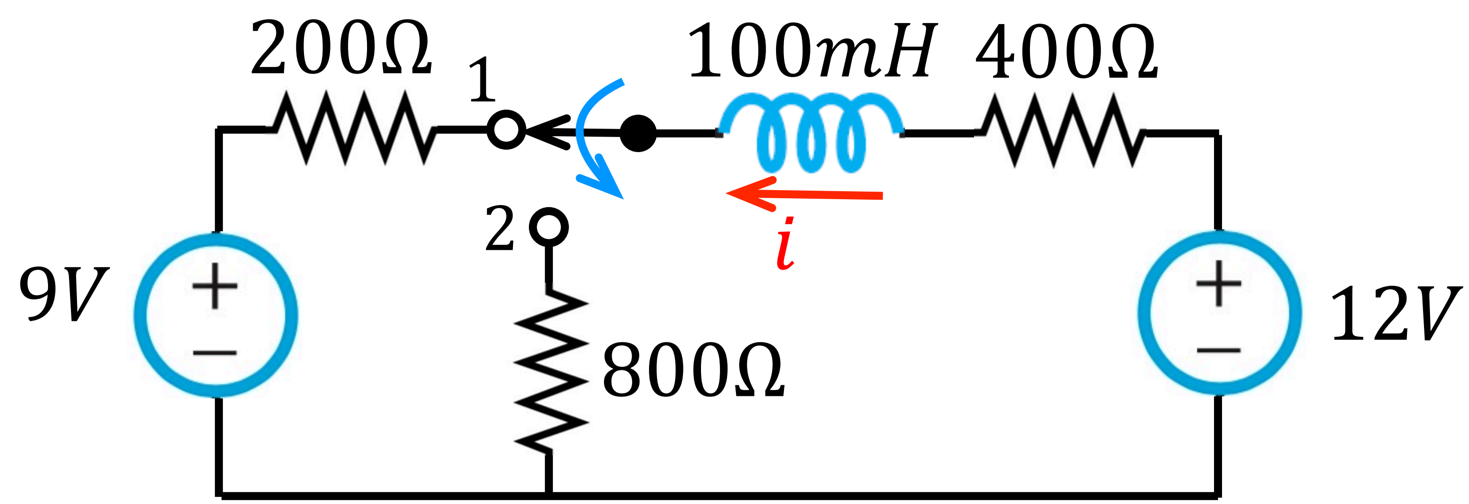
$$i_L(t) = \underbrace{i_L(\infty)}_{2} + (\underbrace{i_L(0)}_{1} - \underbrace{i_L(\infty)}_{2})e^{-\frac{R}{L}t}$$

$\frac{1}{RL}$ with capacitor

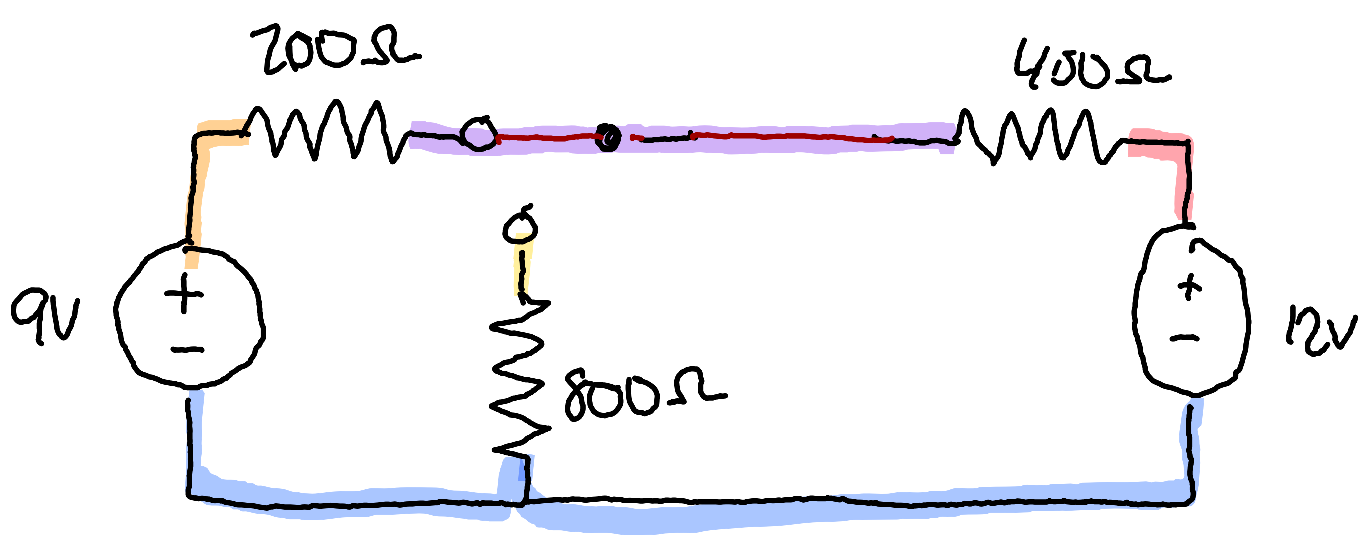


Example 1

"For a long time" before $t = 0$, switch at 1. At $t = 0$, switch at 2. Find $i_L(t)$, for $t \geq 0$.

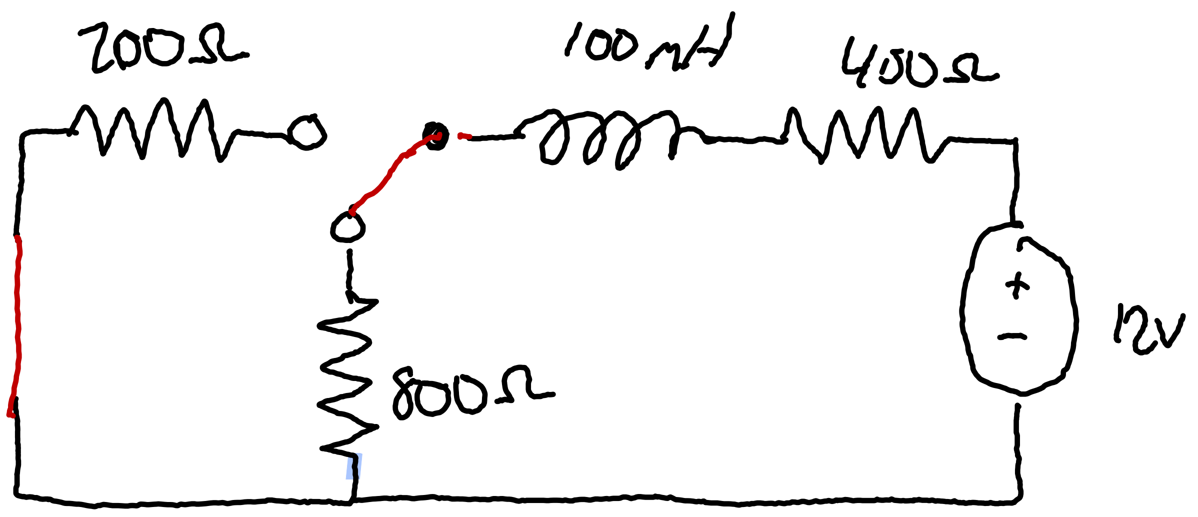


1. Initial Condition



$$i_L(\infty) = \frac{600}{100} \cdot 21 = 86\,A$$

2. Steady State



Example 2

After having been in position 1 for a long time, the switch in the circuit was moved to position 2 at t = 0. Determine:

A. $i_L(0)$
B. $i_L(\infty)$
C. $i_L(t)$ for $t \geq 0$
D. $v_L(t)$ for $t \geq 0$