회로이론 HW#4.

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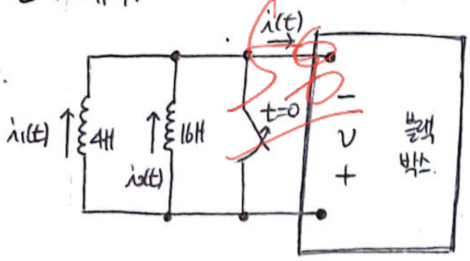
#6.24.



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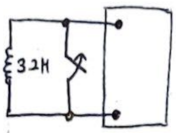
(a) 4H와 16H가 병렬연결 돼있으므로

$L_{eq} = 4H \| 16H = \frac{4\cdot16}{4+16} = 3.2H.$



t>0일 때 $V = 64e^{-4t} = 3.2\frac{di}{dt}$

$\frac{di}{dt} = 20e^{-4t}$, $di = 20e^{-4t}dt$.

$i(t) = \int_0^t 20e^{-4t}dt + i(0)$

$= -5e^{-4t}|_0^t - 5$

$= -5e^{-4t}$ 이다.

(b) t>0일때 $i_1(t)$는 $V_1(t) = 4\cdot\frac{di_1}{dt} = 64e^{-4t}$

$\frac{di_1}{dt} = 16e^{-4t}$. $di_1 = 16e^{-4t}dt$.

$i_1(t) = -4e^{-4t}|_0^t + i_1(0)$

$= -4e^{-4t}|_0^t - 10 = -4e^{-4t} - 6$

(c) t>0일때 $i_2(t)$는 $V_2(t) = 16\cdot\frac{di_2}{dt} = 64e^{-4t}$

$di_2 = 4e^{-4t}\cdot dt$

$i_2(t) = -e^{-4t}|_0^t + i_2(0) = -e^{-4t} + 6.$

(d) $p = -vi = \cancel{-64e^{-4t}}\cdot(-5e^{-4t})$

$= -(-320e^{-8t}W) = 320e^{-8t}W$

$w = \int_0^\infty p\,dt = \int_0^\infty 320e^{-8t}dt = 320\cdot\frac{1}{-8}e^{-8t}|_0^\infty$

$= 40[J]$

(e) 인덕터에서의 에너지 $w = \frac{1}{2}Li^2$으로 구할 수 있다.

$\frac{1}{2}\cdot4(-10)^2 + \frac{1}{2}\cdot16\cdot5^2 = 200+200 = 400[J]$.

(f) 인덕터에 갇혀있는 에너지(이상적인 경우)는

$W = W_{초기에너지} - W_{블랙박스로 전달된에너지} = 400-40$

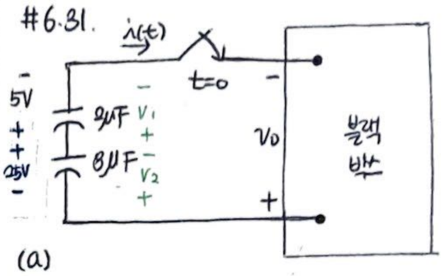
$= 360[J]$

$i_1(t)$, $i_2(t)$에서 $t\to\infty$일 때

$i_1 = -6$. $i_2 = +6$이다.

(g) $W = \frac{1}{2}\cdot4\cdot(-6)^2 + \frac{1}{2}\cdot16\cdot6^2 = 360[J]$로 (f)의 결과와 일치한다.

#6.31.



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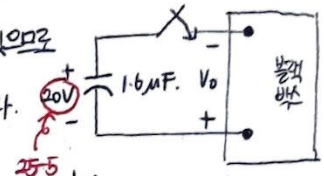
(a) 2μF과 8μF이 직렬연결돼있으므로

$C_{eq} = \frac{2\cdot8}{2+8} = 1.6\mu F$이다.



t>0일때 $i(t) = 800e^{-25t}\mu A = C\frac{dv}{dt} = 1.6\mu\cdot\frac{dv}{dt}$

$\frac{dv}{dt} = 500e^{-25t}$, $dv = 500e^{-25t}dt$.

$V(t) = \int_0^t 500e^{-25x}dx + V(0)$

$= -20e^{-25x}|_0^t - 20 = -20e^{-25t}$

(b) 2μF에 걸리는 전압 $V_1(t)$는 전압분배법칙에 의해 $V_1(t) = \frac{8}{2+8}\cdot V(t) + C = -16e^{-25t} + C$

$V_1(0) = 5$이므로 t=0일 때 $V_1(0) = -16+C = 5$.

C=21. ∴ $V_1(t) = -16e^{-25t}+21$ [V]이다.

(c) 8μF에 걸리는 전압 $V_2(t)$는

$V_2(t) = \frac{2}{2+8}V(t) + C = -4e^{-25t} + C$

$V_2(0) = -25$이므로 t=0일 때 $V_2(0) = -4+C = -25$

C=-21.

∴ $V_2(t) = -4e^{-25t} - 21$ [V]

(d) $p = -vi = -(-20e^{-25t})(800e^{-25t}\cdot10^{-6})$

$= 16\cdot10^{-3}\cdot e^{-50t}$

$W = \int_0^\infty 16\cdot10^{-3}\cdot e^{-50t}dt = \frac{16\cdot10^{-3}}{-50}\cdot e^{-50t}|_0^\infty$

$= -0.32\cdot10^{-3}e^{-50t}|_0^\infty = 320\mu J$

(e) $W_{초기} = \frac{1}{2}(2\cdot10^{-6})(5)^2 + \frac{1}{2}(8\cdot10^{-6})(25)^2 = 2525\mu J$

(f) 이상적인 축전기에 갇혀있는 에너지는 $W = W_{초기} - W_{블랙박스로 전달된에너지}$

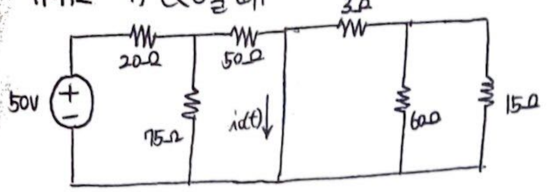
$= 2525 - 320 = 2205\mu J$이다.

(g) $V_1(t)$, $V_2(t)$에서 $t\to\infty$일 때 $V_1 = 21$, $V_2 = -21$[V]이다.

따라서 $W = \frac{1}{2}\cdot(2\times10^{-6})(21)^2 + \frac{1}{2}\cdot(2\times10^{-6})(-21)^2$

$= 2205\mu J$로 (f)의 결과와 일치한다.

#7.2 1) $t<0$일 때



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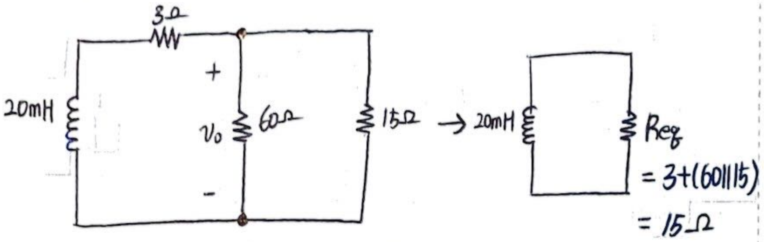
$i_o(0)$은 50Ω에 흐르는 전류와 동일하다.

$$i_o(0) = \frac{50V}{20+(75\|50)} \cdot \frac{75}{75+50} = 0.6\ A.$$

2) $t\geq 0$ 일 때



(a) $i_o(t) = i_o e^{-\frac{t}{\tau}}$, $\tau = \frac{L}{R} = \frac{0.02}{15} \rightarrow \frac{1}{\tau} = 750\ s$

$\Rightarrow i_o(t) = 0.6 e^{-750t}$ [A]

(b) $V_L(t) = L \cdot \frac{di_o}{dt} = 0.02 \times 0.6(-750) e^{-750t}$

$= -9e^{-750t}$ [V]

V_o는 전압분배법칙에 의해.

$V_o(t) = -9e^{-750t} \cdot \frac{60\|15}{3+(60\|15)} = -9e^{-750t} \cdot \frac{12}{15}$

$= -7.2e^{-750t}$ [V]

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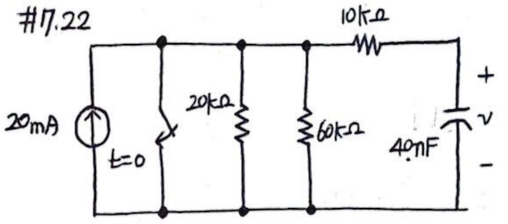
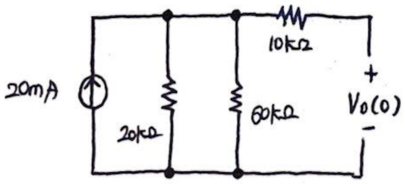
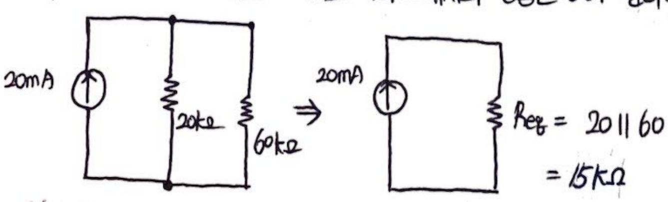
#7.22



$t<0$ 일 때는 회로가 아래와 같으며 축전기는 open시킬 수 있다.

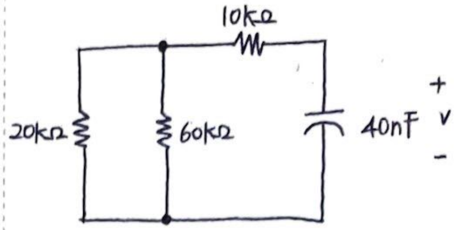


open circuit에서 전류는 0이므로 10kΩ에서의 전압은 0이 된다.

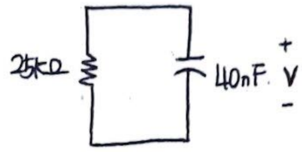


$V_o(0)$는 20kΩ, 60kΩ에 병렬연결 되있으므로 20kΩ, 60kΩ에 걸리는 전압과 동일하다. 따라서 $V_o(0) = 15\cdot 10^3 \cdot 20 \cdot 10^{-3} = 300V$

$t\geq 0$일 때



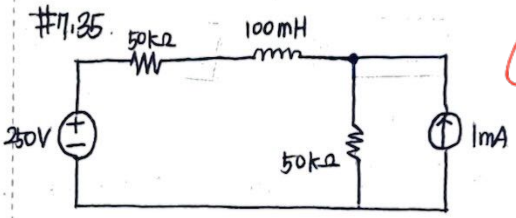
$R_{eq} = (20\|60)+10 = 25k\Omega$



$\tau = RC = 25\cdot 10^3 \cdot 40 \cdot 10^{-9} = 1ms.$

$v(t) = V_o e^{-\frac{t}{\tau}} = 300 \cdot e^{-1000t}\ V.$

#7.35



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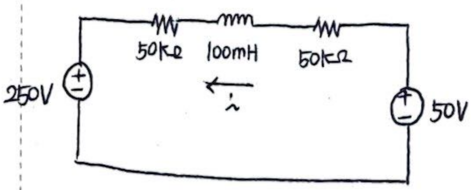
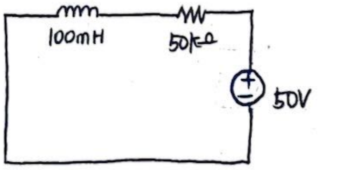
$t<0$일 때.



(a) $i_o = \frac{50-250}{50k+50k} = \frac{-200}{100k} = -2$[mA]

$t\geq 0$일 때.



(b) $t\to\infty$일 때 전류 i의 최종값은 50kΩ과 50V에 의해 $i(\infty) = \frac{50}{50k} = 1mA.$

(c) $R = 50k\Omega$, $L = 100mH$

$\tau = \frac{L}{R} = \frac{100m}{50k} = 2\mu s$

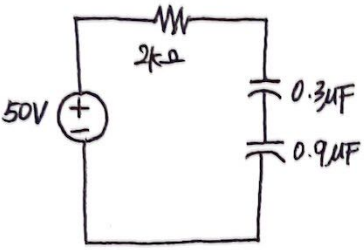
(d) $i(t) = \frac{V_s}{R} + (I_o - \frac{V_s}{R})e^{-(R/L)t}$

$= i(\infty) + (i_o - i(\infty))e^{-\frac{1}{2\mu s}t}$

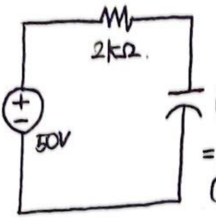
$= 1mA + (-2mA - 1mA)e^{-5\cdot 10^5 t}$

$= 1 - 3e^{-5\cdot 10^5 t}$ mA.

#7.65 t<0일때



$\rightarrow$



$C_{eq} = \dfrac{0.3 \cdot 0.9 \cdot 10^{-12}}{(0.3+0.9)10^{-6}} = 0.225\mu F$

$V_0(0) = 50V$

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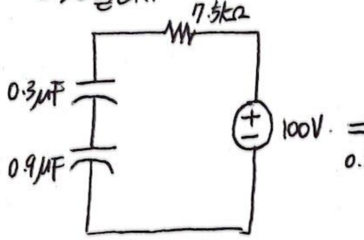
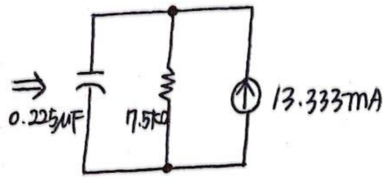
$V_1(0) = 50 \cdot \dfrac{0.9}{0.3+0.9} = 37.5V$

$V_2(0) = 50 \cdot \dfrac{0.3}{0.3+0.9} = 12.5V$

t>0일때.



$\Rightarrow$



(a) $V = I_SR + (V_0 - I_SR)e^{-t/RC}$, $\tau = RC = 7.5k \cdot 0.225\mu = 1.6875\ ms$

$= 100 + (50-100)e^{-592.59t}$

$= 100 - 50e^{-592.59t}$

(b) $i_o(t) = -C\dfrac{dV}{dt} = -(0.225 \cdot 10^{-6}) \cdot (50 \cdot 592.59)e^{-592.59t}$

$= -6.667e^{-592.59t}$ [mA]

(c) 축전기에 걸리는 전압은 $V = \frac{1}{C}\int i_o(t)\,dt + V_o(0)$ 이다.

$V_1(t) = \dfrac{-1}{0.3 \cdot 10^{-6}} \int_0^t -6.667e^{-592.59x} \cdot 10^{-3}\,dx + 37.5$

$= \dfrac{-10^{-3}}{0.3 \cdot 10^{-6}} \cdot \dfrac{6.667}{592.59} e^{-592.59x}\Big|_0^t + 37.5$

$= -37.502e^{-592.59t} + 75.002$ [V]

(d) $V_2(t) = \dfrac{-1}{0.9 \cdot 10^{-6}} \int_0^t -6.667e^{-592.59x} \cdot 10^{-3}\,dx + 12.5$

$= \dfrac{-1 \cdot (-6.667) \cdot 10^{-3}}{0.9 \cdot 10^{-6}(-592.59)} e^{-592.59x}\Big|_0^t + 12.5$

$= -12.5e^{-592.59t} + 35$ [V]

(e) $W = \frac{1}{2}CV^2 = \frac{1}{2} \cdot 0.225 \cdot 10^{-6} \cdot (50)^2 = 281.25\mu J$