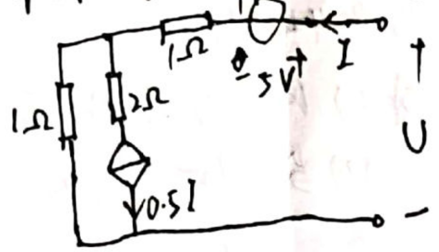
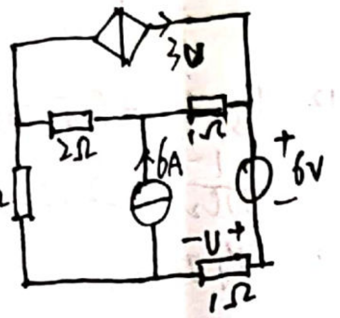
20~21

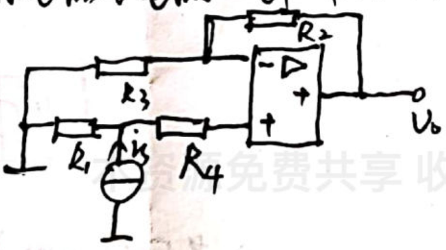
1. 求图示电路最简等效电路



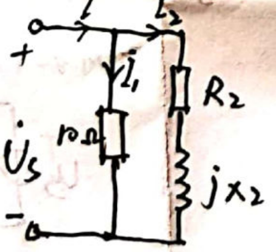
3. 求图示电路中受控源发出的功率



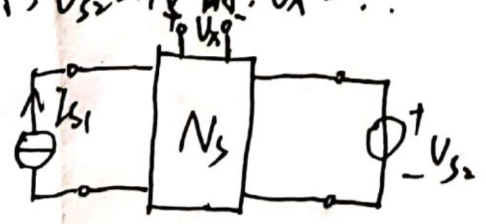
4. 图示电路为电流一电压转换器，求 U_0/i_s



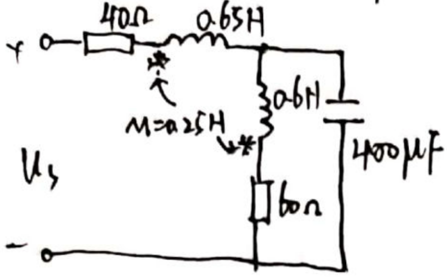
5. 已知 $I=\sqrt{3}A$, $I_1=I_2=1A$. 以 $\dot{U}_s$ 为参考相量画出图中标出的相量，求 R_2 及 X_2 的值



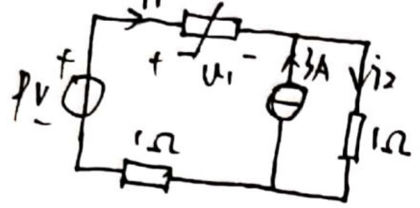
2. 图中 N_s 为有源线性三端口网络，已知 $I_{s1}=8A$, $U_{s2}=10V$ 时, $U_x=10V$; $I_{s1}=-8A$, $U_{s2}=-6V$, $U_x=-22V$; ~~I_{s1}~~ $I_{s1}=U_{s2}=0$ 时, $U_x=2V$; 求 $I_{s1}=2A$, $U_{s2}=4V$ 时, $U_x=?$



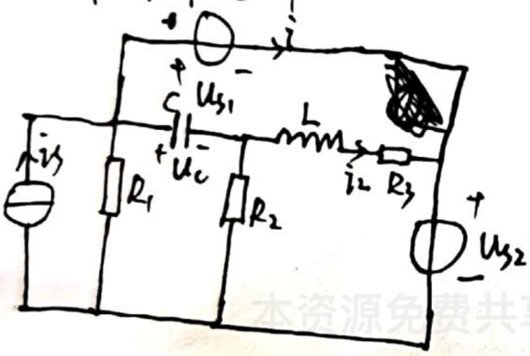
6. 图示正弦稳态电路，已知电源 $u_s=500\sqrt{2}\cos 100t$ V，求其发出的有功功率 P 和无功功率 Q。



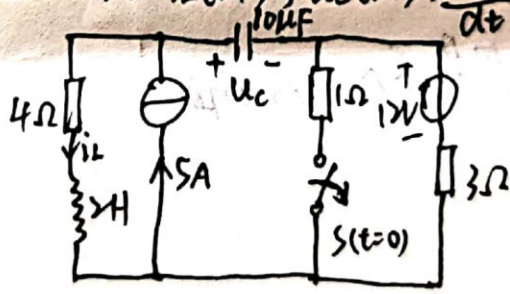
8. 非线性电阻伏安特性为 $u_1=i_1^2$，试求 (1) 静态工作点；(2) i_2。



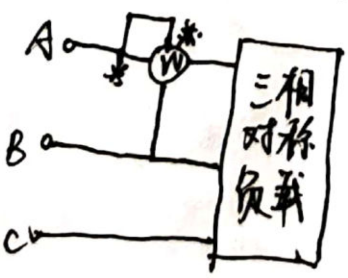
9. 写出标准状态方程



10. 开关S断开前电路已达稳态，试求：$i_L(0_+)$，$u_C(0_+)$，$\frac{di_L}{dt}\Big|_{0_+}$，$\frac{du_C}{dt}\Big|_{0_+}$。



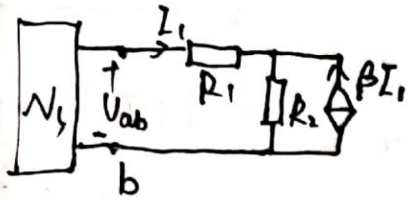
7. 图示对称三相电路中，已知线电压 $U_{AB}=380$V，功率表读数为 15.3W，负载功率因数为 0.6。求：(1) 线电流 I_A；(2) 负载吸收的总功率。



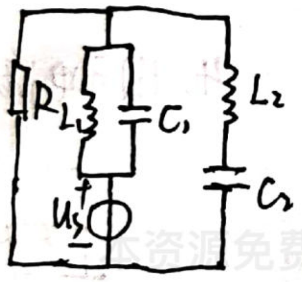
11. N_s为线性有源电阻网络，$R_1=R_2=10\Omega$，当$\beta=1$时，$U_{ab}=6V$；当$\beta=4$时，$U_{ab}=8V$。

求(1) 网络N_s的戴维南等效电路；

(2) 当$\beta=7$时，U_{ab}为多少？

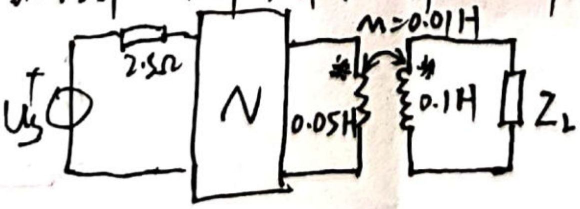


12. $u_s=(150+60\sqrt{2}\cos\omega t+30\sqrt{2}\cos 3\omega t)V$，$\omega L_1=\frac{1}{\omega C_1}=2\Omega$，$\omega L_2=3\Omega$，$\frac{1}{\omega C_2}=27\Omega$，$R=10\Omega$，求电容$C_2$两端电压有效值及电路消耗的平均功率。

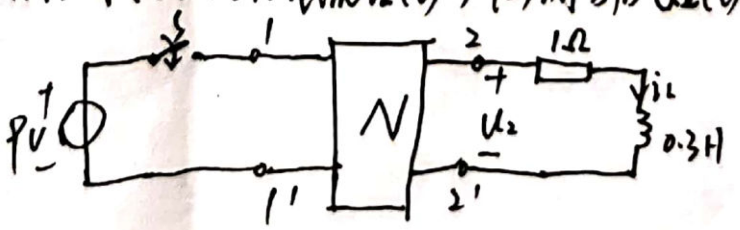


13. 若网络N的Y参数矩阵为$Y=\begin{bmatrix}0.6 & -0.4\\ -0.4 & 0.6\end{bmatrix}S$，电源电压$u_s=20\sqrt{2}\cos 10t\,V$。

求(1)负载$Z_L=0.5\Omega$时消耗的平均功率P；(2)若负载Z_L可变，则Z_L为何值时可获得最大功率，并求此最大功率P_{max}。

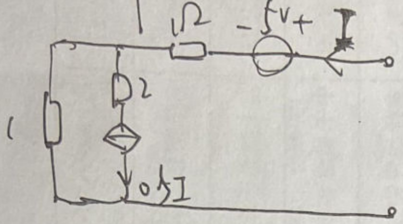


14. 如图所示无源线性二端口网络N的R参数矩阵为$\begin{bmatrix}4 & 2\\ 2 & 3\end{bmatrix}\Omega$，$t=0$时，开关S闭合，闭合前电流$i_L(0_-)=1A$，求(1)闭合后电流$i_L(t)$；(2)闭合后$u_2(t)$.

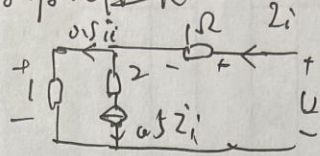


2021年电路Ⅲ（南航）

1：解析：最简等效⇒戴维南/诺顿等效



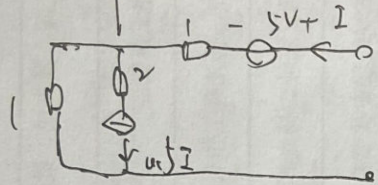
①除源电阻 R_i



$0.5i+i=U_i$

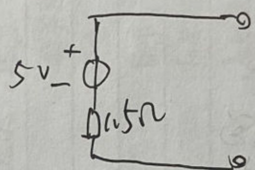
$\therefore \frac{U_i}{i}=R_i=1.5\Omega$

②开路电压 U_0



由开路知 I ⇒ 于是 $U_0=5V$

故最简 简化电路



2：原题见习题册 由题意不妨设

解：$U_x=k_1I_{s1}+k_2U_{s2}+k_3$

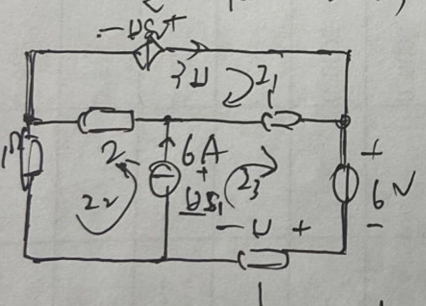
则 $\begin{cases}10=8k_1+10k_2+k_3\\-22=-8k_1-6k_2+k_3\\2=0k_1+0k_2+k_3\end{cases} \Rightarrow \begin{cases}k_1=6\\k_2=-4\\k_3=2\end{cases}$

$\therefore U_x=6I_{s1}-4U_{s2}+2$

代入 $I_{s1}=2A$；$U_{s2}=4V$

可得 $U_x=2\times6-4\times4+2=-2V$

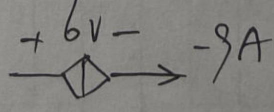
3：



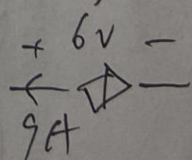
解：由题图设网孔电流 $I_1、I_2、I_3$

$\begin{cases}3U\times3+I_2\times2-I_3=U_{s2} & ①\\ I_2\times3+2I_1=U_{s1} & ②\\ I_1=3U & ③\\ I_3\times2-3U\times1=U_{s1}-6 & ④\\ I_3=U & ⑤\\ I_2+I_3=6 & ⑥\end{cases} \Rightarrow \begin{cases}I_1=-9A\\I_2=9A\\I_3=-3A\\U=-3V\\U_{s1}=9V\\U_{s2}=-6V\end{cases}$

由方程组解得 $\begin{cases}U_{s2}=-6V\\U=-3V\end{cases}$ 即

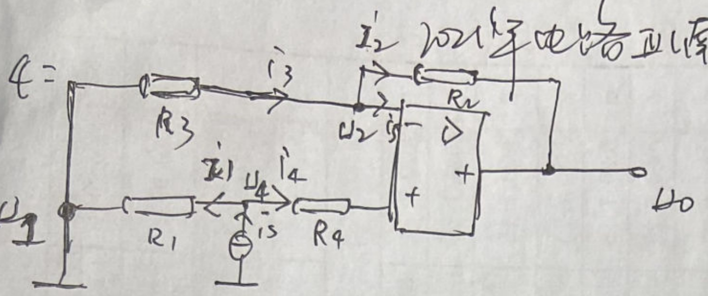


⇒



该受控源为受控电流源 向外发出功率 $P_{发}=6\times9=54W$

2021年电路Ⅱ(南航)



求 u_0/i_S

解析：考查基本运放的虚短虚断

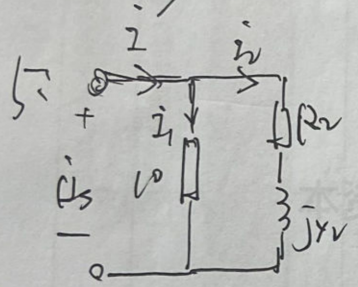
由虚短可得 $u_2=u_4$ ①；由虚断可得 $\begin{cases} i_5=0 \\ i_4=0 \end{cases}$；$\begin{cases} i_S=i_1 & ② \\ i_3=i_2 & ③ \end{cases}$

而 $u_1=u_4-i_1R_1$ ④　故而 $u_2=u_1+i_3R_3$ ⑤　$u_1=0$ ⑦

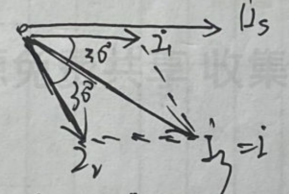
又有 $u_0-u_2=i_2R_2$ ⑥　联立①②③④⑤⑥可得

$$u_0/i_S=\frac{R_1(R_2+R_3)}{R_3}$$

5、



解析：由 $I_2、I_1、I_3$ 三者关系易得 $I_1、I_2$ 呈60°合成出 I_3



相量图为左图示

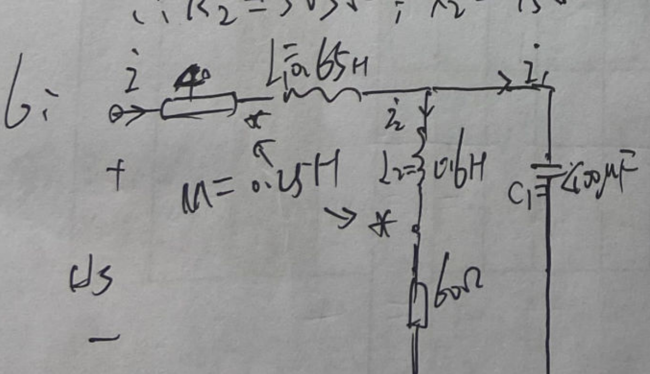
而根据图示得 $u_S=I_1\cdot 10$ 先不妨设 $I_1=\sqrt{3}\angle 0°$ A

则 $u_S=10\sqrt{3}\angle 0°$ V　且 $I_2=1\angle -60°$ A

又有 $u_S=I_2(R_2+jX_2)\Rightarrow R+jX_L=\frac{10\sqrt{3}\angle 0°\,V}{1\angle -60°\,A}=(5\sqrt{3}+15j)\Omega$

∴ $R_2=5\sqrt{3}\Omega$；$X_2=15\Omega$

6、



解：$jX_1=j\omega L_1=j65\Omega$；$jX_2=j\omega L_2=j60\Omega$

$jX_3=j\omega M=j25\Omega$；$\frac{1}{j\omega C_1}=-j25\Omega$

$$\begin{cases} 40I+(j65I-j25I_2)-j25I_1=u_S & ① \\ (j60I_2-j25I)+60I_2=-j25I_1 & ② \\ I_1+I_2=I & ③ \end{cases}\Rightarrow\begin{cases} I_1=\frac{25}{4}(1-j) \\ I=\frac{25}{4}(1-j) \\ I_2=0 \end{cases}$$

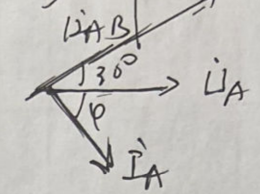
$u_S=500\angle 0°$ V　而 $I=\frac{25}{4}(1-j)$ A

∴ $P=500\times\frac{25}{4}=3125W$；$Q=500\times(-\frac{25}{4})=-3125\,Var$。　[跟答案就好]

2021年电路II（南航）

7：解析：考查线电压相电压线电流相电流以及功率表使用

(1) 由图易知 $P = U_{AB} \cdot I_A \cdot \cos$（线电压和相电流）



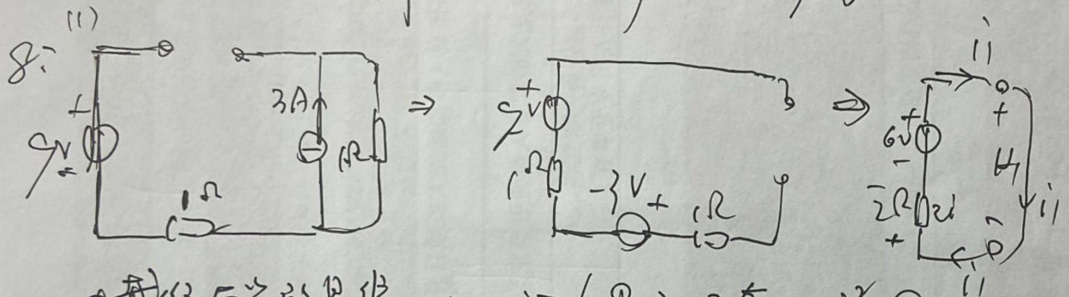
根据相量图 线电压与相电流 $= \varphi + 30^\circ$

∴ 代入求解 $I_A = \dfrac{P}{U_{AB}\cdot\cos(\varphi+30^\circ)} = \dfrac{275.3}{380\times\cos(53^\circ+30^\circ)} = 5.94\,A$

(2) 根据功率计算公式 $P = 3U_\varphi I_\varphi \cos\varphi = 3\times\dfrac{380}{\sqrt{3}}\times 5.94\times\cos 53^\circ$

∴ $P = \sqrt{3}\times 380\times 5.94\times 0.6 = 2346\,W$

8：(1)

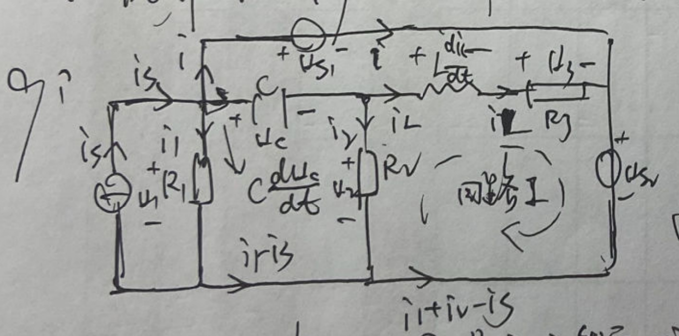


由戴维南定理易得 $u_1 + 2i_1 = 6$ ① 而又有 $u_1 = i_1^2$ ②

联立①②求得 $i_1^2 + 2i_1 - 6 = 0 \Rightarrow i_1 = (-1+\sqrt{7})A$（舍负值）

(2) 根据 $i_1 = -1+\sqrt{7}\,A$ 回到原图易得 $i_2 = 3 + i_1 = 3 - 1 + \sqrt{7} = 2+\sqrt{7}\,A$

9：



$i_1 + i + i_C = i_S$ 即 $i_1 + i + C\dfrac{du_C}{dt} = i_S$ ①

$i_C = i_2 + i_L$ 即 $C\dfrac{du_C}{dt} = i_2 + i_L$ ②

而 $u_L + u_3 + u_{S2} = u_2$ 即 $L\dfrac{di_L}{dt} + R_3 i_L + u_{S2} = i_2 R_2$ ③

$u_1 = u_C + u_2$ 即 $i_1 R_1 = u_C + i_2 R_2$ ④

$u_C + u_L + u_3 = u_{S1}$ 即 $u_{S1} = u_C + L\dfrac{di_L}{dt} + i_L R_3$ ⑤

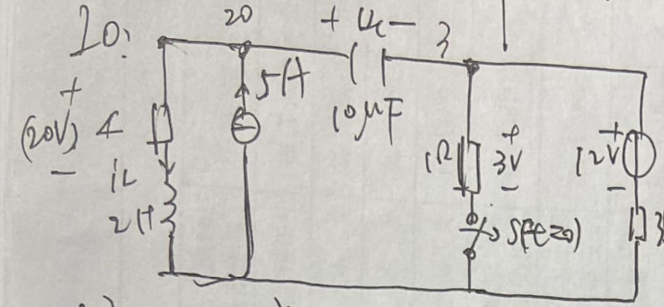
$i = i_L + i_1 + i_2 - i_S$ 即 $i = i_S - i_L - i_1 - i_2$ ⑥

联立①②③④⑤⑥（先由③得 i_2）然后代入④得 i_1 最后代入⑥得 i 再依次代入①②⑤

$$\begin{cases} C\dfrac{du_C}{dt} = \dfrac{u_{S1}}{R_2} - \dfrac{u_C}{R_2} + \dfrac{u_{S2}}{R_2} + i_L \\ L\dfrac{di_L}{dt} = -u_C + u_{S1} - i_L R_3 \end{cases} \Rightarrow ⑦ \begin{bmatrix} \dot{u}_C \\ \dot{i}_L \end{bmatrix} = \begin{bmatrix} -\frac{1}{R_2C} & \frac{1}{C} \\ -\frac{1}{L} & -\frac{R_3}{L} \end{bmatrix}\begin{bmatrix} u_C \\ i_L \end{bmatrix} + \begin{bmatrix} \frac{1}{R_2C} & \frac{1}{R_2C} \\ \frac{1}{L} & 0 \end{bmatrix}\begin{bmatrix} u_{S1} \\ u_{S2} \end{bmatrix}$$

2021年电路Ⅲ(南航)

10:



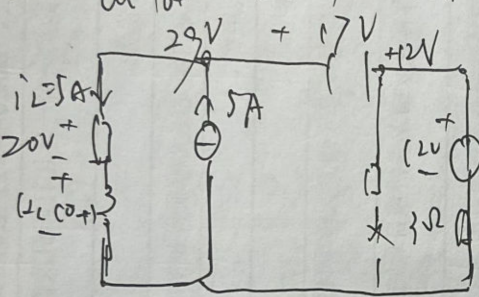
求: $i_L(0_+)$, $u_C(0_+)$

$\frac{di_L}{dt}\Big|_{0+}$　$\frac{du_C}{dt}\Big|_{0+}$

解析: 电感电流不会突变，电容电压也不会突变

$i_L(0+)=i_L(0-)=5A$ ∴ $u_C(0+)=u_C(0-)=17V$

而 $L\frac{di_L}{dt}\Big|_{0+}=u_L(0+)$ 则求 $u_L(0+)$ S断开之后有新节点电压



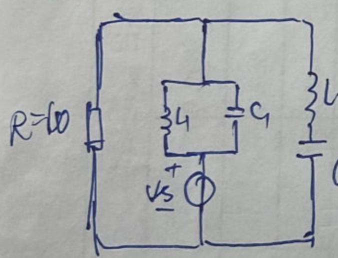
因此由左图可求解得

$u_L(0+)=29-20=9V$

而 $i_C(0+)=0$ 故 $\frac{du_C}{dt}\Big|_{0+}=\frac{i_C(0+)}{C}=0\ V/s$

而 $\frac{di_L}{dt}\Big|_{0+}=\frac{u_L(0+)}{L}=4.5A/s$

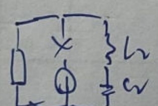
12:

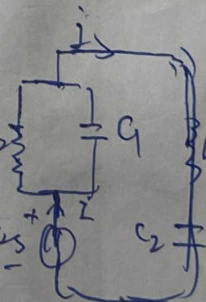


解: (1) ① 直流时: 存在容回路 则C_2端电压 $U_{C_2(直)}=U_R=150V$

② 当$u_s=60\sqrt{2}\cos\omega t$时: 有 $\frac{1}{\omega C_1}=\omega L_1$ 即C_1与L_1并联谐振

此时所有电压均加载在L_1与C_1并联回路上 因而相当于开路

即  故而C_2端电压 $U_{C_2(交1)}=0$



③ 当$u_s=30\sqrt{2}\cos3\omega t$时: 有 $3\omega L_2=\frac{1}{3\omega C_2}$ 即C_2与L_2串联谐振

此时 $Z=\frac{6j\times\frac{2}{3}(-j)}{j6-\frac{2}{3}j}=-j\frac{3}{4}\Omega \Rightarrow \dot I=\frac{\dot U_s}{Z}=\frac{30\angle0^\circ}{-j\frac{3}{4}}=40j$ 假设$\dot U_s=30\angle0^\circ$

则而 $\dot U_{C_2}=\dot I\cdot\frac{1}{j3\omega C_2}=40j\times\frac{9}{j}=360\angle0^\circ \Rightarrow U_{C_2(交2)}=360V$

故$U_{C_2}=390V$

因此综合①②③计算可得电容C_2两端电压有效值为 $U_{C_2}=\sqrt{U_{C_2(直)}^2+U_{C_2(交1)}^2+U_{C_2(交2)}^2}$

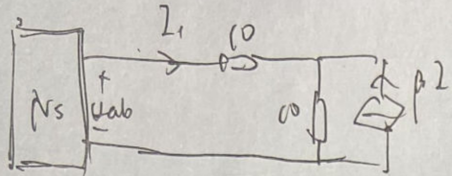
∴$U_{C_2}=390V$ (2) 电路消耗的平均功率 即为电压源发出的平均功率

① 直流时 $P_1=2250W$

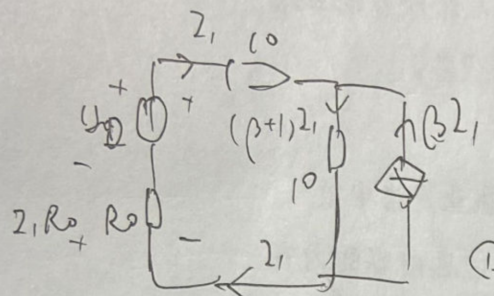
② 三次谐波时 $P_3=60\times40=\frac{2400W}{2}=1200W$

综上得 $P=P_1+P_3=2250W+1200W=3450W$

11;



(1)



有 $U_0 - R_0 I_1 = 10I_1 + 10(\beta+1)I_1$

$U_{ab} = 10I_1 + 10(\beta+1)I_1$

$U_{ab} = (10\beta+20)I_1$

① $\beta=1$时 有 $I_1 = \frac{U_{ab}}{10+20} = \frac{6}{30} = 0.2A$

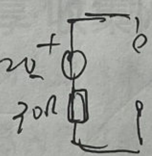
$\therefore 6 = U_0 - R_0\times 0.2$ ①

② $\beta=4$时 有 $I_1 = \frac{U_{ab}}{40+20} = \frac{8}{60} = \frac{2}{15}A \Rightarrow 8 = U_0 - \frac{2}{15}R_0$ ②

$\frac{2}{15}R_0 + 8 = 0.2R_0 + 6$

$2 = (0.2 - \frac{2}{15})R_0 = (\frac{2\times15}{150} - \frac{20}{150})R_0 = \frac{10}{150}R_0 \Rightarrow \begin{cases}U_0=12V\\R_0=30\Omega\end{cases}$

故等效戴维南电路为右图所示



(2) 当$\beta=7$时 有 $U_0 - R_0I_1 = (10\beta+20)I_1 = 90I_1$

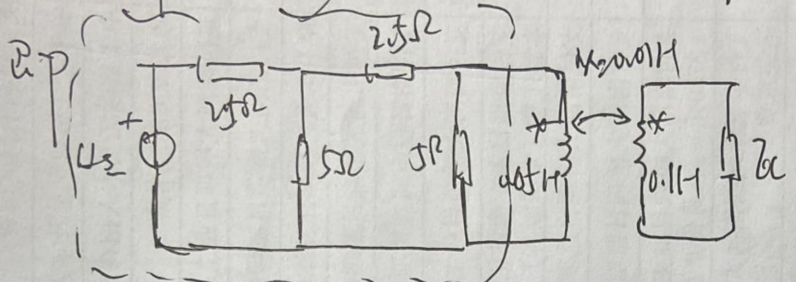
而 $\begin{cases}U_0=12\\R_0=30\end{cases}$ 代入得 $12 = 120I_1 \Rightarrow I_1 = 0.1A \Rightarrow U_0 - R_0I_1 = U_{ab} = 12-3 = 9V$

2021年电路II（南航）

17：(1) 根据G参 $\begin{bmatrix}0.6 & -0.4\\ -0.4 & 0.6\end{bmatrix} \Rightarrow \begin{bmatrix}G_a+G_b & -G_b\\ -G_b & G_b+G_c\end{bmatrix}$

因此转化为π形等效电路 对应的 $G_b=0.4S$ $G_a=G_c=0.2S$

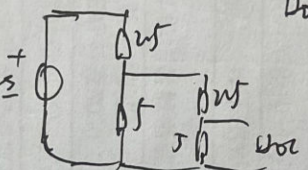
即



设 $\dot U_S=20\angle0^\circ$ V 此时 $\omega=10$

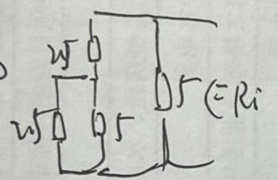
$\dot U_{oc}=\frac{\frac{(\dot U_S)\times5}{2.5+5}\times5}{2.5+5}$

将虚线框内电路等效可得



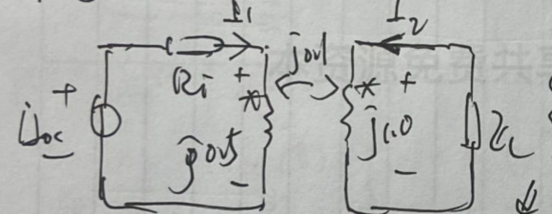
$\dot U_{oc}=\frac{4}{9}\times20\angle0^\circ$ V

再



$R_i=(2.5//5+2.5)//5=\frac{\left[\frac{2.5\times5}{2.5+5}+2.5\right]\times5}{5+\frac{2.5\times5}{2.5+5}+2.5}=\frac{25}{11}\Omega$

即等效为



$\dot U_{oc}=R_i\dot I_1+j\omega L_1\dot I_1+j\omega M\dot I_2$

$j\omega L_2\dot I_2+j\omega M\dot I_1=-\dot I_2Z_L$

$\Downarrow$

$\frac{\dot U_{oc}-j\omega M\dot I_2}{R_i+j\omega L_1}j\omega M+j\omega L_2\dot I_2=-\dot I_2Z_L$ 即 $\frac{\dot U_{oc}(j\omega M)}{R_i+j\omega L_1}=-\dot I_2\left(Z_L-\frac{j\omega M}{R_i+j\omega L_1}+j\omega L_2\right)$

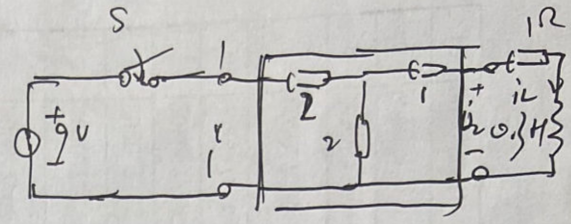
故最终等效 $\dot U_{oc}$为 $\dot U_{oc}'=\frac{\dot U_{oc}(j\omega M)}{R_i+j\omega L_1}$ 而 $Z_i'=j\omega L_2-\frac{j\omega M}{R_i+j\omega L_1}$

(2) 当Z_L与Z_i'共轭时 取得最大功率 P_{max} 计算方法 用U_{oc}实际有效值除以4倍R_i 即可得到最终结果 即 $P_{max}=\frac{U_{oc}^2}{4R_i}$

解：

2021年电路三（南航）

(4) 如图下所示的电路处于稳态电路为



S闭合前 $i_L(0^-)=1A$

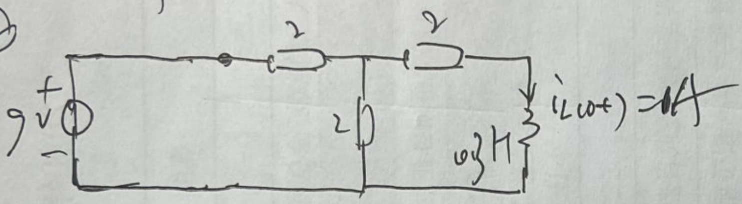
(1) 求S闭合时对应电流 $i_L(t)$

(2) 求S闭合后对应 $u_2(t)$

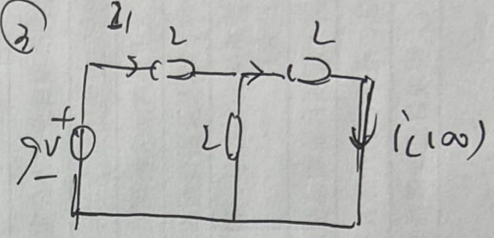
①

(1) 换路之前 $i_L(0_-)=1A$

②

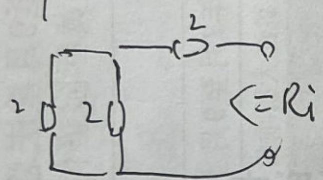


③



$i_1=\frac{9}{3}=3A \Rightarrow i_L(\infty)=1.5A$

④ 除源等效电阻



$\Rightarrow R_i=2+2//2=2+1=3\Omega \Rightarrow \tau=\frac{L}{R}=\frac{0.3}{3}=0.1S$

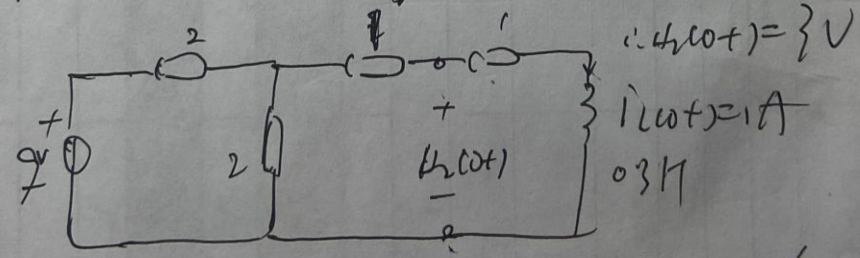
⑤ 对应地 $i_L(t)=i_L(\infty)+\{i_L(0+)-i_L(\infty)\}e^{-\frac{t}{0.1}}=1.5+(1-1.5)e^{-\frac{t}{0.1}}A$

$\therefore i_L(t)=(1.5-0.5e^{-10t})A$

(2) 现求 $u_2(t)$

① 换路之前 $i_L(0-)=1A \Rightarrow u_2(0-)=3V$

② 换路之后



③ 稳定之后 $u_2(\infty)=1.5V$ ④ 除源等效电阻 $\Rightarrow \tau=\frac{L}{R}=0.1S$

⑤ 对应地 $u_2(t)=u_2(\infty)+\{u_2(0+)-u_2(\infty)\}e^{-\frac{t}{\tau}}$.

$u_2(t)=1.5+(3-1.5)e^{-10t}=(1.5+1.5e^{-10t})V$