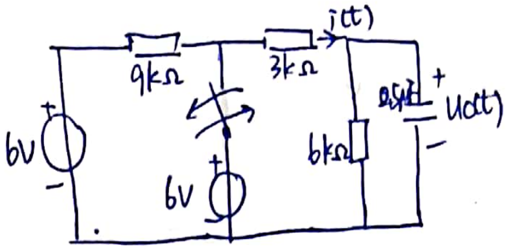
① $t<0$时电路已稳定. $t=0$时打开开关S. $t=8ms$时合上S. 求$t\geq 0$时的$u_C(t)$和$i(t)$. 并画它们的变化曲线.



解: 一. $t\in[0,8]$(ms)

(1) 求$u_C(0_+)$.

$u_C(0_+)=\frac{6}{3+6}\times 6=4V$.

(2) 求$u_C(\infty)$

$u_C(\infty)=\frac{6}{9+3+6}\times 6=2V$.

(3) 求τ_1. (两个电路τ不同).

$R_1=4k\Omega$.

$\tau_1=4k\cdot 0.5\mu=2\times10^{-3}s=2ms$. 注意单位

(4) 表达式.

$u_C(t)=2+2e^{-\frac{t}{2\times10^{-3}}}=2+2e^{\boxed{-500t}}$ V. $\boxed{(0\leq t\leq 8ms)}$

$i(t)=\frac{6-u_C}{12}=\frac{1}{3}-\frac{1}{6}e^{-500t}$ mA $(0\leq t\leq 8ms)$

二. $t\geq 8ms$.

(1) 求$u_C(8ms_+)$

$u_C(8ms_+)=u_C(8ms_-)=2V$.

(2) $u_C(\infty)$

$u_C(\infty)=4V$.

(3) 求τ_2.

$R_2=2k\Omega$. $\tau_2=1ms$.

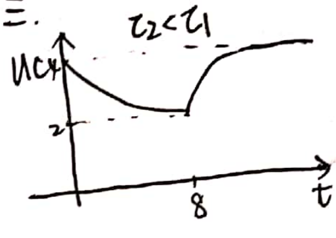
(4) 表达式.

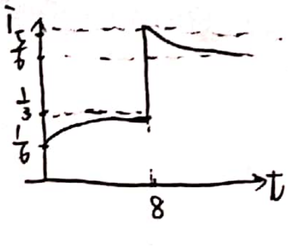
$u_C(t)=4-2e^{-1000(t-8\times10^{-3})}$ V $(8<t)$.

$i(t)=\frac{6-u_C}{3}=\frac{2}{3}+\frac{2}{3}e^{-1000(t-8\times10^{-3})}$ mA $(\cdots)$.

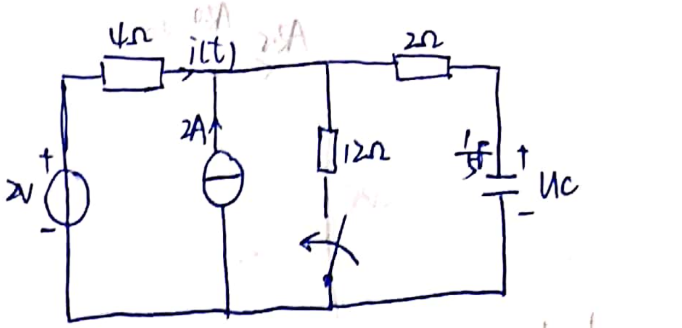
不要照抄.

三. $\tau_2<\tau_1$



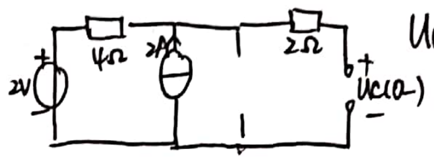


② $t<0$时电路已稳定. $t=0$时合上S. 求u_C. i.



解: i的τ和u_C的τ相同.

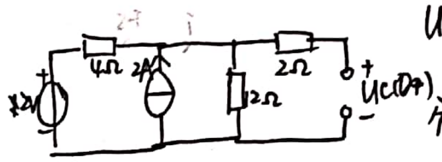
(1) 求$u_C(0_+)$. 画$t=0_-$电路.



$u_C(0_-)=4\times2+2=10V$.

$u_C(0_+)=10V$.

(2) 求$u_C(\infty)$. 画$t=\infty$电路.



$u_C(\infty)=\frac{\frac{2}{4}+2}{\frac{1}{4}+\frac{1}{12}}=7.5V$.

分子: 所有流入节点电流 电导

(3) 求τ $(\underline{t=0_+})$

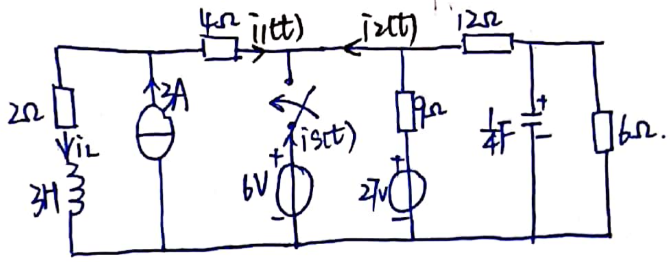
$R_{eq}=3\Omega$. $\tau=1s$.

(4) $\therefore u_C(t)=7.5+2.5e^{-t}$ V $(\underline{t\geq 0_+})$

$i_C(t)=C\frac{du_C}{dt}=-0.5e^{-t}$ A $(t\geq 0_+)$.

$i(t)=\frac{2-(2i_C+u_C)}{4}$

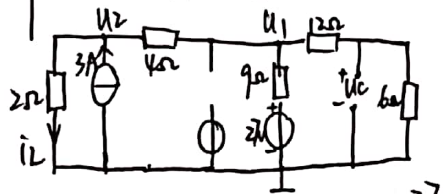
③ $t<0$时电路已稳定. $t=0$时合上S. 求$u_C(t)$. $i_L(t)$. $i_S(t)$.



中间的6V把左右两边分开.

(电压源并联开路).

解: 1. $u_C(0+)$ $i_L(0+)$.



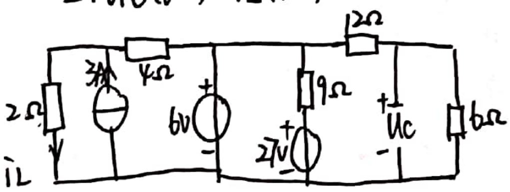
u_1: $(\frac{1}{4}+\frac{1}{9}+\frac{1}{18})u_1-\frac{1}{4}u_2=\frac{27}{9}$.

u_2: $-\frac{1}{4}u_1+(\frac{1}{2}+\frac{1}{4})u_2=3$

$\therefore u_1=12V$. $u_2=8V$.

$u_C(0+)=4V$. $i_L(0+)=4A$.

2. $u_C(\infty)$. $i_L(\infty)$.



$u_C(\infty)=2V$. $i_L(\infty)=3A$.

3. τ_C. τ_L.

$G_L=\frac{1}{6}$. $R_C=4\Omega$.

$\tau_C=1s$. $\tau_L=0.5s$.

4. $u_C(t)=2+2e^{-t}\ V\ (t\geq 0+)$

$i_L(t)=3+e^{-2t}\ A\ (t\geq 0+)$

$i_S(t)=-i_1(t)-i_2(t)$.

$i_1(t)=3-i_L(t)$.

$i_2(t)=\frac{27-6}{9}+\cancel{12}\frac{u_C-6}{12}$.

$i_S(t)=-\frac{5}{3}+e^{-2t}-\frac{1}{6}e^{-t}\ A\ (t\geq 0+)$

等效电阻 { 短路 / 受控

功率

等效变化.

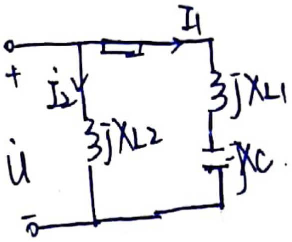
叠加

戴维南

交流 { 谐振 / 非正弦.

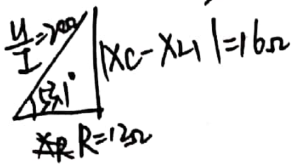
一阶电路.

⑤ $U=100V$. $I_1=5A$. $\dot{U}$滞后$\dot{I}_1$ 53.1°.
且$\dot{U}$与$\dot{I}$同相. 已知$X_C=5X_{L1}$. 以$\dot{I}_1$为参考相量……

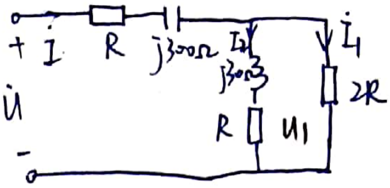


$P=U\cdot I\cos 0°$
$=P_R=I_1^2R$

对I_1求阻抗: → 阻抗三角形.



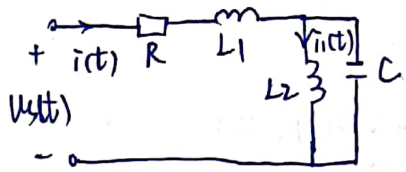
⑥. $I_1=I_2=2A$.



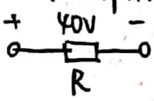
$(2R+j30)\cdot 2\angle ? = 2R\cdot 2$.

I_1与I_2支路上阻抗相同. ∴ $2R=\sqrt{R^2+30^2}$. $R=10\sqrt{3}\Omega$.
设$\dot{I}_1=2\angle 0°A$. ∴ $\dot{U}_1=40\sqrt{3}\angle 0°A$. $\dot{I}_2=\frac{\dot{U}}{R+j30}=\frac{40\sqrt{3}\angle 0°}{20\sqrt{3}\angle 60°}=2\angle -60°$
∴ $\dot{I}=\dot{I}_1+\dot{I}_2=3-j\sqrt{3}=2\sqrt{3}\angle -30°A$.
∴ $\dot{U}=(10\sqrt{3}-j30)\cdot 2\sqrt{3}\angle -30°+\dot{U}_1=80\sqrt{3}\angle -60°V$. $U=80\sqrt{3}V$.
$P=UI\cos\varphi=80\sqrt{3}\cdot 2\sqrt{3}\cdot\cos[-60°-(-30°)]=240\sqrt{3}W$.
(电压-电流的相位差).
$Q=UI\sin\varphi=480\sin(-30°)=-240W$.

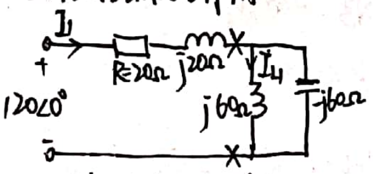
⑦ $u_S(t)=40+120\sqrt{2}\sin\omega t+60\sqrt{2}\sin 2\omega t$.
$R=20\Omega$. $\omega L_1=20\Omega$. $\omega L_2=60\Omega$. $\frac{1}{\omega C}=60\Omega$.
求i_1. i_L和I_L.



1. 40V作用. $i_{10}=i_{L0}=2A$.

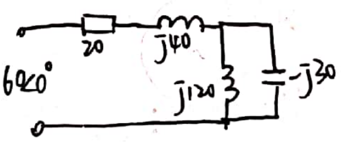


2. $120\sqrt{2}\sin\omega t$作用.



并联谐振. $\dot{I}_1=0$.
$\dot{I}_{L1}=\frac{120\angle 0}{j60}=2\angle -90°$.

3. $60\sqrt{2}\sin 2\omega t$.

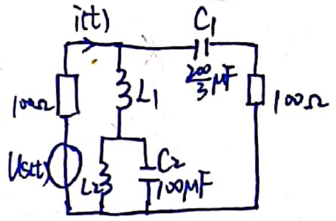


$\frac{j120\times j30}{j120-j30}=\frac{3600}{j90}=j40$

$\dot{I}_2=3A$. $\dot{I}_{L2}=-1A$.
$I=2+3\sqrt{2}\sin 2\omega t$.
$I_L=2+2\sqrt{2}\sin(\omega t-90°)$
$-\sin 2\omega t$.

⑧ $u_S(t)=10+500\sqrt{2}\sin 100t+200\sin 300t$. 若$L_1$中无基波电流. C_1 只有基波电流. 求L_1. L_2和$i(t)$.

(1次)



1. L_2. C_2并联谐振(1次)
$100=\frac{1}{\sqrt{L_2C_2}}$ ∴ $L_2=1H$.
2. L_2并C_2与L_1对3次…串联…
$j300L_1+\frac{j300\times(-j\frac{100}{3})}{j300-j\frac{100}{3}}=0$
$L=0.125H$

$I_0=0.1A$. $\frac{1}{100\times 100\times 10^{-6}}=100\cdot L_2$
$\dot{I}_1=\frac{500\angle 0°}{200-j150}=2\angle 36.9°$.
$\dot{I}_{3m}=\frac{200}{100}=2A$.
$i(t)=0.1+2\sqrt{2}\sin(100t+36.9°)+2\sin 300t$.

两课堂题

概念题.

1. 电流方向是电压降低的方向.

网孔电流法：$(b-(n-1))=m$个方程).

2. 电导单位：西门子(S).

对网孔1：$R_{11}I_{m1}+\underline{R_{12}}I_{m2}+\underline{R_{13}}I_{m3}=U_{s1}$ 电压：电压源升为正.

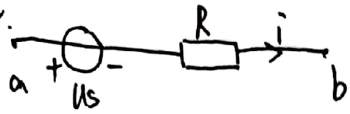
→自电阻（I_{m1}回路上 ΣR）→互电阻（本网孔与其他网孔公共电阻）

省略.

公共支路 方向相同→正 方向相反→负.

3. 额定数值 或 内阻(不变).

4.



$U_{ab}=U_s+R\cdot i$.

$U_{ab}=-U_s+R\cdot i$

支路电流法

$(n-1)+[b-(n-1)]=b$个方程
结点 网孔.

支路电流法.

$G_{aa}U_{na}+G_{ab}U_{nb}=\underline{I_{saa}}$ 等效电流源.

↓恒正 自电导ΣG. ↓恒负 互电导 公共电导 → 流入→正 流出→负.

看到这样的结构先短路掉 对网孔 支路电流法也适用.

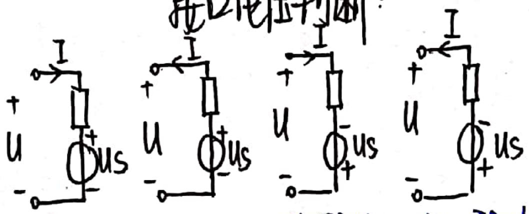
弥尔曼定理(仅有两个结点的电路).

$U_{na}=\dfrac{\Sigma I_s}{\Sigma G}$ 流入结点各等效电流、N支路电导之和(但  中R不用加).

5. 受控源.

controller source
__ C __ S
↑ ↑
V/C V/C.

接口电压判断：



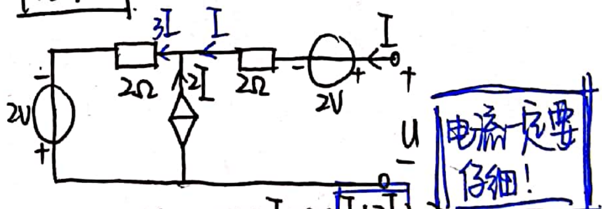
$U=\underline{IR}+U_s$ 符号由I方向定 $U=-IR+\underline{U_s}$ 符号由两边电压是否一致定. $U=IR-U_s$ $U=-IR-U_s$.

积分微分方程？
会考吗

6. 回路：$b-(n-1)=m$
- n 个结点 <node>
- b 条支路 <by-pass>
- m 个网孔 <mesh loop>

7. 电导 G.
- 串联 $G=\dfrac{G_1\cdot G_2}{G_1+G_2}$
- 并联. $G=G_1+G_2$.

仔细!



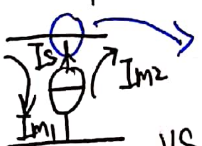
电流一定要仔细!

$R_{eq}=\dfrac{U}{I}=\dfrac{2+2I+2(\boxed{I+2I})-2}{I}=8\Omega$.

8. 叠加定理 只适用于线性电路.

9. 最大功率 $P=\dfrac{U_s^2}{4R_0}$

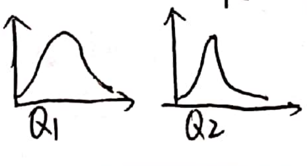
10. 计算电流从结点出发



$I_s+I_{m1}=I_{m2}$

VS 功率因数 $\cos\varphi=\dfrac{P}{S}$.

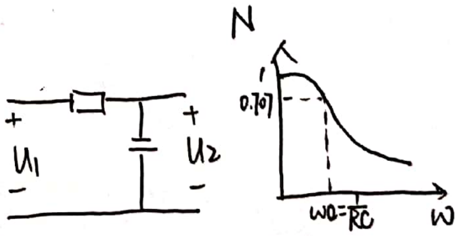
11. 品质因数 $Q=\dfrac{X_L}{R}=\dfrac{X_C}{R}$



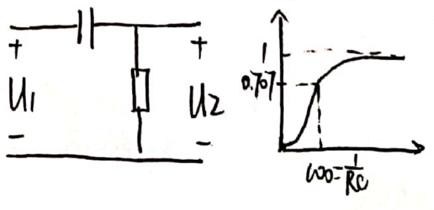
$Q_1<Q_2$
Q_2选择性强

滤波器

低通



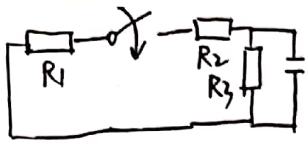
高通



11. $t=\tau$：U_C衰减到0.368 U_0所需时间

12. 微分电路 $t \gg \tau$
    积分电路 $t \ll \tau$

13. τ是从相关元件看进去的等效电阻.
    $t=0_+$时



$t=0_+$时
$$R_{eq}=\frac{(R_1+R_2)\cdot R_3}{(R_1+R_2)+R_3}$$

14. 峰峰值：两峰值之差 = 2×最大值.

15. $P=UI\cos\varphi$
    ↳有效值. $U=\frac{U_m}{\sqrt{2}}$.

16. $u_L = L\cdot\frac{di_L}{dt}$
    $i_C = C\cdot\frac{du_C}{dt}$.

17. 电容电感未储能：
    $u_C(0_+)=u_C(0_-)=0$ ⇒短
    $i_L(0_+)=i_L(0_-)=0$ ⇒断

18. 三要素法：$I(t)=I_{末}-\Delta I\cdot e^{-\frac{t}{\tau}}$ (负号别漏!)