電路學 (一)　第三次測驗　　四電機二 A　　2017 年 12 月 7 日　(星期四)

每題 20 分，滿分 120 分

1. Find the equivalent capacitance between terminals *a* and *b* in the circuit of **Fig. 1**.
2. In **Fig. 2**, the switch has been placed at position 1 for a long time before moving to position 2 at t=0. If $v_{c2}(0^-)$=0, (a) find $i(t)$ for t>0; (b) find the energy dissipated by the 3-Ω resistor.

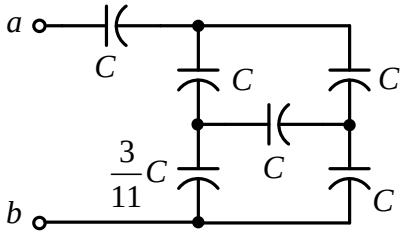


Fig. 1

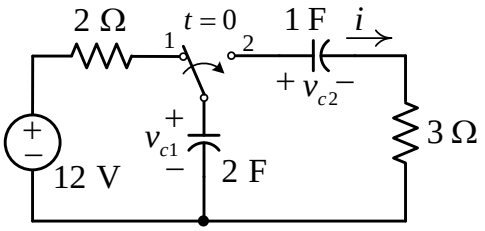


Fig. 2

3. Find $v_C(t)$ for t>0 in the circuit of **Fig. 3** if the switch opens at t=0.
4. In the circuit of **Fig. 4**, the switch closes at t=0. If the initial value of i_L is zero, find $i_L(t)$ for t>0.

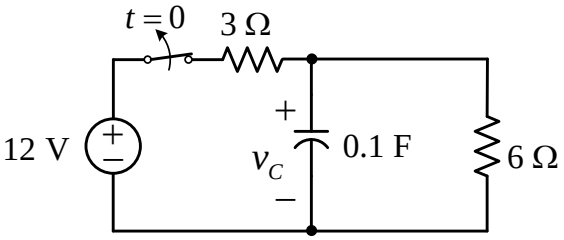


Fig. 3

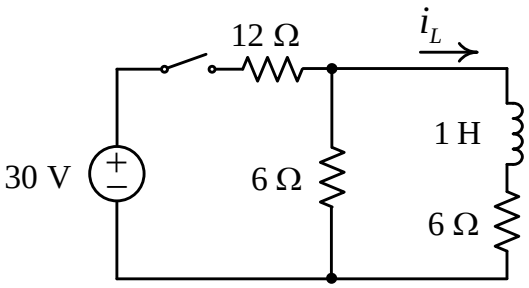


Fig. 4

5. The switch in **Fig. 5** has been closed for a long time before opening at t=0. Find the voltage $v_o(t)$ for t>0.
6. The circuit in **Fig. 6** has reached steady-state before the switch closes at t=0, find $v_o(t)$ for t>0.

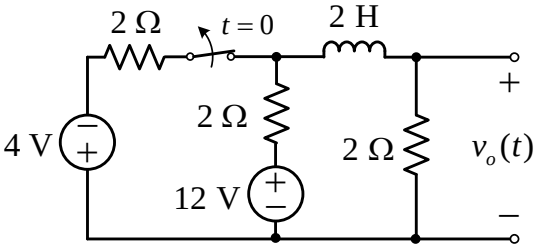


Fig. 5

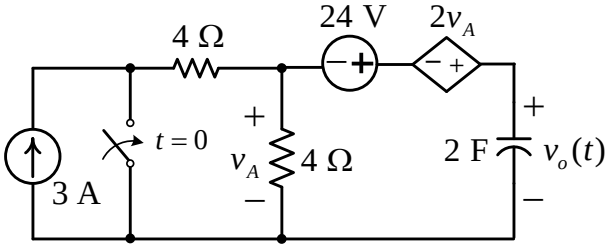


Fig. 6

電路學(一) 第三次考試　　四電機二 A　　2017 年 12 月 7 日(星期四)

每題 20 分，滿分 120 分

1. Find the equivalent capacitance between terminals a and b in the circuit **Fig. 1.**

2. In **Fig. 2** the switch has been placed at position 1 for a long time before moving to position 2 at t=0. If $V_{C2}(0^-)$ =0, (a) find $i(t)$ for t>0; (b) find the energy dissipated by the 3-Ω resistor.

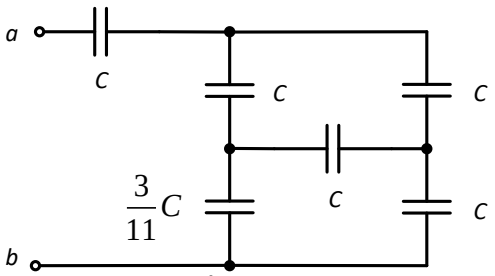


Fig. 1

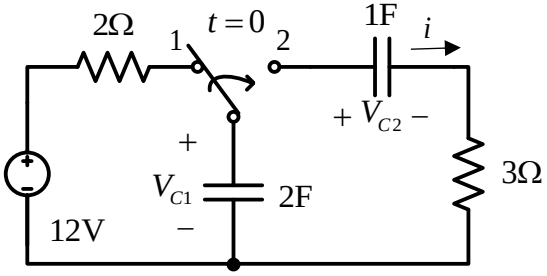


Fig. 2

3. Find $v_C(t)$ for t>0 in the circuit **Fig. 3** if the switch opens at t=0.

4. In the circuit of **Fig. 4**, the switch closes at t=0. If the initial value of i_L is zero , find $i_L(t)$ for t>0.

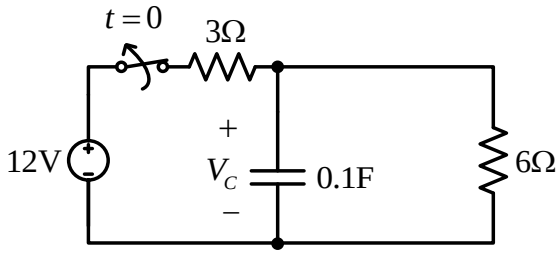


Fig. 3

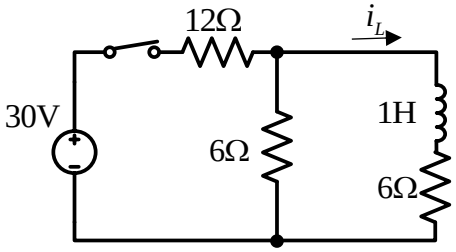


Fig. 4

5. The switch in **Fig. 5** has been closed for a long time before opening at t=0. Find the voltage $v_o(t)$ for t>0.

6. The switch in **Fig. 6** has reached steady-state before the switch closes at t=0, find the voltage $v_o(t)$ for t>0.

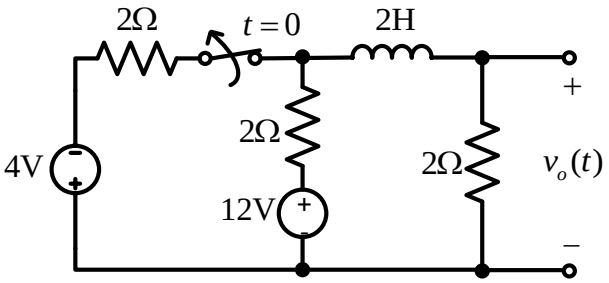


Fig. 5

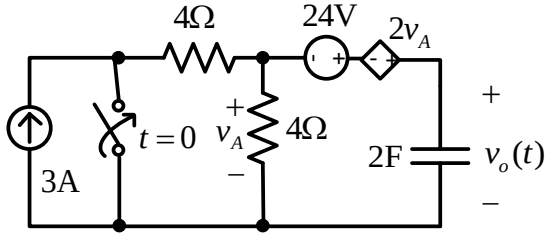


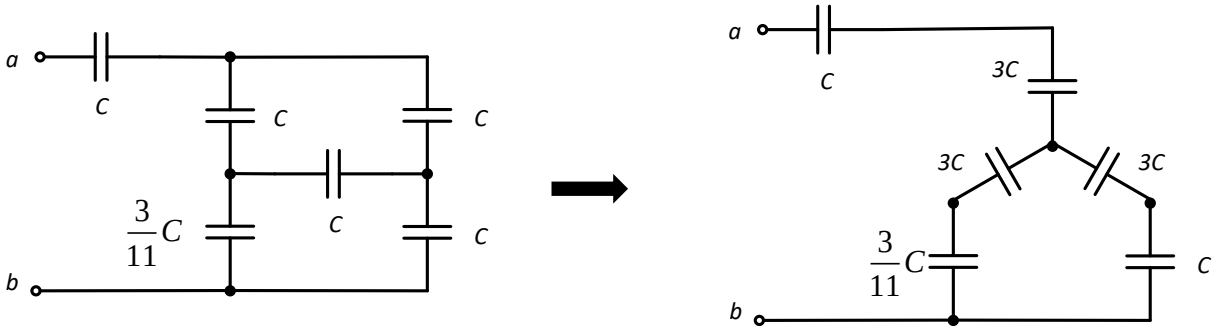
Fig. 6

電路學(一) 第三次考試 參考解答

1. 將圖 1 利用Δ-Y 轉換,如下圖所示

$$C_1^{-1}=\frac{\frac{1}{C}\times\frac{1}{C}}{\frac{1}{C}+\frac{1}{C}+\frac{1}{C}}=\frac{1}{3C}\quad,\quad C_1=3C=C_2=C_3$$

$$C_{ab}=C//3C//\left[(3C//\frac{3}{11}C)+(3C//C)\right]=C//3C//C=\frac{3}{7}C(\mathrm{F})$$



2. ⑷電流初值: $i(0)=\frac{12}{3}=4\mathrm{A}$ ，電流終值: $i(\infty)=0\mathrm{A}$

令 $i(t)=A+B\mathrm{e}^{-\frac{t}{\tau}}$ ， $i(0)=A+B=4$ ， $i(\infty)=A=0$ ， $B=4$

$\tau=RC=3\cdot\frac{2}{2+1}=2\mathrm{s}$ ，最後得知 $i(t)=4\mathrm{e}^{-\frac{t}{2}}\mathrm{A}$

⑸計算開關閉合前後的儲能差值

$Q=CV=2\cdot12=24\mathrm{F}$ ，

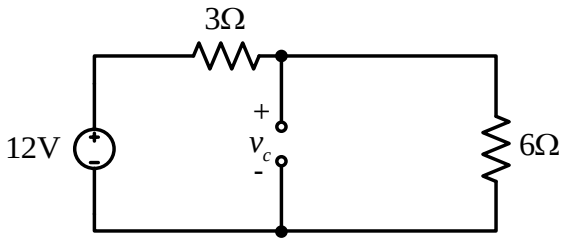
$t=\infty$ ， $C_1\cdot V_{c1}+C_2\cdot V_{c2}=3V_f=24$ ， $V_f=8\mathrm{V}$ ， $V_{c1}=V_{c2}$

開關閉合前， $t=0$ ， $W_0=\frac{1}{2}\cdot C_1\cdot V_1^2=\frac{1}{2}\cdot2\cdot12^2=144\mathrm{J}$

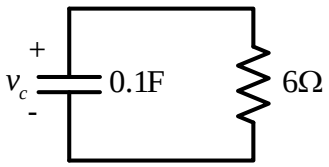
開關閉合後， $t=\infty$ ， $W_1=\frac{1}{2}\cdot C_1\cdot V_f{}^2+\frac{1}{2}\cdot C_2\cdot V_f{}^2=\frac{1}{2}\cdot2\cdot8^2+\frac{1}{2}\cdot1\cdot8^2=96\mathrm{J}$

$\Delta W=W_1-W_2=144-96=48\mathrm{J}$

3. 開關閉合時,電壓初值: $v_c(0)=12\cdot\frac{6}{3+6}=8\text{V}$



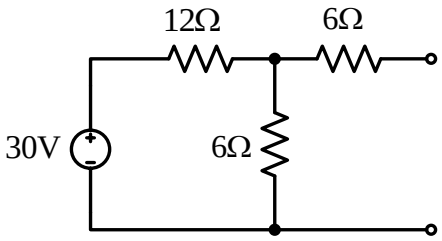
$t=0$時,開關打開,電壓終值: $v_c(\infty)=0\text{V}$

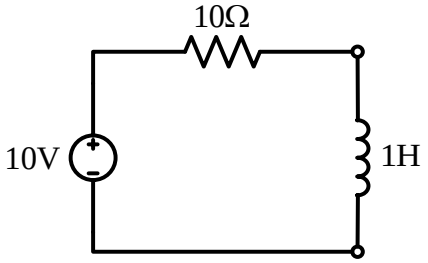


$v_c(t)=A+B\text{e}^{-\frac{t}{\tau}}$ ， $v_c(0)=A+B=8$ ， $v_c(\infty)=A=0$ ， $\tau=RC=6\cdot0.1=0.6\text{s}$

最後得知 $v_c(t)=8\text{e}^{-\frac{t}{0.6}}\text{V}$

4. 電流初值: $i_L(0)=0\text{A}$ ； $t=0$時開關閉合,由電感看入求戴維寧等校電路





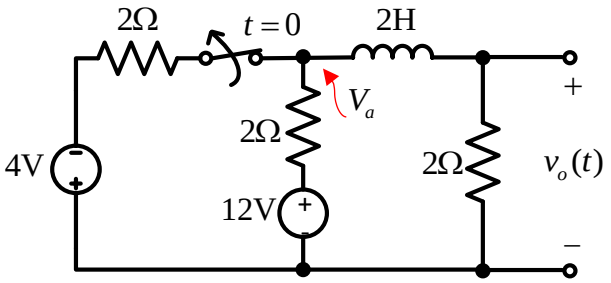
$\text{R}_{th}=(12//6)+6=10\Omega$ ， $\text{V}_{th}=30\cdot\frac{6}{12+6}=10\text{V}$

$i_L(\infty)=\frac{10}{10}=1\text{A}$ ， $i_L(t)=A+B\text{e}^{-\frac{t}{\tau}}$ ， $i_L(0)=A+B=0$

$i_L(\infty)=A=1$ ， $B=-1$ ， $\tau=\frac{L}{R}=\frac{1}{10}=0.1\text{s}$

最後得知 $i_L(t)=1-\text{e}^{-\frac{t}{0.1}}=1-\text{e}^{-10t}\text{A}$

5. 將圖五 a 點電壓設為 V_a



$$\frac{V_a+4}{2}+\frac{V_a-12}{2}+\frac{V_a}{2}=0$$

$$V_a+4+V_a-12+V_a=0$$

$$V_a=\frac{8}{3}\text{V}$$

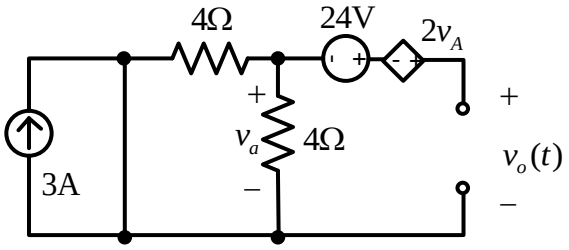
$$i(0)=\frac{\frac{8}{3}}{2}=\frac{4}{3}\text{A}\ ,\ i(\infty)=\frac{12}{2+2}=3\text{A}\ ,$$

$$i(t)=A+B\text{e}^{-\frac{t}{\tau}}\ ,\ i(0)=A+B=\frac{4}{3}\ ,\ i(\infty)=A=3\ ,\ B=-\frac{5}{3}\ ,$$

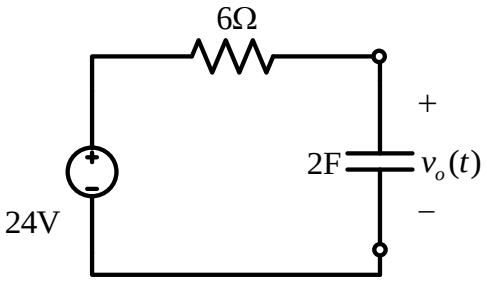
$$\tau=\frac{L}{R}=\frac{2}{4}=0.5\text{s}\ ,\ i(t)=3-\frac{5}{3}\text{e}^{-\frac{t}{0.5}}=3-\frac{5}{3}\text{e}^{-2t}\text{A}$$

最後得知 $v_o(t)=2\cdot i(t)=6-\frac{10}{3}\text{e}^{-2t}\text{V}$

6. 開關閉合前, $v_A=3\cdot 4=12\text{V}$, $v_o(0)=v_A+24+2v_A=60\text{V}$



開關閉合後,由 $v_o(t)$ 看入求戴維寧等校電路,此時 4Ω 無電流通過, v_A=0V ,因此開路電壓 $V_{oc}=24\text{V}$; 利用克希荷夫電路定律寫出下列方程式 $24=v_A+2v_A$, v_A=8V ,得到開路電流 $I_{sc}=\frac{v_A}{4}\cdot 2=\frac{8}{4}\cdot 2$=4A ,因此求得 $R_{th}=\frac{V_{oc}}{I_{sc}}=6\Omega$ 。



$$v_o(\infty)=24\text{V}$$

$$v_o(t)=A+B\text{e}^{-\frac{t}{\tau}}\ ,\ v_o(0)=A+B=60$$

$$v_o(\infty)=A=24\ ,\ B=36$$

$$\tau=RC=6\cdot 2=12\text{s}$$

最後得知 $v_o(t)=24+36\text{e}^{-\frac{t}{12}}\text{V}$