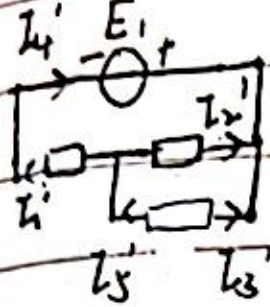
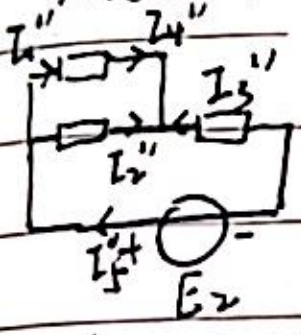
4.28. 只有E_1作用



$I_4' = I_1' = \frac{E_1}{R+R//R} = 1A$　　$I_2' = \frac{-1}{2}I_1' = -\frac{1}{2}A$

$I_5' = \frac{1}{2}A$　　$I_3' = -\frac{1}{2}A$

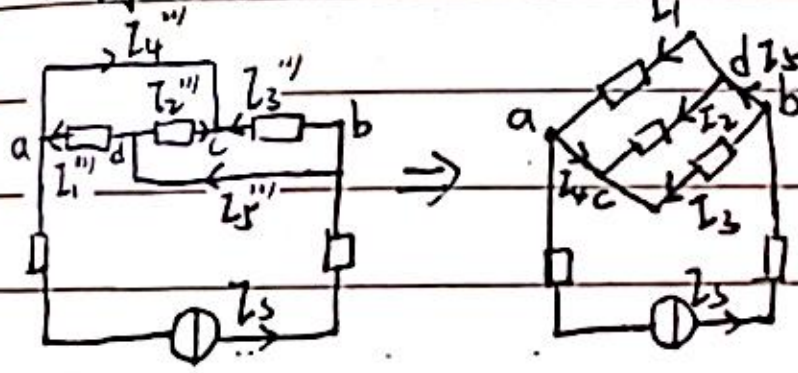
只有E_2作用



$I_5'' = \frac{E_2}{R+R//R} = 1A$　　$I_2'' = \frac{1}{2}A$

$I_1'' = I_4'' = \frac{1}{2}A$　　$I_3'' = -1A$

只有I_5作用



$\Rightarrow$

$I = I_5 = 1A$

$I_1''' = I_2''' = I_4''' = \frac{1}{3}A$

$I_3''' = \frac{2}{3}A$　　$I_4''' = -\frac{2}{3}A$

$I_1 = I_1' + I_1'' + I_1''' = \frac{11}{6}A$

$I_2 = \frac{1}{3}A$

$I_3 = -\frac{7}{6}A$

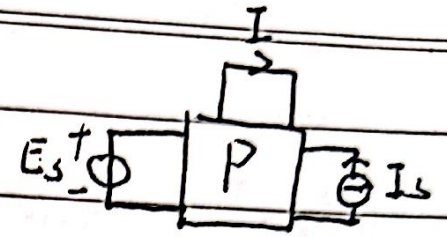
$I_4 = \frac{5}{6}A$

$I_5 = \frac{13}{6}A$

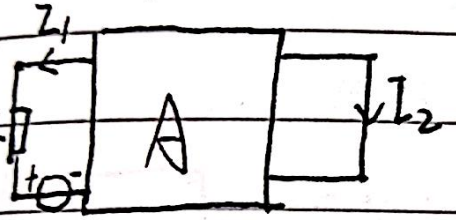
4.31. 设 $I = gE_S + \alpha I_S$

$2 = g\times 1 + 0 = 4$

$E_S = 3 \quad I = 4\times 3 + 0 = 12A$



4.32: 将R看作$R_0+\Delta R$. 将$\Delta R I_1$看作电流源U_S



$I_1 = g_1(\Delta R I_1) + I_{A1}$

$$\begin{cases} I_1 = 2 = g_1(0\times I_1) + I_{A1} \\ I_1 = 1.7 = g_1(10\times I_1) + I_{A1} \end{cases} \quad \begin{cases} g_1 = \frac{1}{30} \\ I_{A1} = 2 \end{cases}$$

当 $R=-10$, $I_1 = \frac{1}{3}I_1 + I_{A1} \quad I_1 = 3A$

此时将整个二支路看作电流源.

$$I_2 = \alpha I_1 + I_{A2}$$

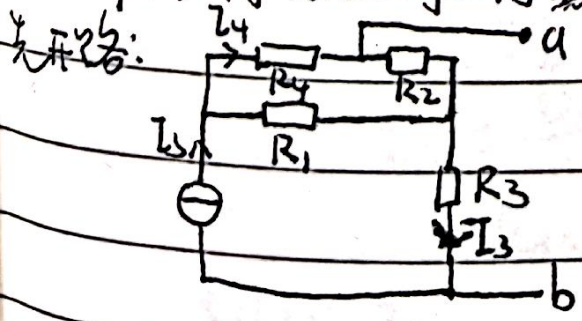
$$\begin{cases} I_2 = \frac{1}{3} = 2\alpha + I_{A2} \\ I_2 = 0.5 = 1.5\alpha + I_{A2} \end{cases} \quad \begin{cases} \alpha = -\frac{1}{3} \\ I_{A2} = 1 \end{cases}$$

代入 $I_1 = 3A$ 得 $I_2 = 0A$

$I_1 = 3A \quad I_2 = 0A$

4.34(1) 将R左侧进行戴维宁等效

先开路:



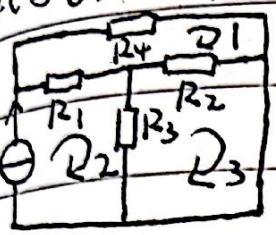
$I_3 = I_S = 1A$

$I_4 = I_S \times \frac{40}{24+40} = \frac{5}{8}A$

$U_{ab} = R_2 I_4 + R_3 I_3$

$= 8V$

网孔电流法：



用网孔电流

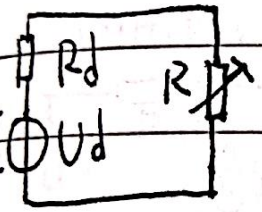
1: $I_{m1}(R_1+R_2+R_{24}) - I_{m2}R_1 - I_{m3}R_2 = 0$

2: $I_{m2} = I_S$

3: $I_{m3}(R_2+R_3) - I_{m1}R_2 - I_{m2}R_3 = 0$

$I_{m3} = 0.8A$ 即 $I_d = 0.8A$

$R_d = \frac{U_{ab}}{I_d} = 10\Omega$



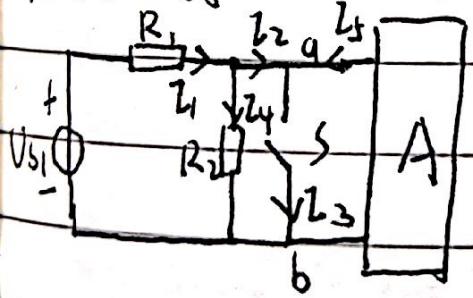
当 $R = R_d = 10\Omega$ 时

$P_{大} = (\frac{8}{20})^2 \times 10 = 1.6W$

(2) 当 $R = 0\Omega$, $I_{大} = \frac{8}{10} = 0.8A$

(3) 当 $R \to +\infty$ $U_{大} = U_d = 8V$

4.36, S打开时, $I_2 = 0$ 由KCL: $I_1 = I_4$



即 $I_1R_1 + I_4R_2 = U_{S1}$

$I_4 = \frac{5}{3}A$

$U_d = U_{ab} = I_4R_2 = \frac{20}{3}V$

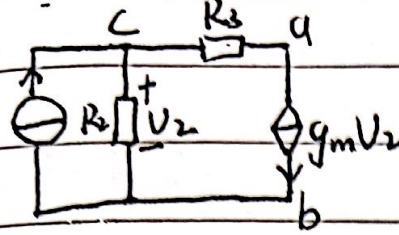
S闭合时: $I_3 = I_2' + I_5'$

$I_2' = \frac{U_{S1}}{R_1} = 5A$ $I_5' = 3A$

$\therefore R_d = \frac{U_d}{I_5'} = \frac{20}{9}\Omega$

即 $U_d = \frac{20}{3}V$ $R_d = \frac{20}{9}\Omega$

4.37. ab断开：



令b为参考点

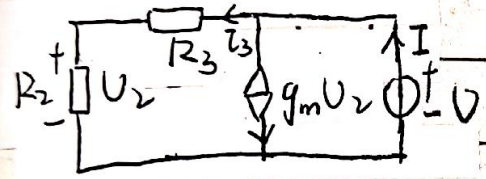
a: $U_a \cdot \frac{1}{R_3} - U_c \cdot \frac{1}{R_3} = -g_m U_2$

c: $U_c(\frac{1}{R_3}+\frac{1}{R_2}) - U_a \frac{1}{R_3} = I_{s1}$

$U_2 = U_c \quad U_c = -2V$

$U_a = -8V$ 即 $U_d = U_{ab} = -8V$

加压法：



$I_3 = \frac{U}{5} \quad U_2 = \frac{2}{5}U$

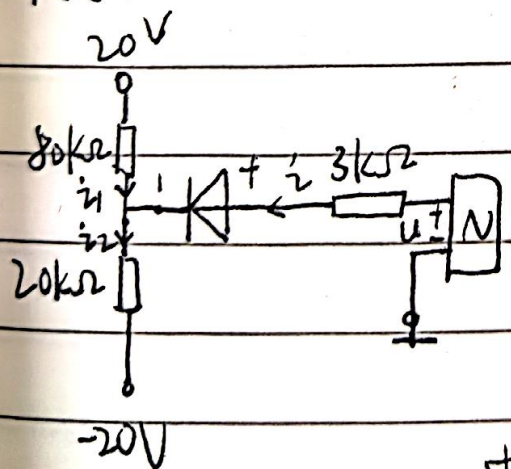
由KCL: $I = I_3 + g_m U_2$

$I = -\frac{U}{5}$

$R_d = \frac{U}{I} = -5\Omega$

即 $U_d = -8V \quad R_d = -5\Omega$

4.38.



假设二极管导通

由20V→-20V：

$80k i_1 + 20k i_2 = 40$

由20V→接地

$80k i_1 - 3k i + u = 20$

由伏安曲线：$u = 4 - 1k i$

代入解得 $i = 0.8mA$ 正向导通

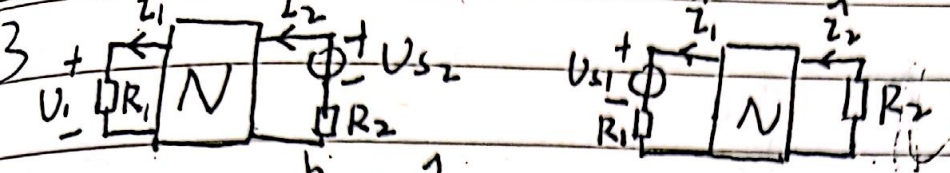
$u = 4 - 1k i = 3.2V$

由①节点KCL

$i_1 + i = i_2$

先将R_L断路，将电流源等效

4-43



由特勒根 $\sum_{k=1}^{b} \dot{U}_k \dot{I}_k = 0$

$$\dot{U}_1 \dot{I}_1 + \dot{U}_2 \dot{I}_2 + \sum_{k=3}^{b} \dot{U}_k \dot{I}_k = 0$$

$$\sum_{k=1}^{b} \dot{U}_k \dot{I}_k = 0$$

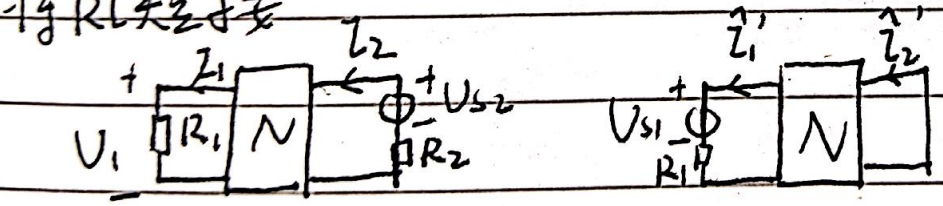
$$\dot{U}_1 \dot{I}_1 + \dot{U}_2 \dot{I}_2 + \sum_{k=3}^{b} \dot{U}_k \dot{I}_k = 0$$

$$\sum_{k=3}^{b} \dot{U}_k \dot{I}_k = \sum_{k=3}^{b} \dot{U}_k \dot{I}_k \qquad U_{S1} = R_1 I_{S1} \quad U_{S2} = R_2 I_{S2}$$

$$\text{即 } \dot{U}_1 \cdot \frac{\dot{U}_1 - U_{S1}}{R_1} + \dot{U}_2 \cdot \frac{\dot{U}_2}{R_2} = \dot{U}_1 \cdot \frac{\dot{U}_1}{R_1} + \dot{U}_2 \cdot \left(\frac{\dot{U}_2 - U_{S2}}{R_2}\right)$$

$$\dot{U}_1 - 1 + \dot{U}_2 = \dot{U}_1 - 2\dot{U}_2 \qquad \dot{U}_2 = \frac{1}{3}V$$

将R_L短接



同理有：$\dot{U}_1 \dot{I}_1' + \dot{U}_2 \dot{I}_2' = \dot{U}_1' I_1 + \dot{U}_2' I_2$

$$1 \times \dot{I}_1' + 2 \times \dot{I}_2' = (U_{S1} + \dot{I}_1' R_1) \cdot \frac{\dot{U}_1}{R_1}$$

$$2\dot{I}_2' = 1 \qquad \dot{I}_2' = \frac{1}{2}A$$

$R_d = \frac{\frac{1}{3}}{\frac{1}{2}} = \frac{2}{3}\Omega$

当$R_L = R_d = \frac{2}{3}\Omega$时

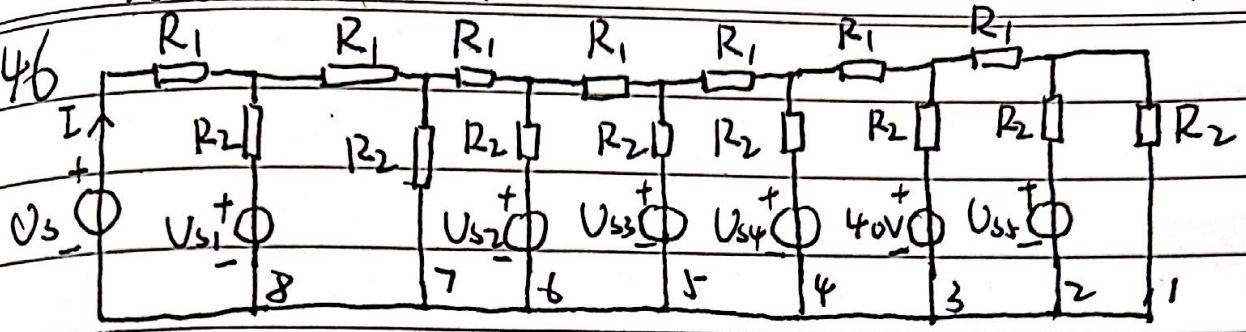
接入R_L后$\dot{U}_2$不变 $P = \frac{\dot{U}_2^2}{R_L} = \frac{1}{6}W$（消耗）

即$R_L = \frac{2}{3}\Omega$时

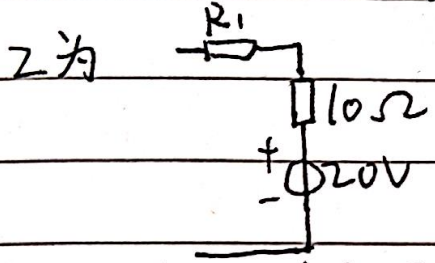
功率最大$\frac{1}{6}W$

4.46

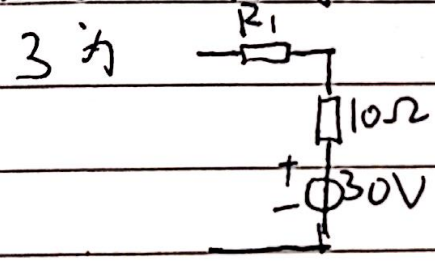
原电路先等效为：



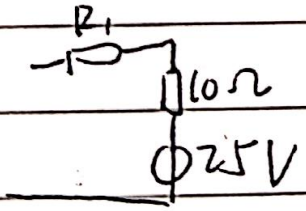
先将2改为电流源，与1等效后，再改为电压源。



后23改为电流源，等效再改回

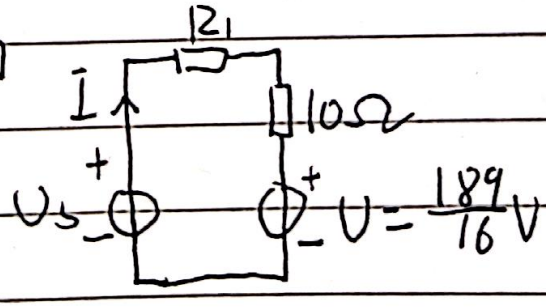


再等效34



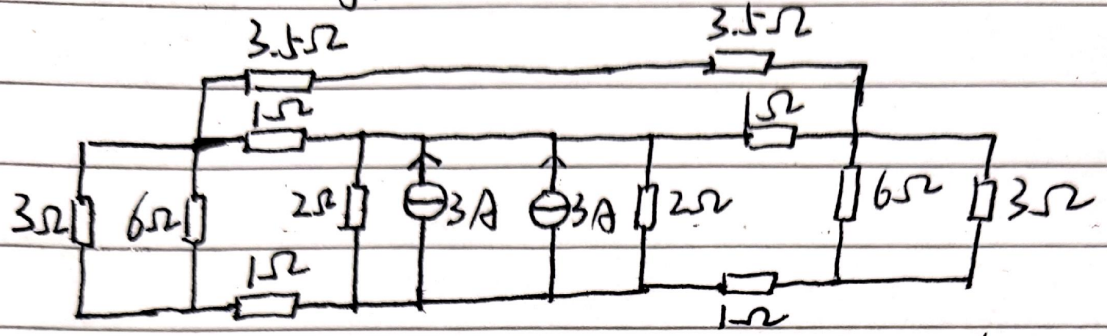
以此类推

一直等效到8

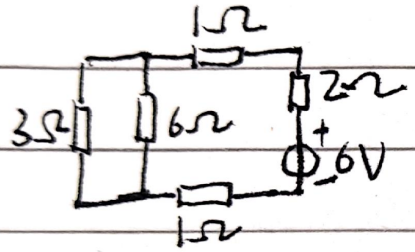


$$I=\frac{U_S-U}{R_1+10}=\frac{67}{320}A=0.21A$$

4.47. 万电路等效于



为各自独对称，平行线断路，将电流源改为电压源



$$I' = \frac{6V}{3//6+1+1+2} = 1A$$

$$I = 2I' = 2A$$

$P = I \cdot U = 12W$ (非关联正，产生)