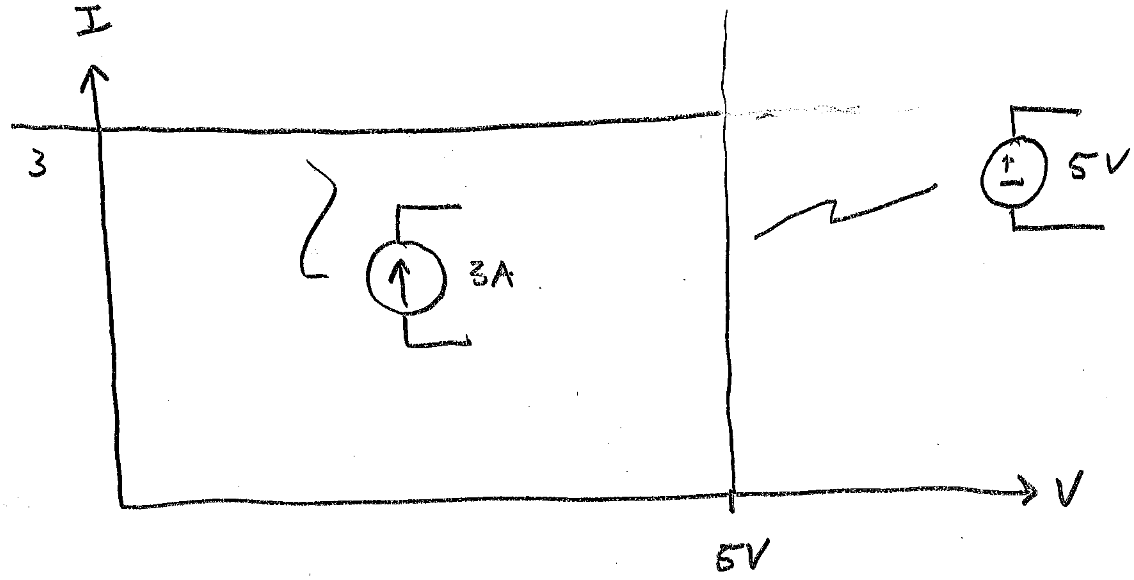
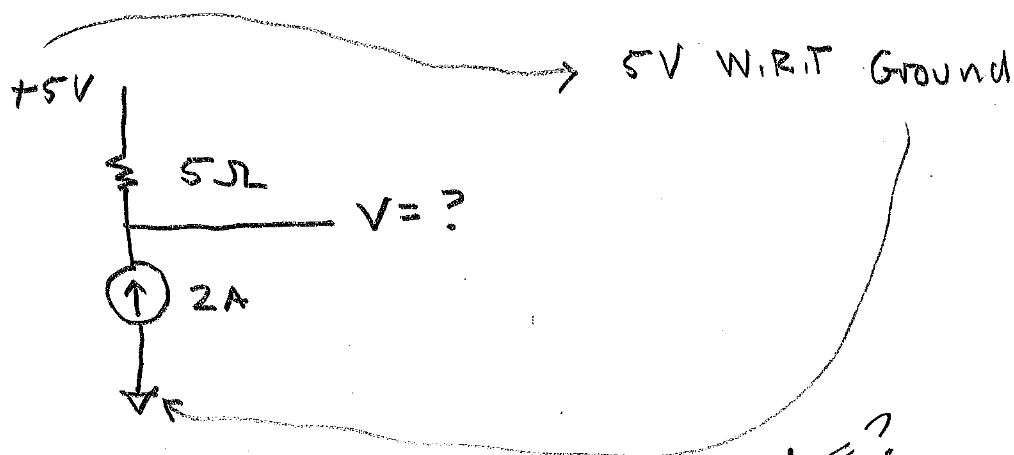
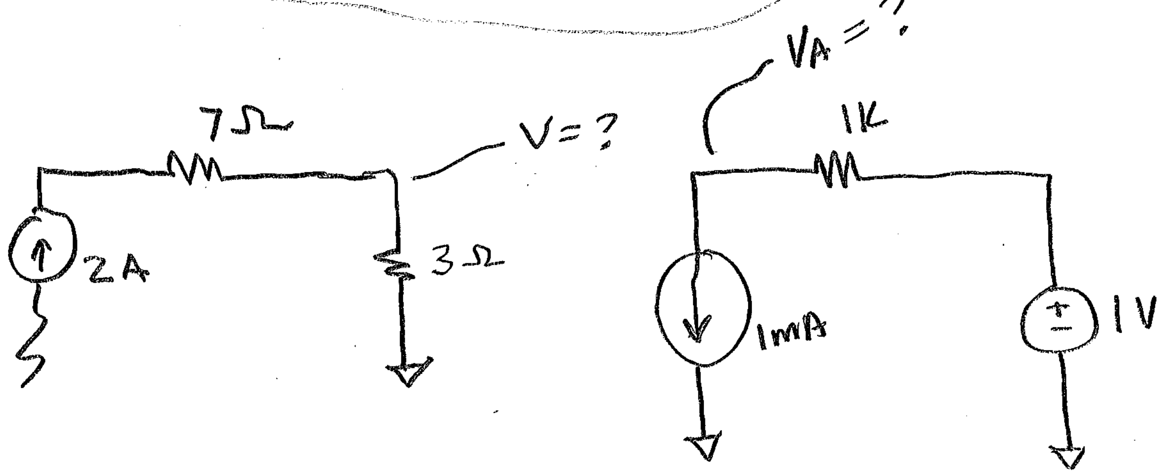
LECTURE #2

INITIAL CONDITIONS & OHM'S LAW



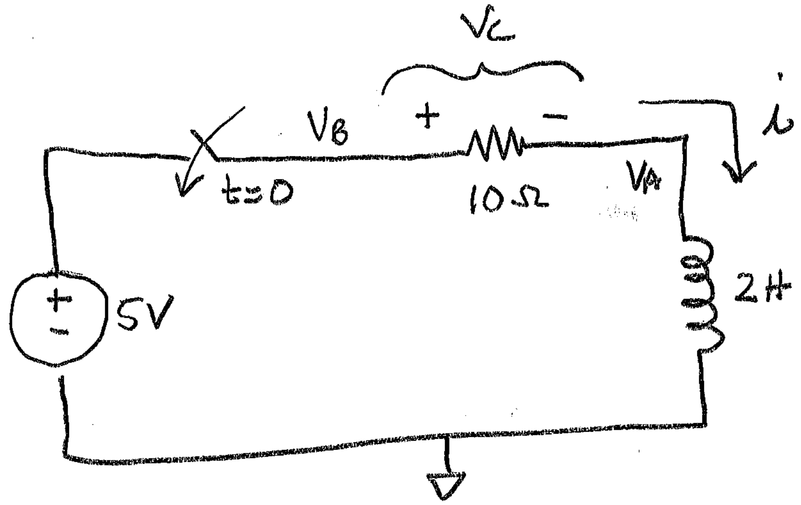
Voltage and Current sources





The Rules

"Verbal"	Equation	
Inductor current cannot change instantaneously"	$i_L(0^+) = i_L(0^-)$	(1)
Capacitor voltage cannot change instantaneously	$V_C(0^+) = V_C(0^-)$	(2)
Inductor voltage can change instantaneously	$V_L = L \frac{di}{dt}$	(3)
Capacitor current can change instantaneously	$i_C = C \frac{dv}{dt}$	(4)
At steady state $\frac{di}{dt} = 0$ so inductor voltage is zero	$V_L(\infty) = 0$	(5)
At steady state $\frac{dv}{dt} = 0$ so $i_C = 0$	$I_C(\infty) = 0$	(6)

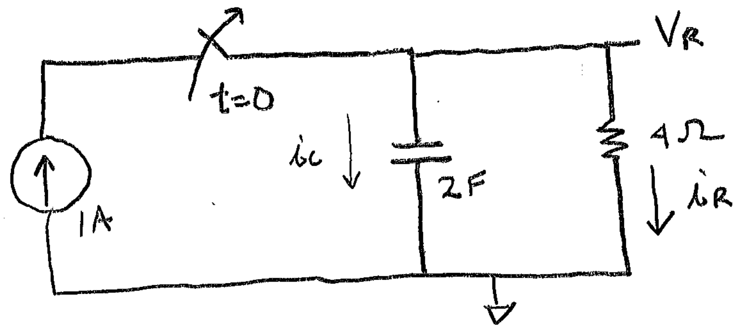


$i(0^-)=?$, $i(0^+)=?$, $i(\infty)=?$, $V_A(0^-)=?$, $V_A(\infty)=?$

$V_B(0^-)=?$, $V_B(0^+)=?$, $V_B(\infty)=?$, $V_C(0^-)=?$, $V_C(0^+)=?$

$V_C(\infty)=?$

$\frac{di}{dt}(0^+)$, $V_A(0^+) = L\frac{di}{dt}(0^+)$ so $\frac{di}{dt}(0^+) = \frac{V_A(0^+)}{L}$



$V_R(0^-) =$

$V_R(0^+) =$

$V_R(\infty) =$

$i_c(0^-) =$

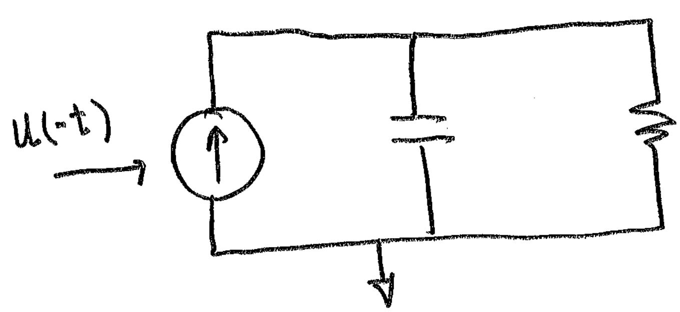
$i_c(0^+) =$

$i_c(\infty) =$

$\frac{dV_R}{dt}(0^-) =$

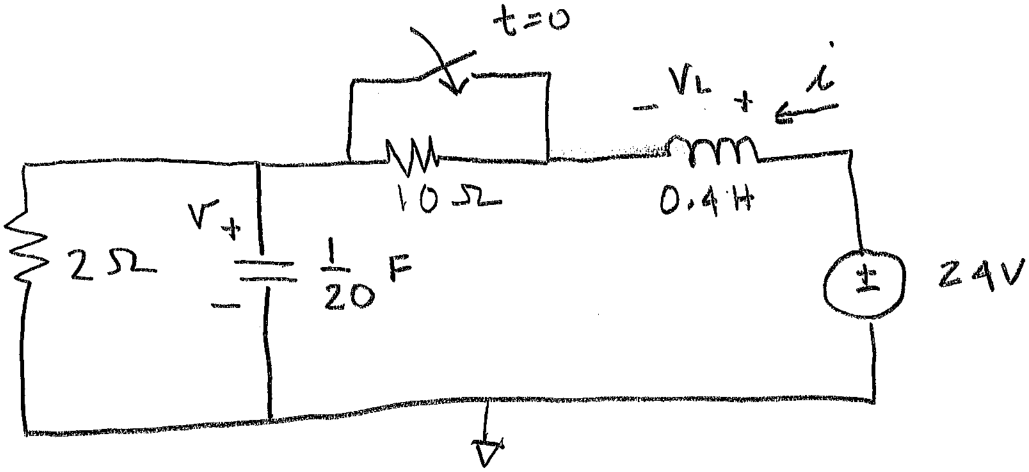
$\frac{dV_R}{dt}(0^+) = \longrightarrow \quad i_c(t=0^+) = C \frac{dV_c(0^+)}{dt}$ so $\frac{dV_c(0^+)}{dt} = \frac{i_c(0^+)}{C}$

$\frac{di_R}{dt} = \frac{dV_R}{dt}(0^+) \times \frac{1}{R}$



Better way to draw circuit

Practice problem 8.1, PG 316



$\underline{i(0^-)} = \frac{24}{10+2} = 2A$, $\underline{i(0^+)} = i(0^-) = 2A$

$\underline{v(0^-)} = \frac{2}{10+2} \times 24 = 4V$, $\underline{V(0^+)} = V(0^-) = 4V$

$\underline{\frac{di(0^+)}{dt}}$ $\quad V_L = L\frac{di}{dt}$ so $\frac{di}{dt}(0^+) = \frac{V_L(0^+)}{L}$

Since $V_c(0^+) = V_c(0^-) = 4V$ and switch is closed,

$V_L(0^+) = 24 - 4 = 20V$

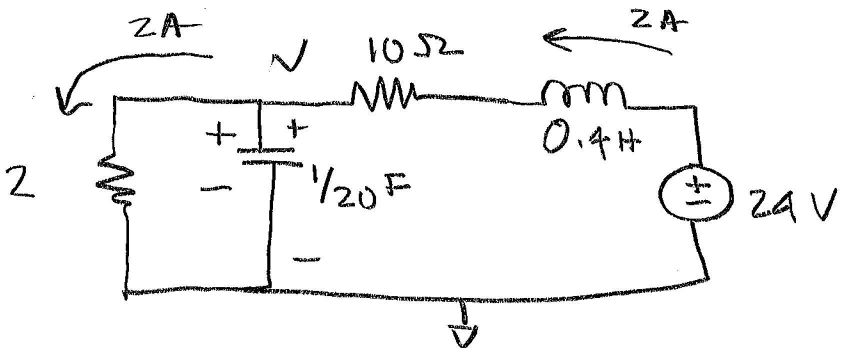
so $\frac{di}{dt}(0^+) = \frac{V_L(0^+)}{L} = \frac{20}{0.4} = 50 A/s$

Does the sign make sense?

Practice problem 8.1 CONT

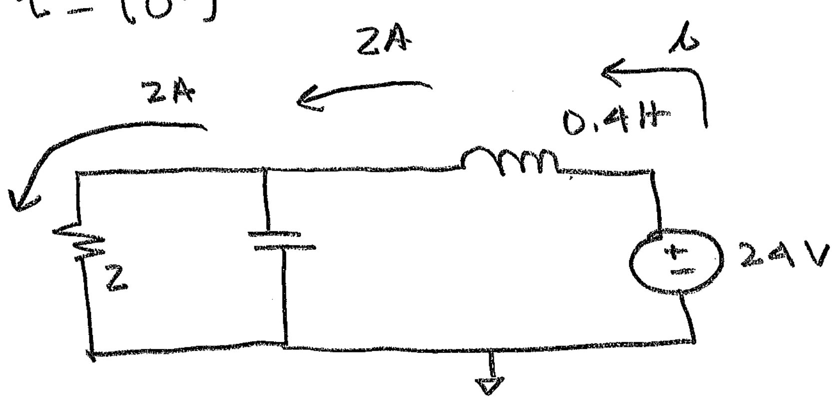
$\frac{d\,v(0^+)}{dt}$

$i = C\frac{dv}{dt}$ so $\frac{dv}{dt} = \frac{i}{C}$



At $t = 0^-$ There is no current in capacitor

at $t = (0^+)$

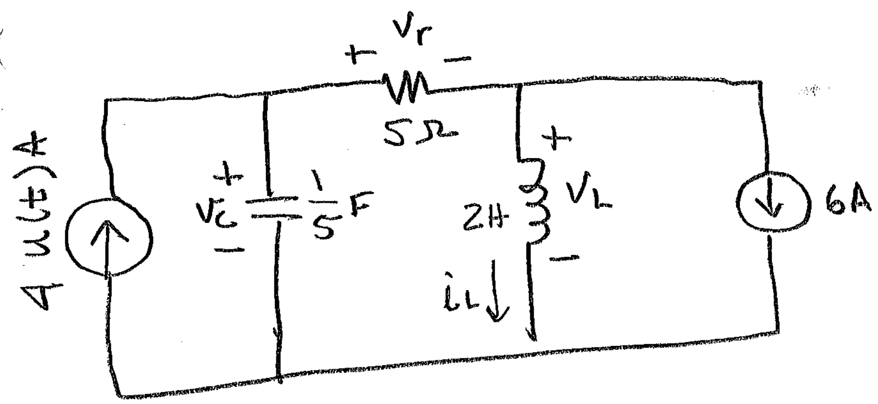


At $t = 0^+$, Capacitor current is zero!

so $\frac{dv}{dt}(0^+) = \frac{i}{C} = \frac{0}{C} = 0\ V/sec$

$i_\infty = \frac{24\ V}{2\ \Omega} = 12A$, $V_\infty = 24\ V$

Practice problem 8.2, Pg 319 LECTURE #2



$i_L(0^+) = i_L(0^-) = -6A$, $V_c(0^-) = V_c(0^+) = 0\,V$

$V_R(0^+) = 5\Omega \times i_R(0^+) = 5 \times 0 = 0$ (step current goes into cap.)

$\frac{di_L}{dt}(0^+) = \frac{V_L(0^+)}{L} = 0\,\frac{A}{s}$ (all step current goes in cap)

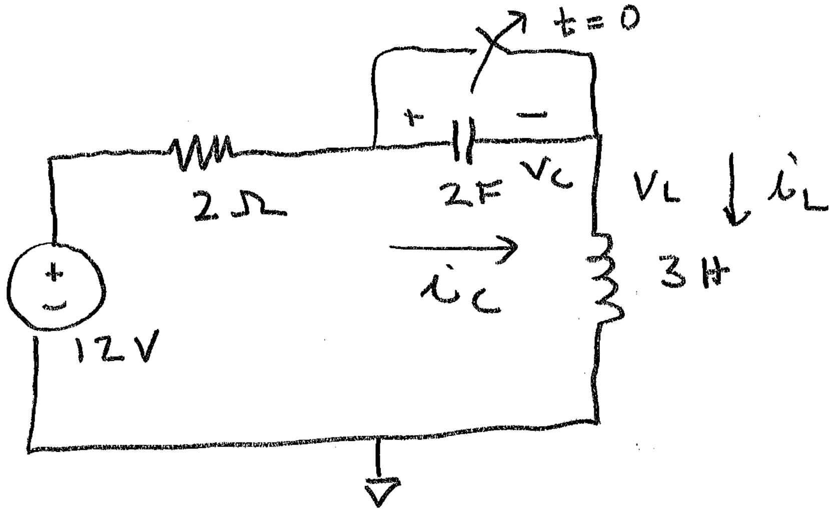
$\frac{dV_c}{dt}(0^+) = \frac{i_c(0^+)}{C} = \frac{4}{1/5} = 20\,\frac{V}{s}$

$\frac{dV_R}{dt}(0^+) = 20\,V/s$ answer in book is wrong!

$i_L(\infty) = 4A - 6A = -2A$

$V_c(\infty) = 4A \times 5\Omega = 20V$

$V_R(\infty) = 4A \times 5\Omega = 20\,V$



$V_L(0^-) =$

$i_L(0^-) =$

$i_L(0^+) =$

$i_C(0^-) =$

$i_C(0^+) =$

$V_C(0^-) =$

$V_C(0^+) =$

$V_L(0^+) =$

$\frac{dV_C}{dt}(0^+)$

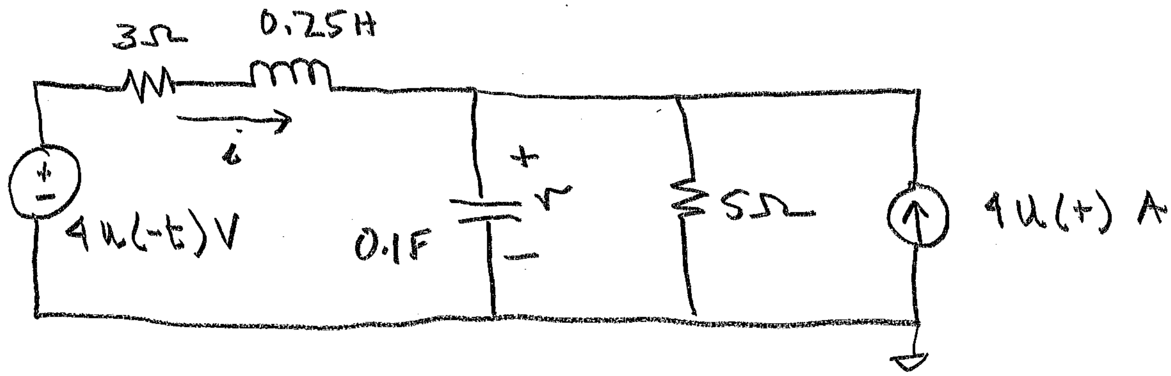
$\longrightarrow \frac{di_L}{dt} =$

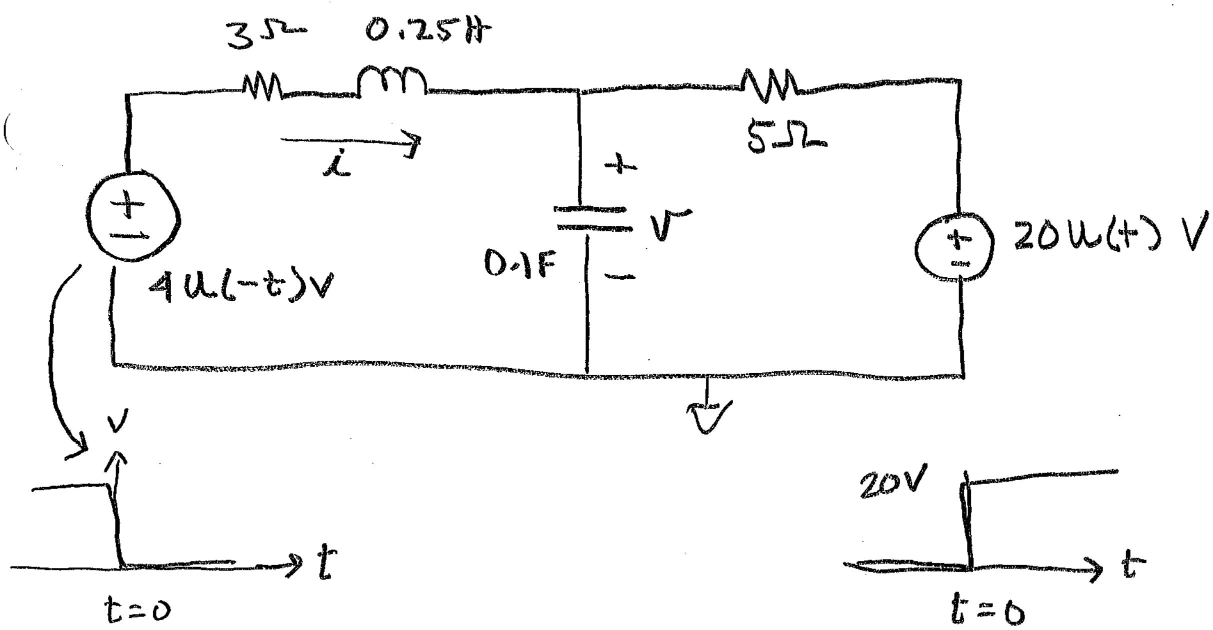
$V_L(\infty)$

$V_C(\infty)$

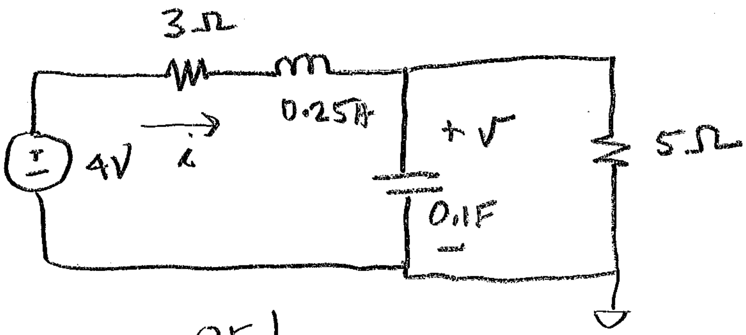
PR 8.4

Find $v(0^+)$, $i(0^+)$, $\frac{dv(0^+)}{dt}$, $\frac{di(0^+)}{dt}$, v_∞, i_∞

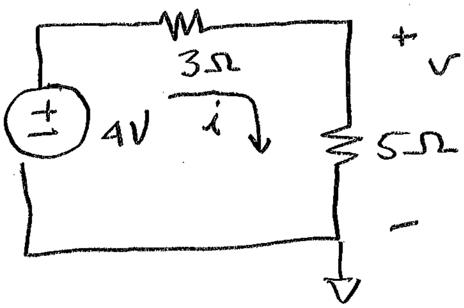




At $t = 0^-$ we have



or ↓

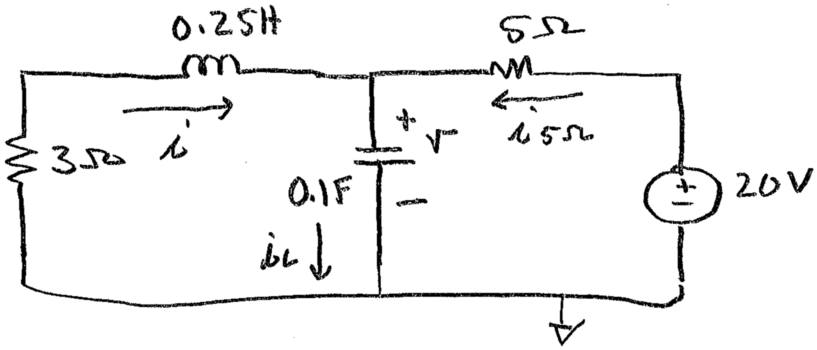


$$V = \frac{5}{5+3} \times 4 = 2.5V$$

$$i = \frac{4}{3+5} = 1/2 A$$

Note $V(0^+) = V(0^-)$ and $i(0^+) = i(0^-)$

At $t=0^+$ we have



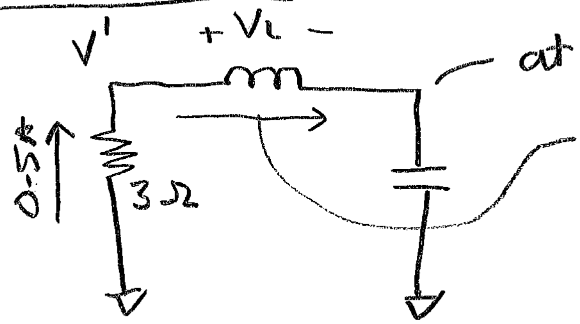
$i(0^+) = i(0^-) = 0.5A$, $V(0^+) = V(0^-) = 2.5V$

$$i(5\Omega) = \frac{20 - 2.5}{5} = 3.5A$$

so $i_C = 0.5 + 3.5 = 4A$

$i_C(0^+) = C\dfrac{dV_C(0^+)}{dt}$ so $\dfrac{dV_C}{dt} = \dfrac{i_C}{C} = \dfrac{4}{0.1} = \underline{40\ V/s}$

find $\dfrac{di}{dt}(0^+)$



at $t=0^+$, $V_C = 2.5V$

at $t=0^+$, $i = 0.5A$

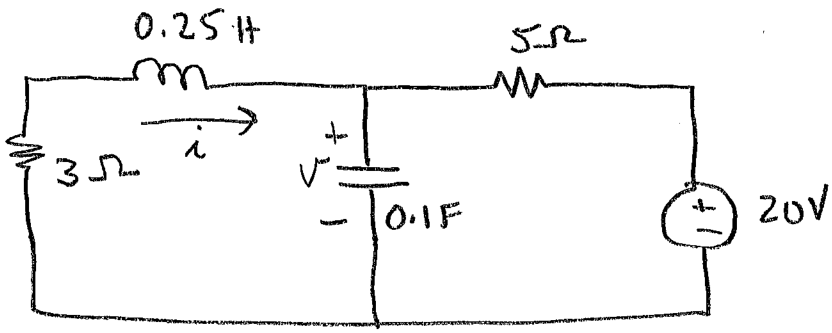
So $V' = -1.5V$

and $V_L = V' - v$

$= -1.5 - 2.5 = -4V$

$V_L = L\dfrac{di}{dt}$, $\dfrac{di}{dt} = \dfrac{V}{L} = \dfrac{-4}{0.25} = \underline{-16\ A/s}$

At $t = \infty$



$$V_\infty = \frac{3}{3+5} \times 20 = \underline{7.5\,V}$$

$$i_\infty = \frac{-20}{5+3} = \underline{-2.5A}$$